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Study the Compatibility Effect of Some Mango Rootstocks on the Growth of Mango cv. Naomi

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Abstract: The study was carried out in the 2020 and 2021 seasons at the Tropical Fruit Department's greenhouse at the Horticulture Research Institute of the Agricultural Research Center in Giza, Egypt. The purpose of the study was to assess how various root stocks affected the scion growth of the mango cultivar "Naomi." Four different root stock types "Zebda", "Sukary," "13/1," and "Peach" grafted using the Cleft technique. Four grafting combinations (one scion × four rootstocks) with three duplicates of fifty mango pants each were used in the experiment, and they were arranged in a randomized complete block pattern. The percentage of graft success, total number of leaves per shoot, scion length (cm), scion thickness (cm), number of nodes, leaf width, leaf length, leaf area, number of roots, and thickening of roots were the characteristics that were measured. To investigated the anatomy of the observer the way in which rootstock influences scion growth. The findings showed that while scion thickness increased with "13/1" and "Peach" rootstock, "Sukkary" and "13/1" rootstocks were more satisfactory for increasing the number of leaves per shoot, scion length, number of nodes per scion, and number of roots. When using "Sukkary" and "Zebda" rootstock, there was more impact on leaf width, length, area, and thickening of the roots. When "Sukkary" and "13/1" rootstock were combined with Naomi scion, the formation of callus tissue was more enhanced and hopeful, reflecting the quick differentiation of cambia strips for generating a union zone between both rootstock and scion. High compatibility between the rootstock "13/1" and Naomi scion, with "Sukkary" exhibiting the most vigorous growth while "13/1" rootstock had a dwarfing impact on Naomi scion.

Key words: Mango, rootstocks, Naomi, grafting, growth.

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1. Introduction

One of the most popular tropical fruit trees worldwide is the mango (*Mangifera indica* L.). Due to its high nutritional value, economic appeal, and widespread cultivation, mangoes are among the most popular tropical and subtropical fruits in the world, ranking among the top five fruits in 2013 with a volume production of 43.3 x 106 tons **(FAO, 2013)**. Mango (*Mangifera indica* L.) is a member of the family Anacardiacae. The king of fruits is a dicotyledonous tree.

Mangos are grown in subtropical and tropical climates. Mangos are tolerant of a wide range of climates; nevertheless, frost is a limiting concern because it causes chilling harm to the plant. Rainfall during flowering is undesirable because it disrupts pollination and has an immediate impact on the setting of the fruit. Excessive temperatures during the post pollination phase prevent fruit set and have an impact on fertilization **(Erickson and Markhart 2002)**.

Mango vigor management is crucial, particularly for high density planting and orchard management including harvesting, canopy control, and plant protection techniques to guarantee high quality planting material, the best rootstock needs to be chosen **(Nor Hazlina *et al.*, 2008)**. The Significance of the Rootstock for mango rootstocks, the most crucial characteristics are vigor, high potential yield, compatibility with scion varieties, environmental adaptability, and disease and pest resistance **(Rossetto *et al.*, 1996)**.

Rootstock study and its association with selected scion cultivars is an essential, and possibly the most significant, area of research deficient on mangos, despite the noticeable impact on cultivars' development, production, resistance to salt, nutrient absorption, and fruit quality **(Galán Saúco, 2008)**. This information could help to explain why polyembryonic rootstocks, or cultivars of the Criollo type, which have been around for a while, are typically chosen for propagating mangoes in tropical climates because of their greater adaptability to the many environments in which they grow. Using the right rootstock for grafting could make harvesting and management easier **(Minja *et al.*, 2017)**.

Additionally, both in the field and in the nursery, rootstocks are crucial to the growth and development of grafted seedlings. As stated by **(Baita *et al.*, 2010)**, In order to grow a mango plant, the ideal rootstock has to have a greater number of roots, stem diameter, leaves, percentage of scion success, and overall crop vigour. Until further focused research is done on each area, these seedlings will remain the only alternative available to mango producers as a source of well chosen, uniform seedlings with a more consistent bearing state Grafting is limited to close species relationships Grafting's primary benefit is that it modifies a plant's traits, making it stronger than its parent plant. A significant part of improving inferior types is also played by grafting. It is a popular and favored means of propagation **(Bally, 2006)**. When it comes to grafting, compatibility is key. The development of a new shoot begins if the root stock and scion get along well. Desirable characteristics are the basis for selecting the rootstocks **(Simons, 1987)**. The graft success is estimated by the root stock and scion cambium tissues aligned properly **(Pina and Errea, 2005)**. Based on varietal potentiality, several mango cultivars are not compatible with each other Mango graft unions form in four stages the cambial bridge, the callus, the pre callus, and the healed union **(Soule, 1971)**.

Rapidly dividing callus cells from the scion and rootstock first create the graft union. These cells then differentiate to form the vascular cambium and related vascular system **(Moore, 1984)**. Additionally, biotic and abiotic stressors that rootstocks may encounter include soil infections, heat stress, salt, and nutritional stress **(Reddy et. al., 2003)**.

Mango trees growing on "131" rootstocks did well in sandy soil with 20 percent lime **(Gazit and Kadman, 1980)**. In order to find appropriate graft combinations for commercial nursery production aimed at the mango planting business, this experiment provides a solution. Commercial rootstocks and subsequent selection conducted in a commercial setting to identify potential new cultivar candidates.

A renewed interest in mangoes in other locations and the planting of thousands of Fadden of mangos in Delta lands are results of recent economic success (reclaimed desert land). About 40,000 tonnes are produced annually, of which 40% are exported, mostly to Europe. Compared to plants grown from seeds, mango plants are true to type, use less space, and start bearing fruit quicker. These days, utilizing epicotyl grafting to quickly multiply mangoes is a successful procedure.

2. Materials and Methods

The current study was carried out in the horticulture research institute's tropical fruit department greenhouse at the Agricultural Research Center in 2020 and 2021. The study's objective is to assess how various root stocks affect the scion growth of the mango cultivar "Naomi" Four different root stock types "Zebda", "Sukary" "13/1," and "Peach" all 18 months old were utilized. Seven days prior to splitting and grafting, scion branches underwent leaf defoliation. In this case, the cleft grafting method was employed, and the grafting was done 30 cm above the rootstock's soil surface Four grafting combinations (one segment × four rootstocks) with three duplicates of fifty mango pants each were used in the experiment, and they were arranged in a randomized full block pattern. The percentage of graft success, which was determined by the following equation, was the observation parameter.

$$\text{Graft percentage} = \frac{\text{Number of successful grafts}}{\text{Total number of grafts}} \times 100$$ **(Beshir *et al.*, 2019)**

Length (cm) and thickness (cm) of the scion; number, width, and length of the leaves; number and thickening of the roots; leaf area was calculated using the subsequent formula: LA=0.2454[(L*w)*n].Where W is for width, L for length, and N is for the number of leaves.

In order to support the morphological growth of the scion in each treatment, samples from the grafting zone were obtained at 10-day intervals to observe the development of the cambium between the stock and scion. The parameters were recorded 60 days after grafting for anatomical analysis.

3. Results and Discussion

Grafting success percentage: Compared to "Zebda" and "Peach" rootstocks, the percentage of successful grafts on "Sukkary" and "13/1" rootstocks was higher in the first and second seasons, 'Sukkary' rootstock yielded the best graft success values (94.0, 96.0 and 90.0, 92.0 percent), whereas Peach and "Zebda" rootstock produced the lowest values (84.0, 86 and 80.0, 82.0 percent) (Table 1).

Table (1): Shows the percentage of success in grafting the Naomi scion onto the four tested mango rootstocks, Sukkary, 13/1, Peach, and "Zebda"

Grafted	Grafting percentage
First season; 2000	
Naomi/Sukkary	94.00A
Naomi /13/1	90.00B
Naomi /peach	84.00C
Naomi /”“Zebda””	80.00D
Second season; 2001	
Naomi /Sukkary	96.00A
Naomi /13/1	92.00B
Naomi /peach	86.00C
Naomi /”“Zebda””	82.00D

Means followed by the same letters in the row is not differ significantly according to Duncan`s New Multiple Range t-Test at 5 % level.

The growth of the Naomi scion varied depending on the rootstock that was examined. The information presented in Table (2) demonstrated that, in comparison to Peach and Zebad, Sukkary and 13/1 rootstocks positively increased the growth parameters of number of leaves per scion, scion length (cm), and number of nods per scion (45.67, 62,67, and 2.0 cm) and (43.33, 59.33, and 1.67 cm). Scion thickness was much more adequate in both examined seasons when 13/1 and Peach rootstocks (0.967 and 0.833 cm) were employed.

Table 1 illustrates how rootstock affects root number and thickness as well as leaf growth (length, width, and area cm). With regard to this matter, the use of "Zebda" and Sukkary as rootstock in conjunction with Naomi cv. scion increased leaf length (28.0 and 26.67 cm), leaf width (6.33 and 6.0 cm), and leaf area cm2 (123.07 and 110.94 cm2). In addition, the number of roots was higher with Sukkary (58.33 and 59.67) and 13/1 (47.67 and 49.0) in comparison to "Zebda" (39.67 and 42.0) and Peach (44.67 and 45.67) root stocks in the first and second seasons, respectively. Table (3) makes this evident.

Table (2): Shows the morphological characteristics of the Naomi scion grafted onto the peach, "Zebda," Sukkary, and 13/1 mango rootstocks

Grafted	Total number of leaves on shoot	Scion length (cm)	Scion thickness (cm)	Number of nods
First season; 20				
Naomi/Sukkary	45.67A	62.67A	0.693B	2.00A
Naomi /13/1	43.33B	59.33B	0.967A	1.67B
Naomi /peach	24.00C	30.00C	0.833AB	1.00C
Naomi /Zebda	25.67C	34.00C	0.667B	0.33D
Second season; 20				
Naomi/Sukkary	47.00A	60.67A	1.033B	2.00A
Naomi /13/1	42.33B	60.00A	2.500A	1.33B
Naomi /peach	21.33D	26.67C	1.033B	0.67C
Naomi /Zebda	27.00C	36.33B	0.733C	0.67C

Means followed by the same letters in the row is not differ significantly according to Duncan`s New Multiple Range t-Test at 5 % level.

Table (3): Morphological characteristics of the Naomi scion grafted onto the four mango rootstocks (Sukkary, 13/1, peach, and Zebda) which have been tested

Grafted	Leaf length (cm)	Leaf width (cm)	Leaf area (cm2)	Root thickness (cm)	Root No.
First season; 20					
Naomi/Sukkary	26.67A	6.00A	110.94B	1.40A	58.33A
Naomi /13/1	17.67C	5.33B	65.44D	1.10B	47.67B
Naomi /peach	19.67B	5.33B	72.67C	1.03B	44.67C
Naomi /Zebda	28.00A	6.33A	123.07A	1.32AB	39.67D
Second season; 20					
Naomi/Sukkary	28.00A	6.00A	116.31B	1.51A	59.67A
Naomi /13/1	17.33C	5.50B	64.27D	1.15BC	49.00B
Naomi /peach	19.00B	5.33B	72.79C	1.08C	45.67C
Naomi /Zebda	28.67A	6.17A	122.84A	1.34AB	42.00D

Means followed by the same letters in the row is not differ significantly according to Duncan`s New Multiple Range t-Test at 5 % level.

4. Discussion

These findings were consistent with those of **(Gurudutta *et al.*, 2004 and Patel *et al.*, 2016)**, who found that different rootstock kinds had a significant impact on the scion's growth parameters. According to **Zayan *et al.* (2011)**, there is a correlation between the morphology of the rootstock and the variation in scion growth parameters. Specifically, a larger root system in a rootstock influences scion growth and facilitates the uptake of sufficient nutrients. The efficiency of nutrient uptake capacity can also be linked to scion vigor.

Conversely, **Minja *et al.* (2017)** found that the rootstock and scion type had a significant impact on the grafted mango's performance. They also noted that the variation in leaf count across the scions indicated the influence of genotype on this trait.

(Zayan *et al.*, 2020) indicated that Sukkary rootstock has a superiority influence on vegetative growth parameters grafted by Naomi variety, based on vigor and dwarfing rootstocks Conversely, when grafted by Naomi, hybrid 13/1 rootstocks displayed a dwarfing effect; these findings were also supported by **(Durán-Zuazo, 2004), (Kassem, 2008, Bhuiyan *et al.*, 2010 and Gawankar *et al.*, 2010)**. However, in relation to dwarf rootstock and its characteristics that took into account global rootstocks and offered hope for this search **(Zayan *et al.*, 2020)** verified that a system with a high plant density might use hybrid 13/1 rootstock as a dwarfing rootstock.

We can use hybrid 13/1 rootstock for the Naomi mango variety under environmental stress conditions, particularly salt and drought, as it has a stronger potential to reduce Na accumulation in their leaves. Therefore, the Naomi mango variety is anticipated to have a salt and drought-tolerant rootstock.

Anatomical structure

Four rootstocks were grafted with the Naomi scion: Zebda, Sukkaary, 13/1, and "Beach" in order to examine the histological evaluation of the development of the graft union Figs. (1 to 4) clearly show that all grafting attempts were successful for all rootstocks and Naomi, a scion with varying degrees of callus formation. Additionally, the logic behind the confirmation of graft union compatibility through histological tests is evident.

As seen in Fig. (1), callus tissues were first formed as a bridge to span the union zone between the Naomi scion and the "Zebda" rootstock. This union zone was created by the creation of the xylem ray parenchyma in the rootstock of both scions cells called parenchyma that grow out of and surround injured plant tissues. It emerges from the live cells of the scion and rootstock at the intersection of a graft union. One of the crucial processes in the creation of a callus bridge between the scion and rootstock in a successful graft is the production and interlocking of these parenchyma (or callus) cells.

The mass of parenchyma cells that forms surrounding injured plant tissues is known as callus tissue. It emerges from the live cells of the scion and rootstock at the intersection of a graft union. One of the crucial processes in the creation of a callus bridge between the scion and rootstock in a successful graft is the production and interlocking of these parenchyma (or callus) cells. In a compatible graft, the necrotic layer dissolves after the wound response, maybe as a precondition for the development of subsequent plasmodesmata between the graft partners' cells **(Tiedemann, 1989)**.

The xylem and phloem responsible for wound repair are the first vascular tissues to form in the callus bridge. Instead of the rootstock's activities, the scion tissues are the source of the new wound-repair xylem tissue **(Sax and Dickson 1956, Yeager, 1944)**. Furthermore, rather than the existence of the rootstock, the presence of leaves and branches on the scion has a significant impact on the amount of first graft bridging xylem **(Stoddard and Mc Cully 1980)**.

The scion buds have the ability to successfully induce vascular components in the tissues they are transplanted onto to differentiate. The influence of buds has been demonstrated through the insertion of a scion bud into a Cichorium rootstock root piece. The bud's auxin causes the ancient parenchyma cells to develop into clusters of conducting xylem components **(Graham and Bornmann 1966)**. According to xylem rays were more active in generating callus cells and differentiating cells that corresponded to the growth of most morphological characteristics of the scion, as demonstrated in Table (2), during the grafting between Sukkary and Naomi, as illustrated in Fig (1-2) .however, the graft between the 13/1 rootstock and the Naomi scion was promising, as seen in Fig. (3), where the scion's promise vascular connection with the rootstock was influenced by the scion's callus production in the xylem ray area, which enhanced the union of cambia and the production of continuous xylem and phloem network and shared new vessels initiated inside the scion's callus, improving the morphological characteristics as indicated in Table (1-2). Additionally, the scion will be promising with a feature that is very important as a character of economy Lastly, grafting using Naomi as the scion and Peach as the rootstock, as illustrated in Fig. (4), demonstrated a promise union where it formed callus to fill the spaces between the scion and the rootstock, where promise callus bridge formation to form cambial, which in turn led to the formation of vascular bundles.

According to the aforementioned statistics, callus tissue production was more enhanced and showed promise when Sukkary and 13/1 rootstock were combined with Naomi scion witch reflect quickly differentiate between cambia strips for creating a union zone between the scion and the rootstock It was determined that the xylum and phloem tissue rays were what made the grafting process successful. Conversely, the "Zebda" and Peach rootstocks with Naomi scion exhibited greater contact, resulting in the formation of callus tissues that filled in the gaps between the rootstock and scion, creating a bridge and tightening the cambium to generate vascular bundles.

These findings were concurred with by **Omima *et al.* (2012)**, who noted that regular condense homogeneity callus that bridges the Rootstock and scion (Alphonso/Zebda) It might be a juvenile stage of ground rootstocks' effect on the vessels differentiation by reduction since a good connection by callus bridge was cleared without the creation of new vessels. Conversely, the developed callus filled in the voids and voids in the graft union area between the two graft patterns, resulting in a strong bond and allowing water and nutrients to flow through the callus area to the upper scion Kett, keeping it nourished and alive. The parenchymatic cells of the xylem ray of the scion and rootstock are the source of the callus tissues, which fill the spaces between the scion and rootstock until the formation of the vascular link. These new arteries have meristematic cell origins secondary tissues that have connected the vascular tissues of the rootstocks and scion have been produced as a result of the callus.

Moore (1984) also discovered that the graft union is first created by quickly dividing callus, which subsequently differentiates to form the vascular cambium and related vascular system.

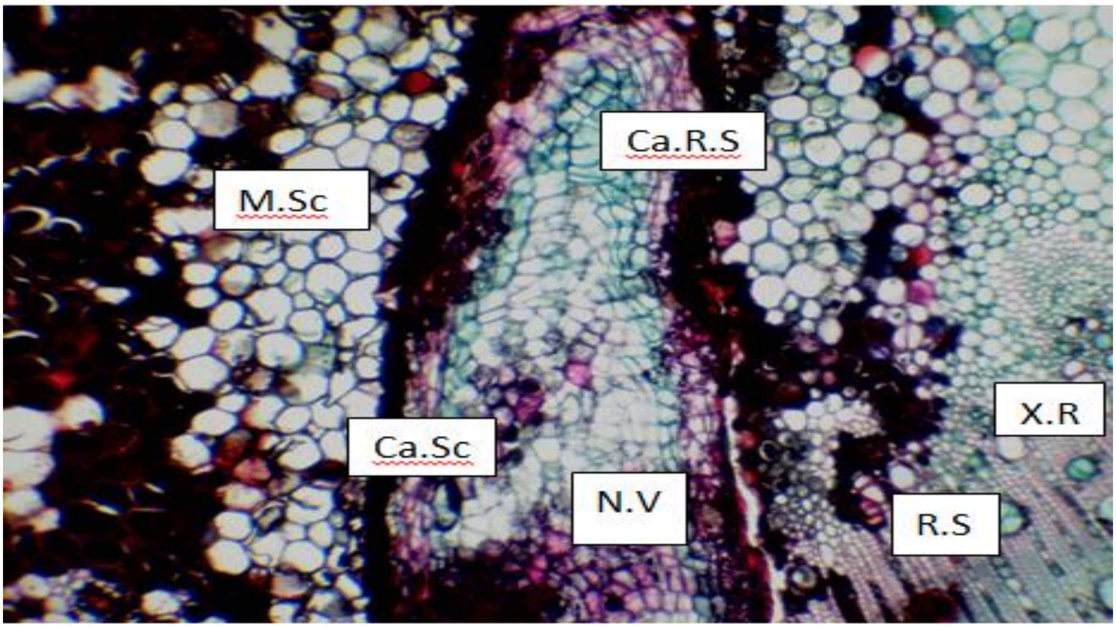

Figure (1). A light micrograph of a cross-ection in the union zone of the mango cv. Noami scion top-cleft grafted onto the "Zebda" rootstock demonstrates two types of callus: new vessels initiated in various callus positions, and callus originating from xylem rays cells of both the scion and rootstock and distinguished by a thin necrotic layer.

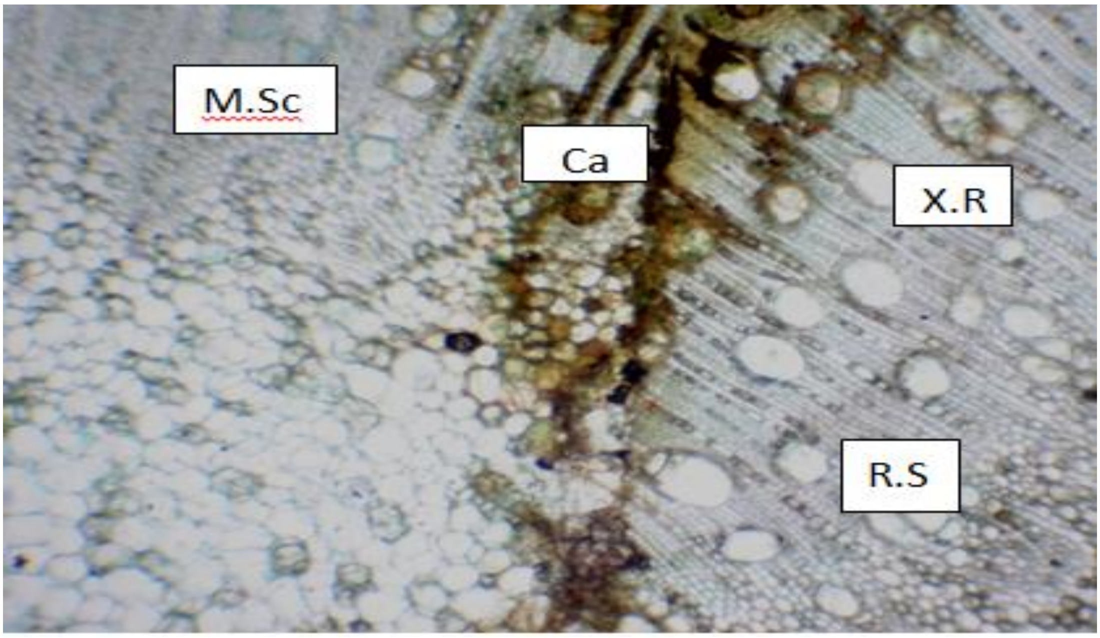

Figure (2). A light micrograph of the union zone cross-section of the mango cv. Noami scion top-cleft grafted onto Sukkary rootstock reveals two types of callus: new vessels initiated in many callus positions (X 250) and callus originated from xylem rays cells of both the scion and rootstock and distinguished by a thin necrotic layer.

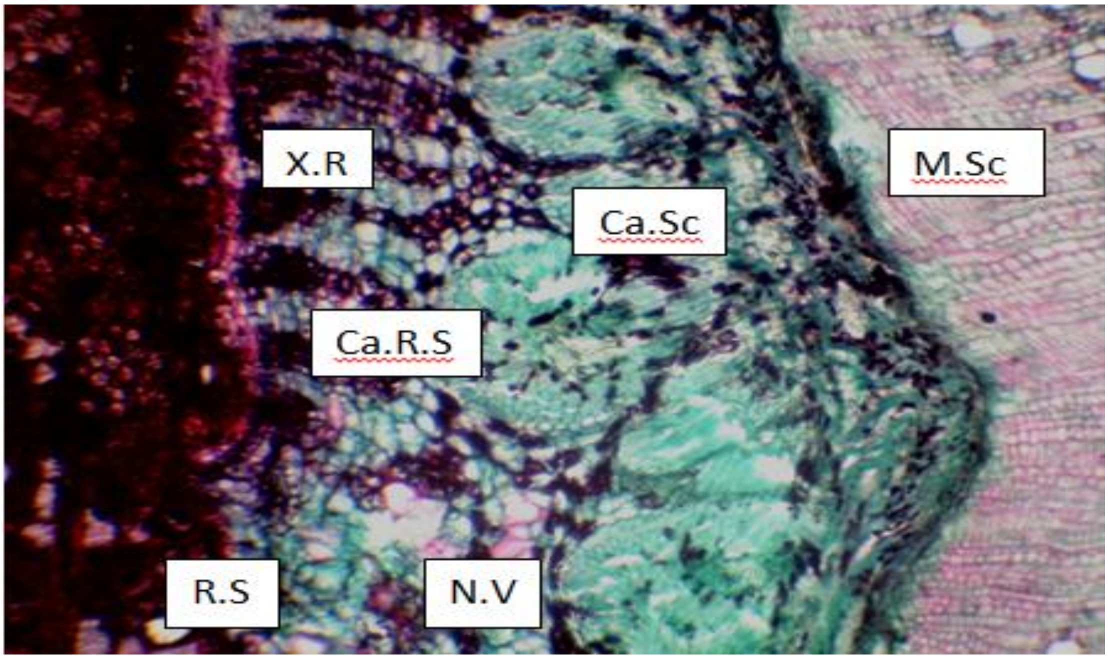

Figure (3). A light micrograph of the union zone cross-section of the mango cv. Noami scion top-cleft grafted onto 13/1 rootstock reveals two types of callus: new vessels initiated in many callus positions (X 250) and callus originated from xylem rays cells of both the scion and rootstock and distinguished by a thin necrotic layer.

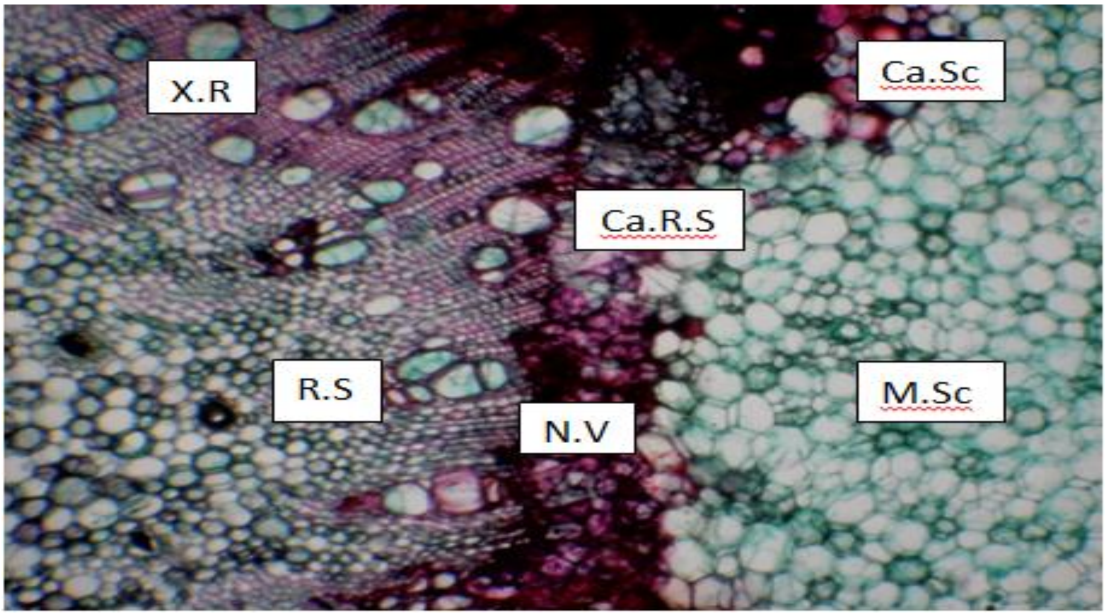

Figure (4). A light micrograph of a cross-section in the union zone of a mango cv. Noami scion top-cleft grafted onto a peach rootstock reveals two types of callus: new vessels initiated in many callus positions (X 250) and callus originated from xylem rays cells of both the scion and rootstock and distinguished by a thin necrotic layer.

Table 4: Abbreviations list.

M.Sc	Middle scion
Ca	Callus
X.R	Xylem Rays
R.S.	Rootstock
Ca.Sc	Callus of the scion
Ca.R.S	Callus of the rootstock
N.V	New vessels

Different levels of rootstock/scion compatibility may account for the variation in graft success, which may have consequences for wound healing **(Ajal and Kizito, 2012; Minja *et al.*, 2017)**.

Failure of the translocation of water, carbohydrates, sugars, and minerals across the graft union may potentially result in an unsuccessful graft take **(Minja *et al.*, 2017)**.

Interaction between rootstocks and scion: four months after grafting, mango trees require more than just height.

Because "Sukkary" rootstock expresses a greater growth rate than "Zebda," "13/1," and "peach" rootstocks, "Naomi" scion grafted on it generally measured much taller than those grafted on other rootstocks.

The number, width, and length of leaves showed a substantial interaction between the rootstocks and the "Naomi" scion.

The most leaves were generated by the "Naomi" scion grafted on the "Sukkary" rootstock, followed by the Naomi scion planted on the "Zebda" rootstock.

On the other hand, the lowest number of leaves were produced in both seasons when Naomi scion grafted on the rootstocks 13/1 and peach, respectively. The findings show that all examined rootstocks and Naomi scions have a high degree of compatibility, suggesting that these rootstocks can be successfully utilized to graft Naomi scions.

There have also been reports of variations in graft success between various rootstocks and Naomi scion, which have been linked to genotypic variations.

Therefore, these types' environmental adaptation may be the reason for their superior performance.

Variations in rootstock-scion compatibility may have an impact on wound healing and account for the variation in graft success **(Ajal *et al.*, 2012)**.

Failure of the translocation of water, carbohydrates, sugars, and minerals across the graft union can potentially result in an unsuccessful graft take **(Hariyadi *et al.*, 2014)**. Numerous theories have been put forth, but the mechanisms by which rootstock controls vigor are not entirely known.

Water supply limits, hormone production and translocation, partial compatibility between scions and rootstocks, hydraulic conductivity, and anatomical features of the vascular system are some of the possible causes of dwarfing **(Webster, 2004; Atkinson *et al.*, 2003; Jackson, 1993)**.

Since the morphology of roots and early shoots reflects the genotype vigour differential in rootstocks, it might be able to screen for size regulating rootstock by quickly examining the morphology of roots or shoots **(Tombesi *et al.*, 2011)**. Mango rootstocks in the nursery stage can be categorized using the percentage of bark and the number of xylem. Other useful indicators of dwarfism include the number, size, and proportion of tiny vessels **(Majumdar *et al.*, 1972, Tombesi, *et al.*, 2011 and Hegazi, *et al.*, 2013).**

The potential for water and soluble transport via the stem of the plant is determined by the xylem's area, which directly affects the vigor and growth of the plant.

As to **Majumdar *et al.* (1972)**, a high proportion of xylem is a defining characteristic of a robust mango seedling.

Additionally, **(Tombesi *et al.*, 2011)** reported that the genotype of a chosen rootstock's ability to modulate vigour could be predicted through anatomical examination of the xylem. **Goncalves *et al.* (2007)** found that trees grafted on dwarfing rootstocks had a smaller xylem conduit than trees on vigour rootstocks.

The dwarf Fly Dragon had the highest vessel frequency (140.6 vessel/mm), while the vigorous Rough Lemon rootstock had the lowest vessel frequency (48.7 vessel/mm). Moreover, there was a negative correlation between plant height and the number of vessel elements in the xylem of the stem **(Saeed *et al.*, 2010). (Raimondo *et al.*, 2009)**. In the dwarf olive, there were more conduits.

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