

ACOMPARATIVE STUDY ON POLYEMBRYONIC ROOTSTOCKS GRAFTING THREE MANGO CULTIVARS

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ABSTRACT

Four experiments were carried out during 2000/2001 and 2001/2002 seasons to study the suitable horticultural procedures for three local polyembryony mango cultivars (Hindy Sinnara, White Sukkary and Zebda) were tested for compatible grafts with scions of Fagri Kalan, Ewais and Alphonso mango cultivars. The results revealed that earlier elimination of sex embryos just after germination enhanced production of nucellar seedlings. Husked seeds gave the highest number of germinated embryos per seed and fast germination followed by cracked seed coat treatment. Also, Zebda seeds had the highest number of vegetative embryos and more vigorous seedlings followed by White Sukkary then Hindy Sinnara. White Sukkary and Zebda seedlings were more tolerant to frequency of irrigation intervals than Hindy Sinnara seedlings. With regard to the percentage of graft success and scion growth criteria, it is better to graft Ewais and Fagri Kalan on Zebda seedlings, while Alphonso scion on White Sukkary is recommended. Histological study at the graft union zone of incompatible grafts (Ewais on Hindy Sinnara and Alphonso on Zebda) revealed presence of necrotic layer on both sides of union zone, scattered callus and numerous free of callus positions that lead to weak or fail connection between two graft partners. Meanwhile, light microscopic examination at the grafting zone of analogous compatible grafts Ewais and Alphonso on White Sukkary revealed a condensed and uniformly callus tissue, smallest necrotic spots and initiation of new vascular elements, hence scion continued survival and had good growth.

INTRODUCTION

Rootstock improvement is of major significance in many tree crops, yet it is an area that has received limited exploration in mango. The general absence of major root disease or nematode problems in mango cultivation may partly this situation (Cull, 1991). With regard to the improvement of mango rootstocks, the main desirable features are tolerance to adverse soil condition, good scio compatibility, benefits in fruit quality (Avilan *et al.*, 1997) and resistance to a soil-borne pathogen (Rossetto *et al.*, 1997)

In Egypt, mostly seedlings of whatever type is available and used as rootstock. However, White Sukkary, Hindy Sinnara and Zebda became wide spread as trusty rootstocks, polyembryonic, drought tolerant and harmonize with the most cultivars in some governorates without any detected scientific study. Polyembryonic mango seeds produced nucellar embryos ranged from 2 to 10, seedlings from 1 to 7 and germination from 40.6 to 87.5% under field conditions, and it is suggested that they can be used as rootstocks. (Singh *et al.*, 1983). Considering the selected scions, Alphonso, Ewais and Fagri Kalan trees have wide spread in Egypt because of their highly economic and favourite taste and finally Fagri Kalan trees have an excellent storage ability, good taste, high income and very late mature cultivar and hence it is suitable for exporting.

The graft union is initially formed by rapidly dividing callus cells, originating from the scion and rootstock, which later differentiate to form the vascular cambium and the associated vascular system. The development of a compatible graft is typically comprised of three major events: adhesion of the rootstock and scion, proliferation of callus cells at the graft interface or callus bridge; and vascular differentiation across the graft interface. (Moore, 1984). The cells of callus from a compatible graft show an orderly disposition and are uniformly stained while the cells of callus from incompatible graft show an irregular disposition and the cell walls are thick and irregular (Errea, 1994). The newly formed cambial layer in the callus bridge begins typical cambial activity, laying down new secondary xylem toward the inside and phloem toward the outside thus permits the vascular connection between the scion and the rootstock. This process be completed before much new leaf development arises from buds on the scion (Proebsting, 1928). Soule, 1971 described four stages in formation of mango bud union as follows: pre-callus, where 4 days after budding only a wound periderm was present; callus, where 8 days after budding proliferation from tissues mainly near the cambium resulted in firm attachment of the components; cambial bridge, where 12 days after budding cambial layers from stock and scion formed a bridge and vascular tissues were differentiated within 36-48 days; and the healed union, where after 6-8 months several cylinders of new tissues were present and the lateral shift of the scion to align with the stock had begun. The percentage of the seedlings, which are true to type of the mother tree, were 90 and 91% for Hindy Be-Sinnara and Zebda cultivar respectively. (El-Tomy, 1995).

This study was undertaken to test the three polyembryonic mango cultivars to be recommended as rootstocks for three commercial mango cultivars in Egypt. Also seedlings of rootstocks were tested for their sensitivity to frequency of irrigation intervals. The compatibility between the rootstocks and the selected scion cultivars was evaluated and histologically examined.

MATERIALS AND METHODS

This investigation was carried out in three successive seasons (2000, 2001 and 2002) in the glasshouse of the Pomology Department, Faculty of Agriculture, Cairo University at Giza. Mango cultivars Zebda, Hindy Sinnara and White Sukkary were used as rootstocks, while Alphonso, Ewais and Fagri Kalan cultivars were used as selected scions. The trial are made as follows:

I- Rootstock production:

At the two seasons 2000 and 2001, seeds of Hindy Sinnara, Zebda and White Sukkary cultivars, were fresh collected, selected to be free of diseases and heavy weight. Seeds of each rootstock were divided into 3 classes as follows: seed coat removal, cracked seed and normal seed (control); two seeds of each class were directly cultivated in black polyethylene bag filled with disinfected mixture of soft clay and sand (1:1);

vitafax capitan solution (1g./L) was used as disinfectant. After germination and growth for one month, the sexual or zygotic embryo was eliminated from each pot, as seedling of the zygotic embryo was early emerged, more vigorous and with dark green leaves (fig.1) than nucellus one. Therefore, sexual seedlings could be separated by cutting them with scissors and used the vegetative ones as rootstocks. The nucellus seedlings were individually transplanted in black polyethylene bag filled with the same mixture and disinfected with vitafax capitain solution (1g./L.). They were kept under seran house conditions and received the following horticultural procedures 5g. NH_4NO_3 /Seedling at fortnightly intervals between 15th January and 1st july, irrigation every second day and disease controlling by sulfur, copper oxychloro and mineral oils. The following parameters were measured for each class of the seeds: the germination percentage, number of the embryos/seed, as well as period of germination in days, number of leaves/seedling, number of the main roots/seedling, length of the root system (cm)/ seedling after one month of germination. Data have taken as averages and tabulated for each class of seed as every class of the seed have three replications, each have 30 seeds. Some observations on the germination of the sex embryo have taken. The vegetative or nucellus embryos were grew in the culture bed for about one year before grafting.

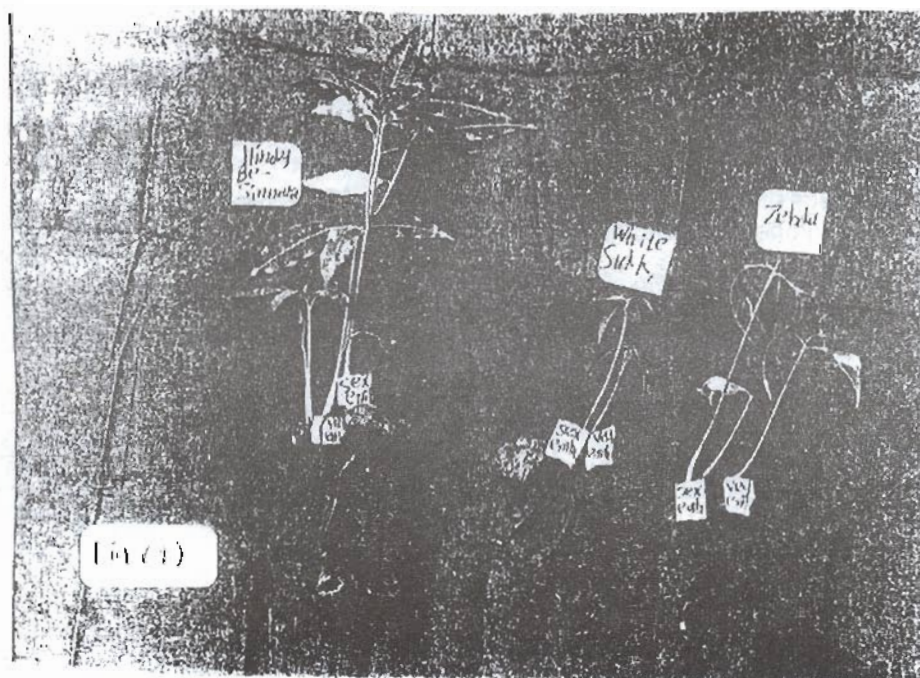


Fig (1): Shows the different characters of germinated sex embryos as compared with the nucellus ones in poly-embryonic rootstocks .

II. Tolerance to water stress:

In this study, nucellus seedlings of the vegetative embryos for each stock, were grown for 12 months in clay sand mixture (1:1) then, tested for water stress tolerant in June, July and August under seran house conditions. The test included the following water frequency: irrigation every second day (control), irrigation at 4,7,10 and 14 days intervals. Each treatment comprised of three replicates, each consisted of 10 pots. The following data have taken: average of dried leaves and burned stem and as well as damaged root system.

III. The grafting test:

The previous selected scions (Fagri Kalan, Ewais and Alphonso) have taken, from trees planted in the orchard of the Faculty of Agriculture, Cairo University- Giza Defoliated scions with a length of 9-12 cm. were top-cleft grafted onto about one-year old of the homogenous vegetative rootstock (Hindy Sinnara, Zebda and White Sukkary) in April of 2001 and 2002, on rootstocks produced in seasons 2000 and 2001 respectively. Each scion cultivar was grafted onto the three rootstocks under study as shown in table(1). The whole scion and the grafting region were completely tied with transparent polye ethylene tapes to prevent the scion's drought and maintenance of the humidity around the graft union region. The scion sprouts were covered with white bag paper to decrease the transpiration. The plants were subjected to the usual horticultural procedures (irrigation, fertilization, suckering, etc.), in the cultural bed and under seran house conditions until data have taken. After one month from the scion sprouting, the bag paper was removed and at the next month, data have taken as successful grafts percentages, number of the sprouted buds per scion, leaf area (cm²), leaves number and length of the new shoots on the scion (cm). Each type of the grafts in Table (1) has three replications and each replicate has three grafted rootstocks. The successful grafts percentage was assessed by recording the number of sprouted scions.

Table (1)

Scions	Rootstocks	Eiwessy (E)	Alphonso (A)	Fagri (FK) Kalan
	Hindy Sinnara (H)	E/H	A/H	FK/H
	White Sukkary (WS)	E/WS	A/WS	FK/WS
	Zebda (Z)	E/Z	A/Z	FK/Z

III. Histological study:

After four weeks of grafting date as the final results of the successful grafts have taken, samples of the grafting union region which containing approximately 2 cm of scion and 2cm of stock were took, killed and fixed in 70% FAA (formalin + acetic acid +95% ethyl alcohol at ratio of 5:5: 90, V/V/V), stored in 70% ethyl alcohol, softened a minimum of 2 weeks in glycerol-alcohol solution (glycerol + 50% ethyl alcohol at ratio of 1:1). Transverse sections were taken at the grafting union region at 25 and 50µ

using a hand-fed sliding microtome. The most clear ness samples, double stained with safranine- fast green, mounted in Canada Balsam (Forest, 1949 & Johansen, 1940), microscopically examined and photographed on Kodak-colour film, investigation and discuss the histological reasons of the compatibility or incompatibility in the grafts

IV. Statistical analysis:

The obtained data were statistically analyzed according to Least Significant Difference (L.S.D.) to compare between means as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSION

I. Rootstock production:

Observations on the germination of the sex embryo revealed that it located and emerged near the upper part of the seed which called the neck of the seed. This sex embryo often germinate firstly and more vigorous, followed by the vegetative embryos (fig 1). Therefore, it could recommend earlier elimination of the sex embryo just after germination to be sure that all of other seedlings were resulted from vegetative (nucellus) embryos. In this concern, Singh *et al.* (1983) suggested using of polyembryonic mango seeds as rootstocks.

Table (2) showed that there are non-significant differences between the two studied seasons 2000/2001 and 2001/2002 in all studied characters of the different rootstocks; (the germination percentage; number of embryos per seed was significantly affected by the type of the seed and the rootstock. Removal of the seed coat gave the highest germination percentage in the two studied seasons followed by cracked coat then coated seed which came in the last rank (87.6, 90.6; 81.3, 82.6, 74 and 74.3 respectively). Considering the rootstocks, Zebda gave the best germination percentage followed by Hindy Sinnara then White Sukkary (92.6, 93.3, 89.6, 91.6, 60.6 and 62.6 for the first and second season respectively). The differences between Zebda and Hindy Sinnara did not reach the significant level. The interaction effect between the seed type and the rootstock was significant in both seasons and went in the same direction as mentioned above.

Number of germinated embryos per seed (Table 2 and figure (1)) was significantly affected by seed coat treatments and the cultivar. Husked seed coat removal gave the highest number of germinated embryos per seed, followed by that with cracked coat then the coated seeds. On the other hand, Zebda seeds had the highest average number of embryos followed by White Sukkary then Hindy Sinnara. The difference between Zebda and the other cultivars was significant at the first season, while at the second season Zebda and White Sukkary seeds significantly equal in this percentage.

Table(2): Effect of coated;coat-removal and cracked seed treatment on some characters of germinated seed of mango rootstocks on seasons 2000 and 2001.

Treatments	Characters	Germination Percentage			Number of germinated embryos/see			No. of leaves/seedling			No. of roots/seedling			Length of roots/seedling (cm.)			Period of germination (days)					
		H	WS	Z	Av.	H	WS	Z	Av.	H	WS	Z	Av.	H	WS	Z	Av.	H	WS	Z	Av.	
Coated seed (control)	A	85	50	87	74	2	3	3	2.6	4	2	4	3.3	3	20	25	30	25	40	28	25	31
	B	87	48	88	74.3	3	4	4	3.6	3	3	5	3.6	4	15	25	30	23.3	45	30	28	34.3
Cracked seed coat	A	89	62	93	81.3	4	3	4	3.6	4	3	5	4	3	21	25	33	26.3	35	30	25	30
	B	91	65	92	82.6	4	4	5	4.3	4	4	5	4.3	4	18	26	30	24.6	32	30	25	29
Seed coat removal	A	95	70	98	87.6	4	5	7	5.3	5	5	7	5.6	5	28	35	37	33.3	28	21	21	23.3
	B	97	75	100	90.6	5	6	6	6.3	6	6	7	6.3	6	30	40	43	37.6	21	18	15	18
Averages	A	89.6	60.6	92.6		3.3	3.6	4.6		4.3	3.3	5.3		3.6	23	28.3	33.3		34.3	26.3	23.6	
	B	91.6	62.6	93.3		4	4.6	5		4.3	4.3	5.6		4.6	21	30.3	34.3		32.6	26	22.6	
L.S.D. (0.05)	Cultivars	23.119(A)26.198(B)																				
	Treatments	5.381(A)8.644(B)																				
L.S.D. (0.05) treatments	Cultivars*	17.618(A)20.081(B)																				
	Treatments	1.914(A)2.016(B)																				
Averages	Cultivars	0.708(A)0.559(B)																				
	Treatments	0.911(A)0.671(B)																				
Averages	Cultivars	0.901(A)0.931(B)																				
	Treatments	0.695(A)0.598(B)																				
Averages	Cultivars	1.581(A)1.313(B)																				
	Treatments	1.262(A)1.613(B)																				
Averages	Cultivars	8.019(A)9.511(B)																				
	Treatments	8.096(A)11.713(B)																				

H=Hindy Be-Sinnara; W.S.=White Sukkary; Z=Zebda; A=Season 2000; B=Season 2001 -Av.=Average, all L.S.D.(0.05) of seasons(A & B) = N.S. (Non Significant).

Number of leaves per seedling (Table 2) after 2 months of germination were at the highest value when seed coat was removed, followed by cracked seed then coated seed (control), with significant in both seasons. As for the effect of genotype in this respect, Zebda seedlings had the significant highest number of leaves per seedling, followed by both Hindy Sinnara and White Sukkary). The difference between the two latter stocks was not significant at the second season. The interaction effect between the seed treatment and the cultivar was significant and went in the same line of the individual factors. Number of roots per seedling was at the highest value with seed coat removal, followed by both cracked seeds and coated seeds classes as they were significantly equal in the two seasons. Zebda seedlings took the first rank with significant differences with the others cultivars at the first season, meanwhile it was equal to Hindy Sinnara seedlings at the second season. The interaction effect was significant in both seasons as Zebda cracked seed gave the highest number of roots per seedling while White Sukkary gave the lowest value.

Length of the root per seedling took the highest value when seed coat was removed in both seasons, while cracked seeds and coated seeds classes came in the second rank without significant differences between them. Considering the cultivars, Zebda took the first rank followed by White Sukkary then Hindy Sinnara. The significant differences were noticed between the stocks specially in the first season. As for the interaction effect between the stocks and seed treatments, Zebda without seed coat gave the highest root length in both seasons while Hindy Sinnara coated seed took the last rank.

Considering the period of the germination, Zebda seeds took the lowest period of germination in both seasons without significant difference with White Sukkary seeds, while Hindy Sinnara took the longest period with significant differences with the other stock. Considering the seed treatments, seed coat removal resulted in the lowest period of germination, while cracking seed coat was significantly equal to the coated seeds. Zebda with seed coat removal took the lowest period of germination in both seasons and Hindy Sinnara coated seed took the longest period. It is evident from the previous results that Zebda could be recommended as a rootstock compared to experimented the other mango cultivars due to its good with respect to germination characters i.e. high germination percentage, speed of germination, high number of germinated embryos, in addition to high number of leaves and roots per seedling and average length of roots. Meanwhile, White Sukkary is more acceptable rootstock than Hindy Sinnara. On the other hand, seed coat removal gave the best results for all the abovementioned germination characters, followed by cracking the seed coat as compared with the control intact seeds. This may be due to the barrier effect of seed coat to germination of embryos. In parallel, Padma and Reddy (1998) found that soaking of mango kernels in water or soaking the stones in 0.5% KNO₃ for 24 hours improved the final germination percentage, besides earlier germination. Also, Abde-Galil (1992) and Padma and Reddy (1997) obtained higher germination percentage and earlier germination with seed coat and taste removal of mango seeds.

II. grafting stage:

Table (3) and figures (2,3 and 4) shows the significance of grafting of the three mango cultivars Ewais,Alphonso and Fagri Kalan each on Hindy Sinnara,White Sukkary and Zebda as rootstocks.With regard to the percentage of graft success,it is better to graft Ewais and White Sukkary (100%) or Zebda(88 and 77%) with no significant difference at the first season,meanwhile Ewais grafts onto Hindy Sinnara had the lowest success percentage(11%). Alphonso scions on White Sukkary stocks had the significant highest success percentage(88%) followed by that grafted on Hindy Sinnara stocks(55 and 66%) with significant difference. However, Alphonso scions failed to union with Zebda stocks in the two seasons. As for Fagri Kalan cultivar,its grafts onto Zebda seedlings were completely successful (100%) at the two seasons.

Table (3): Effect of nucelus mango root stocks on the success grafts percentage and the vegetative characters of the successful scions on seasons 2001 and 2002.

Grafts	Gharacters	Successful grafts%		Number of sprouted scion buds		Leaf area of sprouted scions (cm.2)		Length of sprouted shoots of scions (cm .)		Total leaves number / successful scion	
		2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Eiwassy onto Hindy Sinnara		11	11	1	1	3.5	4	3	3.5	4	3
Al phonso onto Hindy Sinnara		55	66	2	3	4	5	4	5	4	4
Fagri Kalan onto Hindy Sinnara		77	66	2	3	5	5.5	5	5.5	4	5
Eiwassy onto White Sukkary		100	100	2	2	2.5	3	2.5	3	2	3
Al phonso onto White Sukkary		88	88	2	2	3	3	3	3	3	3
Fagri Kalan onto White Sukkary		55	55	1	1	3.5	3.5	3.5	3.5	4	3
Eiwassy onto Zebda		88	77	3	3	8.5	9	6	6.5	6	6
Al phonso onto Zebda		0	0	0	0	0	0	0	0	0	0
Fagri Kalan onto Zebda		100	100	2	2	12	10.5	7.5	10	8	9
Average		63.7	62.5	1.6	1.8	4.6	4.8	3.8	4.4	3.8	4
L.S.D. (5%)of grafts		18.019	15.813	0.893	0.802	2.699	3.537	1.868	2.351	2.998	2.819
L.S.D. (5%)of seasons		N.S.		N.S.		N.S.		N.S.		N.S.	

N.S.= Non Significant

Considering the effect of rootstock on growth criteria of scion,i.e. number of sprouted buds ,length of new shoots ,total leaves number and leaf area per scion,it appeared that grafting of Ewais or Fagri Kalan on Zebda gave the significant best results,meanwhile it was better to graft Alphonso scions on White Sukkary seedlings.

The effect of rootstocks on scion growth was also recorded by several investigators. Cedeno-Maldonado et al.(1988) found that Eldon mango rootstock produced significant reduction in growth of Palmen and Irwin scion,but significant reduction of Edward scion was obtained with Julie rootstock. With Alphonso scion,Kohli and Reddy(1989) obtained least growth on Vellaikulumban rootstock and most growth on Muvandon and Olour rootstocks.They added that leaf N,P,K,Ca,Mg and S contents differed significantly between rootstocks,as Olden had the highest leaf nutrient content,meanwhile Vellaikulumban showing the lowest N,K and Ca.

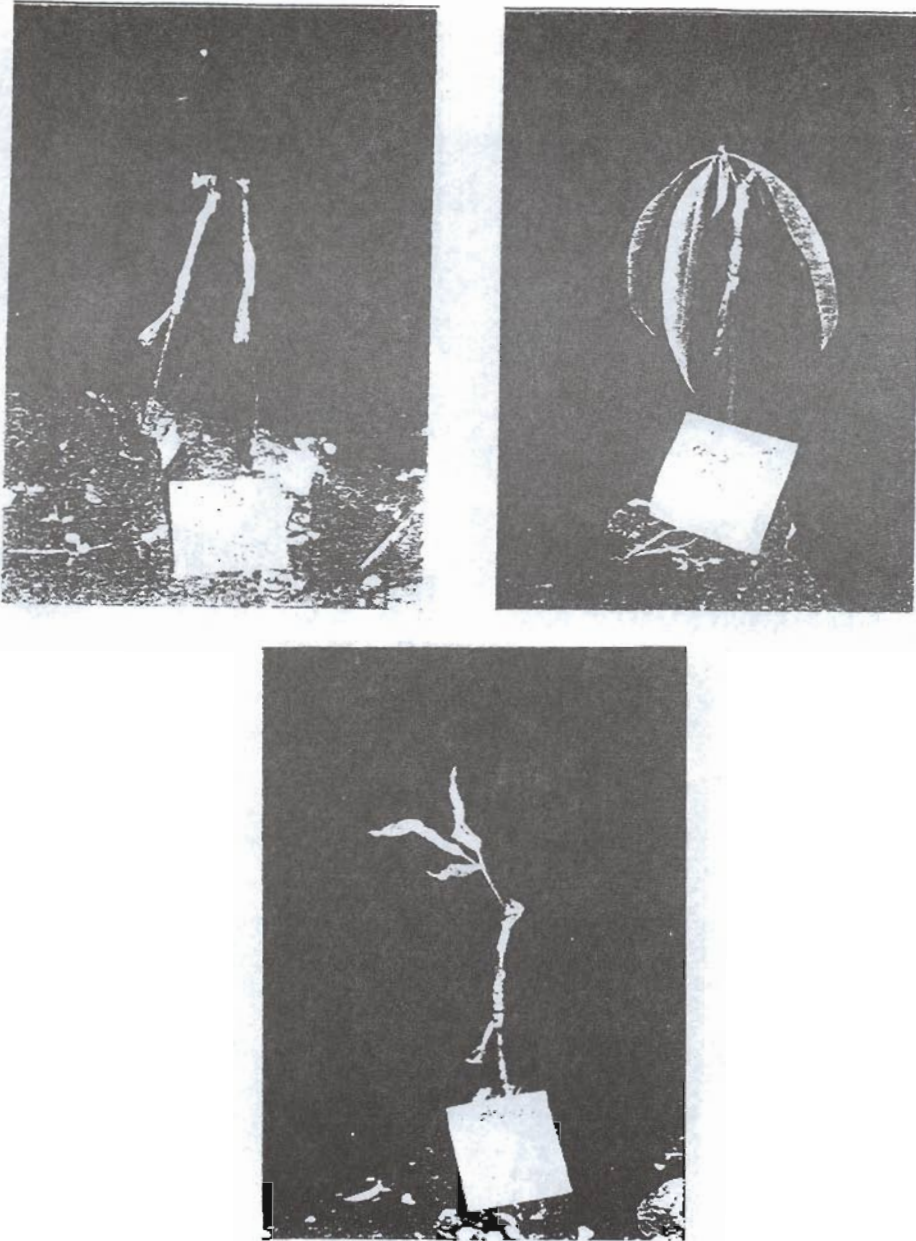


Fig. (2) showed different groups of the grafts in respect of the compatibility, partial incompatibility or incompatibility between the studied scions and the studied rootstocks.

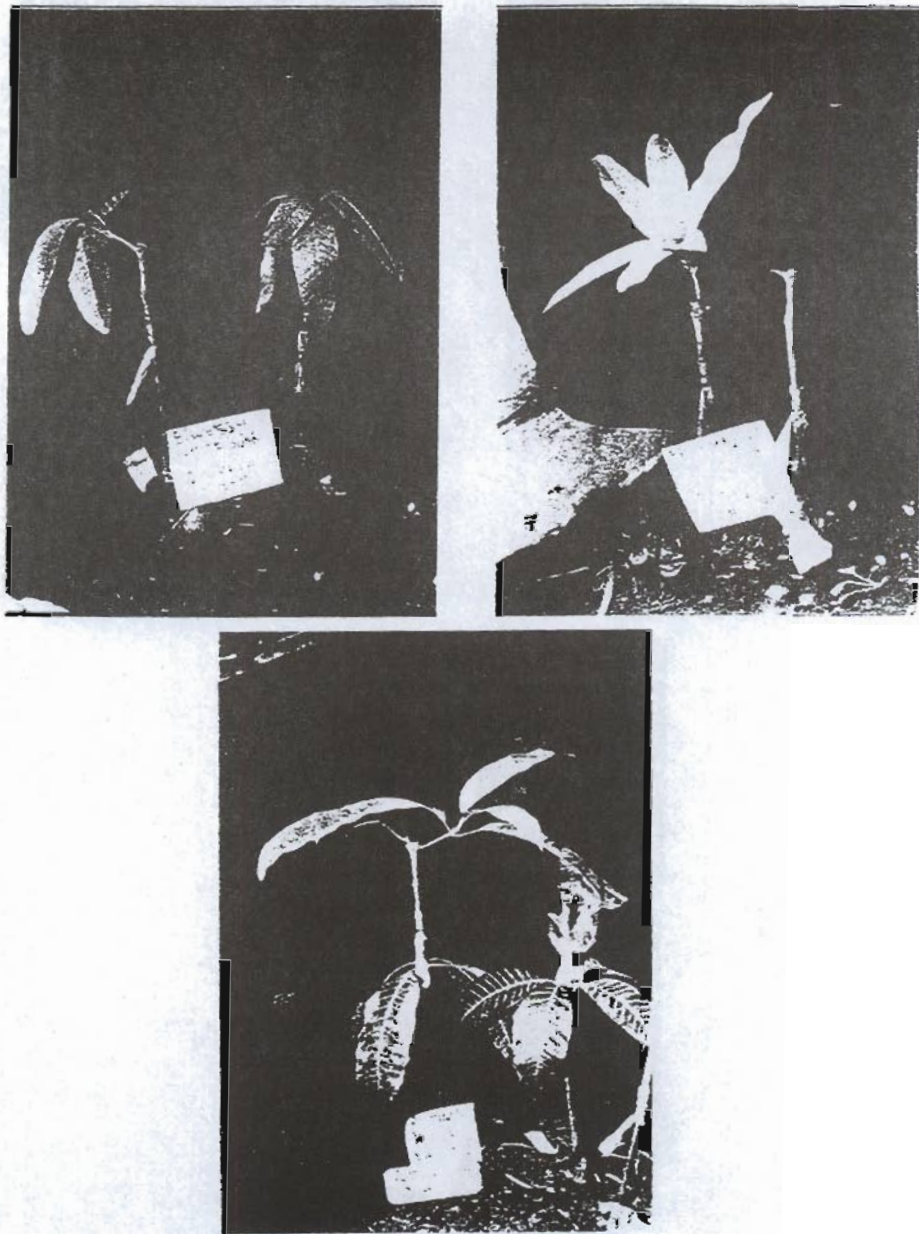


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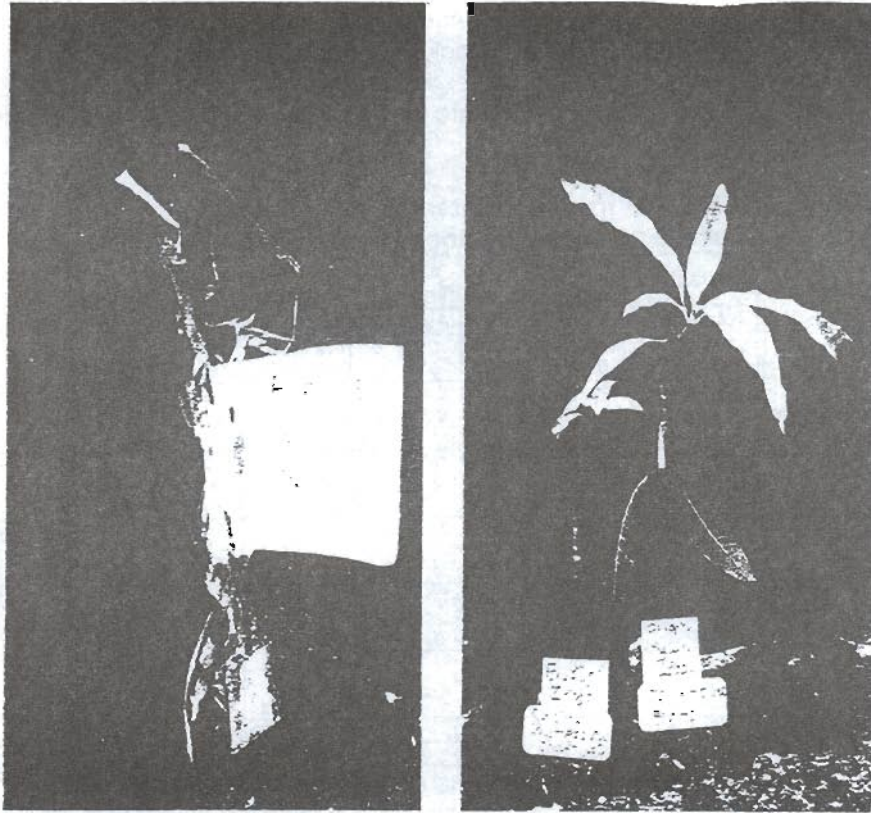


Fig. (4) showed different groups of the grafts in respect of the compatibility, partial incompatibility or incompatibility between the studied scions and the studied rootstocks.

III. Tolerance to water stress:

Table (4) showed that tolerance of mango seedlings to frequency of irrigation intervals, were different according to the genotype as White Sukkary seedlings gave the best result (the lowest number of dry leaves ,browned stem and damaged root system) without significant difference with Zebda seedlings which came in the second rank while Hindy Be-Sinnara seedlings took the last rank (the highest number of the same items) with significant differences with the others rootstocks Therefore, it can be recommend White Sukkary as a good rootstock under water stress conditions followed by Zebda rootstock ,meanwhile Hindy Sinnara could be classified as sensitive rootstock against water stress.

Table(4): Effect of irrigation intervals on the vegetative characters of nucellus mango rootstocks (seasons 2001 and2002).

Irrigation intervals (days)	Characters Rootstocks	Dry leaves number per seedling				Browned stem number				Number of damaged root systems			
		H	WS	Z	Av.	H	WS	Z	Av.	H	WS	Z	Av.
2 days (Control)	A	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0
4 days	A	2	0	0	0.6	2	0	0	0.6	2	0	0	0.6
	B	1	0	0	0.3	2	0	0	0.6	2	0	0	0.6
7 days	A	3	1	1	1.6	3	0	1	1.3	3	0	1	1.3
	B	3	2	1	2	3	0	0	1	4	0	1	1.6
10 days	A	5	2	3	3.3	6	1	3	3.3	7	2	4	4.3
	B	6	3	3	4	5	2	3	3.3	7	3	4	4.6
14 days	A	8	3	5	5.3	10	2	7	6.3	10	3	6	6.3
	B	8	4	6	6	10	3	6	6.3	10	3	5	6
Averages	A	3.6	1.2	1.8		4.2	0.6	2.2		4.4	1	2.2	
	B	3.6	1.8	2		4	1	1.8		4.6	1.2	2	
L.S.D. (0.05)	Cultivars	1.413(A)0.936(B)				1.711(A)1.735(B)				2.083(A)2.335(B)			
	Treatments	1.022(A)1.873(B)				1.961(A)2.102(B)				2.787(A)2.891(B)			
	Cultivars and Treatments	2.946(A)2.778(B)				3.844(A)2.609(B)				4.293(A)3.661(B)			

H=Hindy Be-Sinnara;W.S.=White Sukkary;Z=Zebda;A=Season 2000;B=Season 2001
 Av. =Average ; all - L.S.D.(0.05) values between the studied seasons were non significant(N.S.).

As for the effect of irrigation intervals,data revealed that watering every 14 days gave the worst results (the highest number of dry leaves, burned stem and damaged root system) in both seasons .On the other side, irrigation at 2,4 or 7 days intervals were significantly equal and gave the best result (the lowest number of dry leaves,browned stem and damaged root system). The interaction effect between the rootstocks and the drought treatments were significant and proved that White Sukkary and Zebda seedlings tolerated irrigation up to 7 days intervals under the experimental conditions without any significant injury,meanwhile Hindy Sinnara seedlings were only healthy when irrigated every 2 or 4 days. In this concern,Litz(1995) pointed out that irrigation is one of the most powerfull tools to ameliorate drought stress from which mango trees can survive.

III. Histological study:

Transverse sections at the graft union zone of two successful grafts Ewais and Alphonso on White Sukkary were compared with their analogous failed grafts (Ewais on Hindy Sinnara and Alphonso on Zebda). Samples were taken after 4 weeks of grafting. Light microscopic examination revealed that anatomical details (features) were varied according to the degrees of compatibility and incompatibility between the scions and the rootstocks (grafting success percentage); as well as proliferation of callus at the union region form callus bridges. In the failed grafts, the original stock wound and inner face of the original scion were present as lines of necrotic layer on either side of the callus (margin) so original cut was easily traced (Fig 5 and 6). Also the tissues around the wound area (cut area) were dark brown because of they were filled with resinous material presumably from leakage of laticiferous canals. Incompatible features were characterized by an irregular disposition in the callus cells, thick cell walls, necrotic layers at the margin of the union zone, scattered callus and numerous free of Callus positions in the union region. These features lead to poor translocation between the stock and scion, even with occurrence the connection by 'cement' materials in some situations of union region as it is weak band and prevent water flow, in addition to loss of scion water by transpiration and consequently scion will desiccated and die, and that result in separation of the two graft partners. These results agreed with Moore and Walker, 1981; Warmand *et al.*, 1993 and Errea *et al.*, 1994 and. Figures (7 and 8) illustrate the anatomical features of high compatible graft Ewais and Alphonso on White Sukkary which seem in an orderly disposition condensed and uniformly callus tissue and initiation of new vascular elements in union region from the callus which originated from the wounded end of xylum ray cells of both scion and rootstock. Callus and new vessels formed the main connection materials in numerous situations of graft union region, thus translocation can take place through the callus cells firstly and through the new vessels late on, hence scion continued survival and good growth. The cell walls of both grafting partner were fused by a "cement" or binding materials with smallest necrotic spots, in this union region. Also some resinous pockets were found in union region, that may play some role in the adhesion of the scion and stock. These anatomical features could explained the highly success percentage of Ewais and Alphonso on White Sukkary rootstock which revealed high compatibility between these partners. In parallel to these finding, Errea (1994) pointed that cells of callus from a compatible graft show an orderly disposition while cells of callus from incompatible graft show an irregular disposition and cell walls are thick and irregular. Moreover, Moore (1981) recorded that lethal cellular has resulted in the formation of necrotic layer of collapsed cells that separates the two partners of an incompatible graft. Meanwhile, the incompatible grafts, Esau (1953) recorded that the new parenchyma cells are produced adjacent and internal to the necrotic layer, soon they intermingle and interlock, filling up the spaces between scion and rootstock and development in the healing of a graft union. The cambial activity in the callus has resulted in the production of secondary tissues which have joined the vascular tissues of the stock and the scion.

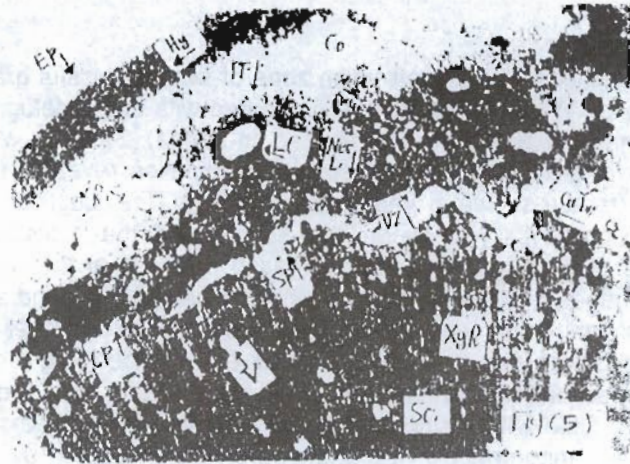


Fig (5)
 Transverse section through top-grafting union in "Alphonso" on first-flush "Zebda" rootstock examined 4 weeks after grafting, show the separation and disconnection positions in union zone and show that necrotic layer is formed presumably from leakage of L.C. (Ep. = epidermis; Hy = hypoderm; PF = pericyclic fibers; Co = cortex; Lc = laticiferous canal; Nec. L. = Necrotic layer; R.S. = Rootstock; Uz = Union zone; Ca br. = callus bridge; Cp = connection position; Sp = separation position; Xyr = xylum rays; V = vessel; Sc. = scion) X = 144.

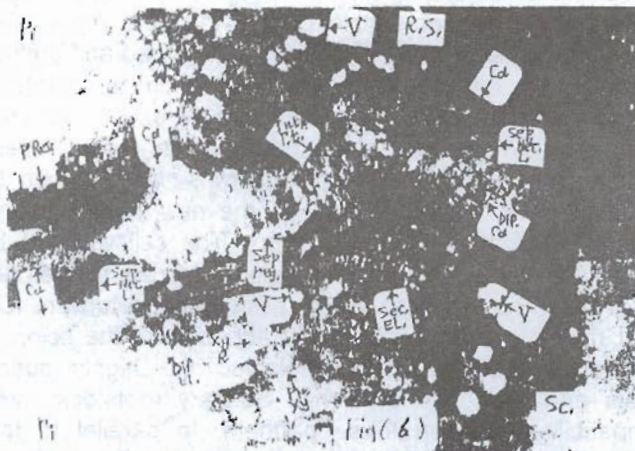


Fig (6)
 Transverse section through top-grafting union in "Ewais" on first-flush "Mindy Simara" stock examined 4 weeks after grafting, show the separation of necrotic layers formed in developed callus; interrupted parenchyma tissue which prevent the vascular connection and initiation of callus from both wounded surface of the scion and the stock. (Sc. = scion; R.S. = rootstock; Pi = Pith; Ca = callus; V = vascular; istr. P.L. = interrupted parenchyma tissue; Sep. Nec. L. = separation necrotic layer; Dif. Ca. = differentiated callus; Sec. El. = secondary elements, sep. reg = separation region; Xy.R. = xylum rays; Dif. El. = differentiated vascular elements; Pr Xy = primary xylum). X = 144

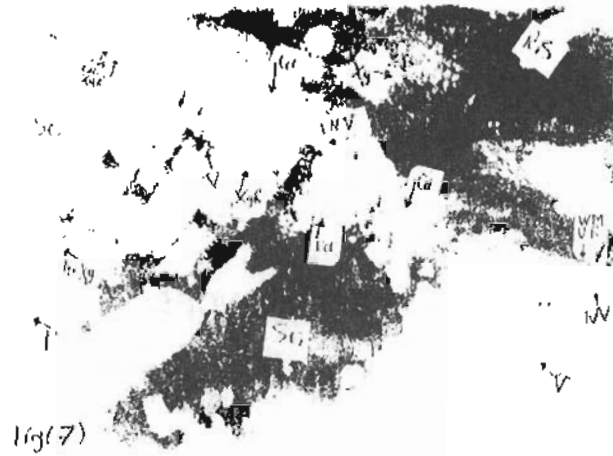


Fig (7)
 Transverse section through top-grafting union in successful grafts of "Alphonso" on first flush "White Sukkary" stock examined 4 weeks after grafting, show the free of necrotic layer; origination of callus from xylem rays of scion and starting of new vessels in callus. (Sc. = scion; R.S. = rootstock; V = vessels; XyR = xylem rays; Ca = callus; NV = new vessels; PXY = primary xylem; P = pith; W.Ed. XyR = wounded end of xylem rays; WMUR = wounded margin of union region) X = 144



Fig (8)
 Transverse section through top-grafting union in "Ewas" on first flush "White Sukkary" stock examined 4 weeks after grafting, show the scattered callus, vascular connection in some parts of union region (R.S. = root stock; Sc. = scion; CC = Callus; PF = pencyclic Fibres; V = vessels; Nec.L = necrotic layer; N Xy = new xylem; Ca = scattered callus; N.V. = New vessels; XyR. = xylem ray; P = pith. X = 144

From these results, it could be concluded that, there are three groups of grafts in accordance with the percentage of successful grafts as follows:

- 1- High compatible grafts (75-100% graft success) which include Fagri kalan on Zebda stock , Ewais on White Sukkary and Alphonso on White Sukkary'.
- 2- Moderate compatible grafts(50-75% success) which include Fagri Kalan on White Sukkary , Alphonso on Hindy Sinnara and Ewais on Zebda
- 3- Incompatible or badly compatible grafts (0-50% graft success) which include Alphonso on Zebda .

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دراسة مقارنة على أصول المانجو عديدة الاجنة لتطعيم ثلاثة أصناف من المانجو

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أجريت أربع تجارب خلال موسمي 2001/2000 و 2002/2001 لدراسة الطرق البستانية المناسبة لثلاثة أصناف من المانجو المحلية العديدة الاجنة (الهندي بسنارة، السكري الأبيض والزبدة) ثم دراسة مدى التوافق للتطعيم بين هذه الأصناف المحلية وطعوم المانجو (الفجري كلان، العويسى والفونس). أظهرت النتائج امكانية استبعاد الاجنة الجنسية مبكرا بعد الانبات مباشرة وتحسين انتاج الاجنة الخضرية. البذور المنزوعة الغلاف أعطت أعلى عدد من الاجنة النابتة لكل بذرة مع سرعة الانبات يليها البذرة المغطاة (المنزوعة الغلاف صناعيا). أيضا أعطت بذور صنف الزبدة أعلى عدد من الاجنة النيوسيلية والشتلات يليها بذور السكري الابيض ثم الهندي بسنارة. شتلات صنفى السكري الابيض والزبدة لفترات عدم الرى من شتلات الهندي بسنارة. فيما يخص النسبة المئوية لنجاح التطعيم وصفات نمو الطعم فانه يكون من الافضل تطعيم صنفى العويسى والفجرى كلان على شتلات الزبدة بينما تطعيم صنف الفونس على السكري الابيض يوصى به. أظهرت الدراسة التشريحية عند منطقة التحام التطعيم أن الطعوم الغير متوافقة (العويسى على الهندي بسنارة والفونس على الزبدة) تظهر وجود طبقة بنية ميتة على كلا جانبي منطقة التطعيم مع خلايا كالس مبعثرة ومواقع كثيرة خالية من الكالس مما يؤدي لبطيء أو فشل الالتحام بين جزئى التطعيم. أظهر الفحص الميكروسكوبى عند منطقة التطعيم للطعوم المتوافقة من صنفى العويسى والفونس على أصل السكري الابيض وجود نسيج كالس متماثل بوفرة ومواقع قليلة جدا من المناطق الميتة البنية مع نشأة عناصر وعائية جديدة وبالتالي يظل الطعم حيا وذو نمو جيد.