IV- RESULTS AND DISCUSSION

IV.1. Propagation of apple rootstocks by stem hardwood cutting:

The rooting measurements for studying the response of hardwood cuttings of MM.106 to the differential investigated preplanting treatments were : rooting percentage, number and average length of developed roots were determined 7 weeks from planting. Besides, other growth parameters were done 6 months later including survival percentage, number of developed leaves / rooted cutting and dry weight of three plant organs (leaves, stem and root), as well as total plant dry weight were discussed. In addition, No growth measurements were done with Mc.9 apple rootstock cuttings because the cuttings failed to remain alive.

IV.1.1. Rooting percentage of apple rootstock cuttings:-

Concerning the effects of collecting date, preplanting treatments and their interaction on rooting percentage of MM.106 apple rootstock cuttings data obtained during 1990-1991 and 1991-1992 seasons are presented in Table (1-a, b and c).

Regarding the specific effect of collecting date at which shoots were excised for preparing cuttings, data presented in Table (1-a) revealed that, rooting percentage of MM.106 apple rootstock cuttings collected on 15th January rooted better than those collected either on December 15th or February 15th during 1990-1991 and 1991 -1992 seasons. Besides, collecting in February 15th gave intermediate value rooting of percentage values. Anyhow, the three collecting dates could be descendingly arranged regarding their specific effect on rooting percentages as follows: January 15th (66.97 and 67.36%), February 15th (44.18 and 44.31%) and December 15th (29.58 and 28.75%) for the first and second seasons, respectively. The differences between the three tested collecting dates were significant at 5% level. These results are in general agreement with

those reported by **Howard, (1973); Wareing (1973); Nicholas (1975); Howard and Pontikis (1977); Harrison et al., (1981); Howard and Harrison (1982) and Yousif and Abdullah (1986).**

As for the specific effect of preplanting treatments, data in Table (11-b) showed clearly that in both seasons, the highest rooting percentage was always concomitant to those cuttings received the preplanting treatment of (wounding + dipping in IBA at 4000 ppm concentration. In addition, preplanting treatments of dipping in IBA at 1000, 2000 and 4000 ppm either bases of MM.106 apple rootstock cuttings were left sound or wounded, resulted in increasing rooting percentage significantly over control. However, the wounded cuttings resulted in a high increase over the unwounded one as they were compared after receiving the same IBA solutions. IBA. Treatments significantly increased the rooting percentage as compared with the control during the two seasons of study, Anyhow, the preplanting treatments (wounding + 4000 ppm IBA) gave the highest rooting percentage (74.07 and 73.83%) for 1990-1991 and 1991-1992 seasons, respectively. On the contrary, dipping in water only, as control was inferior treatment followed by dipping in water + wounding of cutting basis.

The obtained results regarding the specific effect of preplanting treatments are in general agreement with that reported by **Gorecki; (1979), Howard et al., (1979) and Howard et al., (1984)** as the wounding effect was concerned. Meanwhile regarding the response to IBA, obtained result goes with that previously mentioned by **Blomaert; (1958), Bhujabal (1973), Reddy and Majumdar (1979), El-Agamy et al., (1983), Dhua et al., (1984) and Prasad et al., (1991).**

Concerning the interaction effect of collecting date x preplanting treatments, data obtained in Table (1-c) revealed obviously that, the highest rooting percentage was induced by these cuttings collected on 15th January and received the preplanting treatment of wounding + dipping in IBA at 4000 ppm i.e., (77.78 % and 97.785%) during

1990-1991 and 1991-1992 seasons, respectively. Moreover, all other treatments "Combinations" between the collecting date of 15th January from one hand and preplanting treatments of dipping in IBA either at 2000 or 4000 ppm "irrespective of wounding application" ranked statistically second to aforesaid superior treatment and they also were statistically of nearly the same effectiveness as each was compared to other.

On the contrary, the combinations of 15th December collecting date and dipping in various IBA solutions (regardless of wounding application) were statistically of the least effectiveness. However, combinations of 15th February were in between. Such results go in line with the finding of **(Velickov and Jovanovic, 1986)**, who reported that, treated hardwood cuttings of M.26 apple rootstock taken in late November with IBA at 500, 1500 or 2500 ppm rooted better and found that the two higher concentrations increased rooting to 84 and 92%, respectively, compared with 74% in the control, and also improved root quality.

Table (1) : Specific effect of collecting date (a), preplanting treatments (b) and interaction between collecting date and preplanting treatments (c) on Rooting percentage (After 7 weeks from planting) of M.M. 106 apple rootstock during 1990- 1991 and 1991-1992 seasons.

a) Specific effect of collecting date of MM.106 apple rootstock

Collecting date	Rooting %	
	1990-1991	1991-1992
15/12	29.58	28.75
15/1	66.97	67.36
15/2	44.18	44.31
L.S.D at 5 %	**2.39**	**1.74**

b) Specific effect of preplanting treatments

Preplanting treatments	Rooting %	
	1990-1991	1991-1992
Control	21.11	19.63
IBA 1000 ppm	35.18	35.56
IBA 2000 ppm	45.59	46.30
IBA 4000 ppm	53.81	54.44
Wounding.	32.26	32.59
+ IBA 1000 ppm	50.36	50.74
+ IBA 2000 ppm	62.58	61.85
+ IBA 4000 ppm	74.07	73.83
L.S.D at 5%	**3.87**	**2.83**

c) Interaction between collecting date of X preplanting treatments.

Collecting date / Preplanting treatments	1990-1991			1991-1982		
	15/12	15/1	15/2	15/12	15/1	15/2
Control	11.11	35.56	16.67	10.00	33.33	15.36
IBA 1000 ppm	14.48	57.78	33.33	15.56	60.00	31.11
IBA 2000 ppm	25.55	67.67	44.44	24.44	70.00	44.44
IBA 4000 ppm	34.44	73.67	53.33	33.33	75.56	54.44
Wounding	18.89	45.56	32.33	17.78	45.56	34.44
+ IBA 1000 ppm	34.44	71.11	45.55	34.44	71.11	46.67
+ IBA 2000 ppm	42.22	66.67	58.88	40.00	85.56	60.00
+ IBA 4000 ppm	55.56	77.78	68.89	54.44	97.78	67.78
L.S.D at 5%		**5.55**			**4.07**	

.2. Number of developed roots per cutting:-

Regarding the effect of collecting date, preplanting treatments (dipping in IBA solution) for wounded or unwounded cuttings and their combinations on the number of roots developed per each cutting, data obtained during two seasons of 1990-1991 and 1991-1992 are presented in Table (2-a, b and c) and illustrated in Figures (1-A, 1-B and 1-C).

Concerning the specific effect of collecting date, it is quite evident that the greatest number of roots was obtained by 15th January excised cuttings. The increase was significant as compared to those of 15th December or 15th February collected cuttings during two seasons of 1990-1991 and 1991-1992. However, collected cuttings of MM.106 apple rootstock on 15th February showed a significant increase as compared with those of December 15th collected cuttings during the two seasons of study.

Referring to specific effect of the preplanting treatments, data obtained during two seasons as shown in Table (2-b) and Figure (1-B) revealed that preplanting treatments of dipping the cutting base in IBA at (1000, 2000 and 4000 ppm) with or without wounding their basis increased statistically the number of roots per cuttings over control (sooking in water). However, dipping the wounded or unwounded cuttings in the IBA higher concentration (4000 ppm.) ranked statistically First and represented the superior treatments during two seasons of study. On the other hand, dipping in water only without wounding was statistically the inferior preplanting treatment. While wounding of cuttings base plus dipping in water resulted to some extent in increasing number of roots/cutting than the control treatment from one hand but such increase was still so far to be considered as compared to those gained by the above mentioned effective preplanting treatments.

As for the interaction effect on number of roots developed per cutting Table (2-c) and Figure (1-A, B and C) show clearly an obvious response during two seasons of study.

Table (2) : Specific effect of collecgting date (a), preplanting treatments (b) and interaction between collecting date and preplanting treatments (c) on No. of Root/plant (After 7 weeks from planting) of M.M. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

a) Specific effect of Collecting date

Collecting Cutting date	No. of Root/plant	
	1990-1991	1991-1992
15/12	2.18	2.22
15/1	3.10	3.23
15/2	2.37	2.43
L.S.D at 5 %	**0.11**	**0.11**

b) Specific effect of preplanting treatments

Preplanting treatments	No. of Root/plant	
	1990-1991	1991-1992
Control	1.14	1.10
IBA 1000 ppm	1.74	1.76
IBA 2000 ppm	2.44	2.40
IBA 4000 ppm	3.76	3.54
Wounding.	1.21	1.28
+ IBA 1000 ppm	2.23	2.67
+ IBA 2000 ppm	3.41	3.39
+ IBA 4000 ppm	4.70	4.87
L.S.D at 5%	**0.18**	**0.15**

c) Interaction between Collecting date X preplanting treatments

Collecting Date / Preplanting Treatments	1990-1991			1991-1992		
	15/12	15/1	15/2	15/12	15/1	15/2
Control	1.00	1.33	1.10	1.00	1.20	1.10
IBA 1000 ppm	1.63	1.97	1.53	1.40	2.27	1.60
IBA 2000 ppm	2.20	2.77	2.37	1.97	2.83	2.40
IBA 4000 ppm	3.10	4.10	3.60	2.90	4.67	3.07
Wounding	0.90	1.57	1.17	1.07	1.57	1.20
+ IBA 1000 ppm	1.77	2.60	2.13	2.30	3.20	2.50
+ IBA 2000 ppm	2.87	4.73	2.63	3.13	4.07	2.97
+ IBA 4000 ppm	3.97	5.73	4.40	4.00	6.08	4.57
L.S.D at 5%		**0.27**			**0.29**	

1- Control

2- IBA 1000 ppm

3- IBA 2000 ppm

4- IBA 4000 ppm

5- Wounding + Water

6- Wounding + 1000 ppm.

7- Wounding + 2000 ppm.

8- Wounding + 4000 ppm.

Figure (1 - A): Rooted cutting of MM.106 apple rootstock collected in 15th December as affected by the differential preplanting treatments.

1- Control

2- IBA 1000 ppm

3- IBA 2000 ppm

4- IBA 4000 ppm

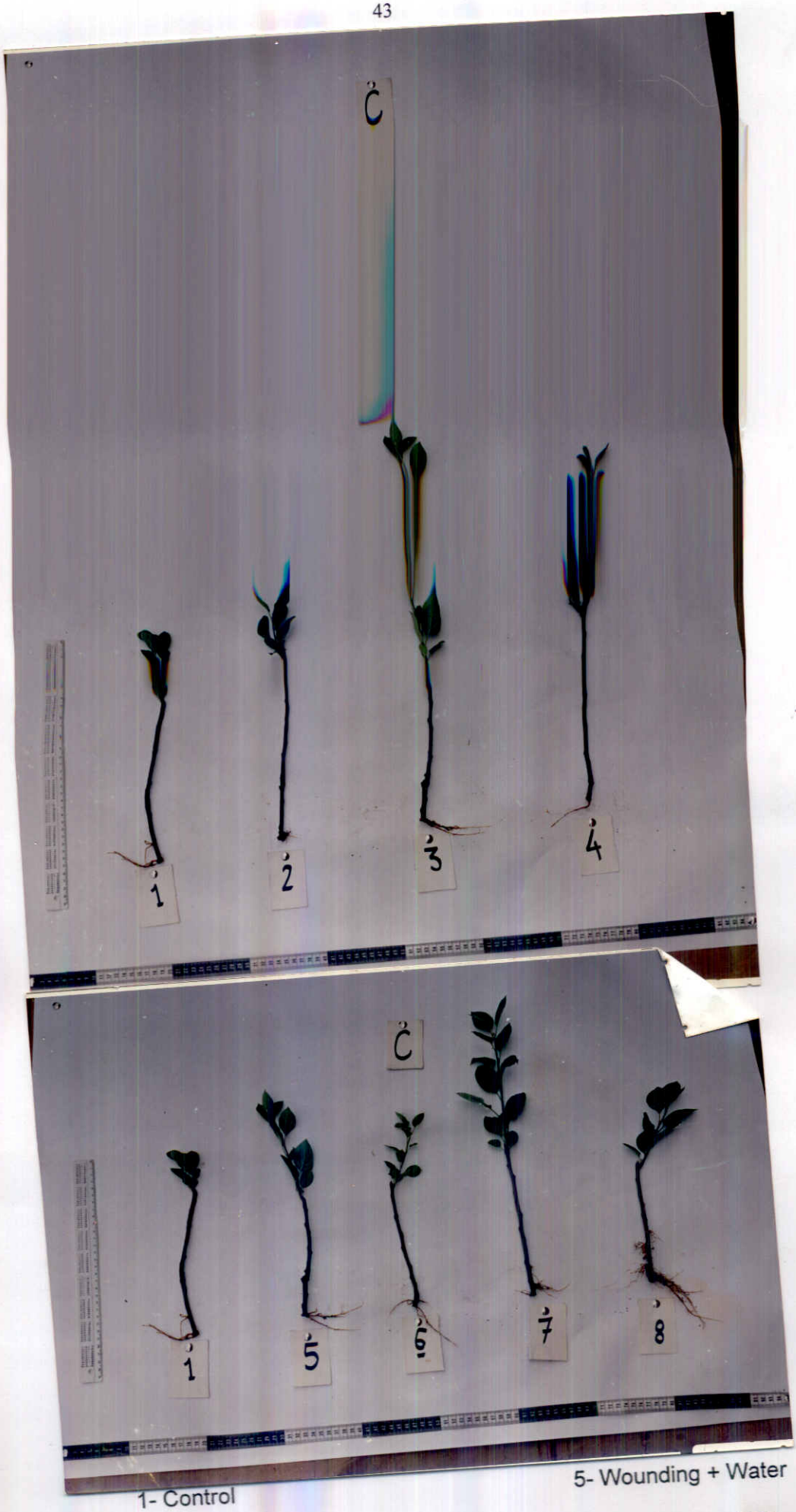
5- Wounding + Water

6- Wounding + 1000 ppm.

7- Wounding + 2000 ppm.

8- Wounding + 4000 ppm.

Figure (1 - B): Rooted cutting of MM.106 apple rootstock collected in 1st January as affected by the differential preplanting treatments.



1- Control

2- IBA 1000 ppm

3- IBA 2000 ppm

5- Wounding + Water

6- Wounding + 1000 ppm.

7- Wounding + 2000 ppm.

IV.1.3. Average root length :-

The average length of roots developed per rooted cuttings of MM.106 apple rootstock, 7 weeks from planting as influenced by differential factors investigated during two seasons of 1990-1991 and 1991-1992, data obtained are tabulated in Table (3-a, b and c) and illustrated in Figure (1-A, B and C).

Concerning the specific effect of collecting date of cutting on average root length, it is obvious that MM.106 apple rootstock cuttings collected on 15th January, showed statistically the tallest roots in 1990-1991 and 1991-1992 seasons, while the 15th December collected cuttings induced statistically the shortest roots during both 1990-1991 and 1991-1992 seasons. Moreover, 15th February excised cuttings were in between, however, the differences were significant as compared with those of two other collection dates during two seasons of study.

As the specific effect of the different eight preplanting treatments was concerned, data in Table (3-b) cleared that the preplanting treatment of dipping the wounded cuttings in the higher IBA concentration (4000 ppm.) resulted in inducing the tallest roots. The increase was significant in comparison with any of the other preplanting treatments investigated during both seasons. Moreover, in this concern, the other preplanting treatments could be arranged statistically into the following descending order : unwounding + IBA at 4000 ppm, wounding + 2000 ppm. IBA, unwounding + IBA at 2000 ppm, wounding + 1000 ppm IBA, unwounding + 1000 ppm. IBA, wounding without IBA application and finally the control (dipping in water only without wounding) which ranked last as representative of the inferior one.

With respect to the response to the interaction effect between collection date x preplanting treatments, it is quite clear that the rooted cuttings obtained from the combination between 15th January collected cutting and the preplanting treatments of dipping in IBA at 4000 ppm. preceding with wounding application was statistically the

superior and induced the tallest roots as compared with the investigated other combinations during 1990-1991 and 1991-1992 seasons. On the other hand, the shortest root length was statistically obtained by those rooted cuttings produced from dipping the unwounded and wounded cuttings gathered on 15th of both December and 15th February in water only during two seasons. In addition, other treatments (combinations) came in between the above mentioned two extents during the two seasons of study.

The obtained data regarding the response of developed roots length are in line with that reported by **Gorecki, (1979); Raddy and Singh, (1989)** as the affect of either wounding and time of cutting preparation of apple and mango, respectively was concerned. Meanwhile the response to IBA is coincided with the findings of **Singh and Gaur, (1971)** on guava, **Zora Singh et al., (1984)** and **Bartolini and Lanni, (1992)** on guava, peach and kiwi trees, respectively.

Table (3) : Specific effect of collecting date (a), Preplanting treatments (b) and interaction between collecting date and preplanting treatments (c) on Root Lenght (cm) (After 7 weeks from planting) of M.M. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

a) Specific effect of Collecting date

Collecting date	Root lenght (cm)	
	1989-1990	1991-1992
15/12	3.22	3.48
15/1	5.06	5.35
15/2	4.02	4.08
L.S.D at 5 %	**0.17**	**0.16**

b) Specific effect of Preplanting treatments

Preplanting Treatments	Root lenght (cm)	
	1990-1991	1991-1992
Control	2.18	2.30
IBA 1000 ppm	3.23	3.19
IBA 2000 ppm	4.36	4.56
IBA 4000 ppm	5.19	5.58
Wounding.	2.41	2.67
+ IBA 1000 ppm	4.07	4.48
+ IBA 2000 ppm	5.01	5.32
+ IBA 4000 ppm	6.37	6.41
L.S.D at 5%	**0.28**	**0.26**

c) Interaction between collecting date X Prelplanting treatments

Collecting Date / PreplantingTreatments	1990-1991			1991-1992		
	15/12	15/1	15/2	15/12	15/1	15/2
Control	1.70	2.50	2.30	1.73	2.73	2.43
IBA 1000 ppm	2.40	3.93	3.37	2.53	3.81	3.23
IBA 2000 ppm	3.37	5.47	4.23	3.77	5.40	4.53
IBA 4000 ppm	4.13	6.40	5.03	4.50	7.13	5.10
Wounding	2.03	2.80	2.40	2.20	3.03	2.47
+ IBA 1000 ppm	3.00	6.33	3.87	3.55	5.86	4.03
+ IBA 2000 ppm	4.10	6.00	4.93	4.43	6.87	4.67
+ IBA 4000 ppm	5.00	8.07	6.30	5.17	8.00	6.13
L.S.D at 5%		**0.40**			**0.38**	

IV.1.4. Survival percentage:-

Concerning the specific effect of collecting date on survival percentage of MM.106 apple rootstock rooted cuttings, Table (4-a) shows in both seasons, that the rooted cuttings survival % was not greatly differed while cuttings collected either on 15th January or 15th December showed a relative increase than those of 15th February (51.41% and 53.78), however, the differences between those two categories were significant at 5% level during two seasons of study.

Regarding the specific effect of preplanting treatments, Table (4-b) reveals in both seasons, that the preplanting dipping of the unwounded and wounded cuttings in the IBA concentrations (1000, 2000 and 4000 ppm.) resulted statistically in increasing the survival percentage than those of control (dipping in water). The 4000 ppm IBA dipped cuttings tended to be the most effective, especially as wounding of cutting base was done whereas, it exceeded statistically all other ones. On the contrary, dipping in water only without wounding (control) was the inferior preplanting treatment, whereas the lowest survival percentage of MM.106 apple rootstock cuttings was obtained during two seasons of study. On the other hand, preplanting treatments of dipping the wounded and unwounded cuttings in IBA (1000 and 2000 ppm.) showed statistically the efficiency of both increasing IBA concentration and wounding application as the survival percentage was regarded during the two seasons of study.

As for the interaction effect of (collecting date x preplanting treatments) on the survival percentage of MM.106 apple rootstock rooted cuttings, data obtained in Table (4-c) showed that the combinations between preplanting dipping in IBA 4000 ppm of the wounded cuttings from one side and three investigated dates (especially 15th January) from the other all were the most effective treatments during 1990-1991 and 1991-1992 seasons. On the contrary all combinations of dipping in water only (Control) followed by

dipping the unwounded cuttings in the lowest IBA concentration (1000 ppm) showed generally the least value of survival percentage during both seasons of study.

The obtained results concerning the response of survival percentage to the different investigated factors are in general agreement with that reported by **El-Tomi et al., (1974)** on apple and **Abou-Rawash et al., (1993)** on two guava cultivars, regarding the effect of IBA, wounding and time of preplanting cuttings, respectively.

Table (4) Specific effect of collecting date(a), and preplanting treatments (b) and interaction between collecting date and preplanting treatments (c) on surival percentage (After 6 months from transplanting) of M.M. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

A) Specific effect of Collecting date.

Collecting Date	1990-1991	1991-1992
15/12	53.24	54.16
15/1	53.73	54.49
15/2	51.49	53.78
L. S. D at 5% .	**2.44**	**2.69**

b) Specific effect of treatments .

Preplanting Treatment	1990-1991	1991-1992
Control	27.16	25.49
IBA 1000 ppm.	33.53	42.79
IBA 2000 ppm.	45.27	45.44
IBA 4000 ppm	59.16	64.94
Wounding	46.28	46.84
+IBA 1000 ppm	56.47	60.05
+ IBA 2000 ppm	67.03	68.97
+ IBA 4000 ppm	77.63	78.62
L.S.D at 5%	**4.22**	**4.40**

c) Interaction between root stock X Collecting date X preplanting treatments.

Collecting Date / Preplanting Treatments	1990-1991			1991-1992		
	15/12	15/1	15/2	15/12	15/1	15/2
Control	30.55	24.83	26.11	33.33	23.16	20.00
+IBA 1000 ppm	37.77	32.63	30.20	43.33	42.57	42.46
+IBA 2000 ppm	43.38	45.94	46.49	45.24	46.02	45.05
+ IBA 4000 ppm	67.79	71.04	68.67	59.73	67.70	67.40
Wounding	46.66	48.89	43.29	43.33	48.71	48.48
+IBA 1000 ppm	57.96	57.79	53.67	61.21	59.39	59.56
+IBA 2000 ppm	65.87	69.20	66.01	69.54	68.82	68.56
+ IBA 4000 ppm	75.92	79.52	77.46	77.59	79.54	78.73
L.S.D at 5%		**3.31**			**3.61**	

IV.1.5. Number of leaves per rooted cutting:-

Referring the number of developed leaves per survived rooted cutting in response to the differential treatments investigated during both 1990-1991 and 1991-1992 seasons, data obtained are tabulated in Table (5-a, b and c).

With regard to the specific effect of collection date, it is quite evident that the December 15th collected cuttings induced significantly survived rooted cuttings of the least number of leaves during both seasons of study. On the contrary, collecting other on 15th January significantly resulted in the greatest number of leaves / rooted cutting while those of December 15th date were in between. In other words, it could be concluded that preparing MM.106 apple rootstock cuttings on 15th January induced survived rooted cuttings having statistically the greatest number of leaves during both 1989-1990 and 1990-1991 seasons, respectively.

As for the specific effect of preplanting treatments on number of leaves per rooted cuttings, Table (5-b) shows clearly that dipping of the unwounded and wounded MM.106 apple rootstock cuttings in IBA at (1000, 2000 and 4000 ppm.) resulted significantly in inducing survived rooted cuttings in their having larger number of leaves than control during both seasons of study. However, dipping of wounded cuttings in IBA at 4000 ppm was the superior. On the contrary, dipping in water only of either the unwounded MM.106 apple rootstock cuttings or the wounded ones induced rooted cuttings of the poorest leaves. However, the wounded cuttings tended to show an increase than the unwounded ones, as cuttings of the same IBA concentration were compared each to other whereas difference reached level of significance regardless of IBA concentration. In addition, other investigated preplanting treatments were statistically in between the above mentioned two extents during 1990-1991 and 1991-1992 seasons.

Concerning the interaction effect of (collecting "planting" date x treatments) on number of leaves / rooted cutting, it is quit evident that, dipping the unwounded or

wounded cuttings of MM.106 apple rootstock in IBA at (1000, 2000 and 4000 ppm) regardless of collecting date increased significantly number of leaves/rooted cutting than control during the 1990-1991 and 1991-1992 seasons. However, both combinations of dipping the wounded cuttings that collected on 15th January in IBA at 4000/2000 ppm were the superior combinations. Since, both represented the highest degree of benefit could be gained by the interaction between the collection dates from one hand and the differential investigated preplanting treatments from the other. On the other hand, dipping the unwounded cuttings of MM.106 apple rootstock and wounded in water only (regardless of preparing date) resulted in inducing rooted cuttings with the poorest number of leaves during 1990-1991 and 1991-1992 seasons of study. In addition, other combinations were in between as compared to both inferior and superior combinations previously mentioned during two seasons of study.

Table (5) Specific effect of collecting date (a), preplanting treatments (b) and interaction between collecting date and preplanting treatments (c) on No. of leaves/plant (After 6 months from transplanting) of M.M. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

a) Specific effect of Collecting date

Collecting Date	No. of leaves / plant	
	1990-1991	1991-1992
15/12	2.83	3.08
15/1	6.10	6.06
15/2	4.40	4.42
L.S.D at 5 %	**0.22**	**0.26**

b) Specific effect of preplanting treatments

Preplanting treatments	No. of leaves / plant	
	1990-1991	1991-1992
Control	2.28	2.11
IBA 1000 ppm	3.67	3.56
IBA 2000 ppm	4.33	4.50
IBA 4000 ppm	5.28	5.61
Wounding.	2.56	2.72
+ IBA 1000 ppm	4.78	4.89
+ IBA 2000 ppm	5.89	6.06
+ IBA 4000 ppm	6.78	6.72
L.S.D at 5%	**0.56**	**0.42**

c) Interaction between Collecting date X preplanting treatments

Collecting date / Preplanting Treatments	1990-1991			1991-1992		
	15/12	15/1	15/2	15/12	15/1	15/2
Control	1.33	3.17	2.33	1.33	2.83	2.17
IBA 1000 ppm	2.33	5.17	3.50	2.17	5.33	3.17
IBA 2000 ppm	2.67	6.17	4.17	3.17	6.17	4.17
IBA 4000 ppm	3.67	6.67	5.50	3.83	7.17	5.83
Wounding	1.67	3.67	2.33	1.67	3.67	2.83
+ IBA 1000 ppm	3.17	6.83	4.33	3.50	6.83	4.38
+ IBA 2000 ppm	3.50	8.17	6.00	4.17	8.00	6.00
+ IBA 4000 ppm	4.33	9.00	7.00	4.83	8.50	6.83
L.S.D at 5%		**0.52**			**0.60**	

IV.1.6. Stem length per cutting :-

Regarding the effect of collecting date and preplanting treatments (dipping in IBA solutions x wounding or no wounding application) and their combinations on the stem length per each cutting, data obtained during two seasons of 1990-1991 and 1991-1992 are presented in Table (6-a, b and c).

Concerning the specific effect of collecting date, it is quite evident that, the greatest value of shoot length was obtained by 15th January excised cuttings. The increase was significant as compared either to those of December 15th or February 15th collected cuttings during two seasons of 1990-1991 and 1991-1992. In addition, MM.106 apple rootstock cuttings collected on February 15th produced statistically longer shoots than those collected on December 15th.

With respect to the specific effect of preplanting treatments, Table (6 - b) shows in both 1990-1991 and 1991-1992 seasons, that treated cuttings with different concentrations of IBA treatments produced longer shoots than those dipped in water only control or in water after wounding their basis . Generally, dipping of wounded cuttings in 4000 ppm IBA treatment proved to be the most effective treatment in this respect. Moreover, (wounding + 4000 ppm. IBA) treatment induced high stimulating effect on stem length and followed descendingly by (wounding + 2000 ppm IBA), (4000 ppm IBA) , (wounding + 1000 ppm IBA) , (wounding + dipping in water) and control treatments.

The obtained data regarding of stem length per cutting are in general agreement with that reported by **Abd-El-Shakaur, (1994)** on guava.

Regarding the interaction effect of collecting dates x preplanting treatments, data obtained during two 1990-1991 and 1991-1992 seasons as shown in Table (6-c) indicated obviously that all combinations of dipping in IBA solutions and wounding of cuttings base resulted in increasing stem length of produced rooted cuttings. Such trend was true during two seasons and differences over control were significant regardless of time of

preparing cuttings, except those collected on mid of either December or February and received the preplanting treatment of (wounding base + dipping in water). Anyhow, both combinations of January 15th collecting date from one hand and dipping of wounded base either in 4000/2000 ppm IBA solutions represented the superior treatments as produced the tollest rooted cuttings during two seasons. Moreover, both treatments of wounded cuttings collected on mid of either January or February and dipped in 2000 or 4000 ppm IBA respectively ranked second to the above mentioned two superior combinations. However, other combinations showed avariable degrees of beneficials in increasing height of roated cuttings over control . The obtained results concerning the response of stem length to the different investigated factors are in general agreement with that reported by **Abd-El-Shokour** on Banaty guava cuttings.

Table (6) : Specific effect of collecting date (a), preplanting treatments (b) and interaction between collecting date and preplanting treatments (c) on stem length (After 6 months from transplanting) of M.M. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

a) Specific effect of collecting date

Collecting date	Shoot length (cm)	
	1990-1991	1991-1992
15/12	8.15	9.02
15/1	18.28	18.83
15/2	12.78	13.17
L.S.D at 5 %	**0.50**	**0.55**

b) Specific effect of preplanting treatments .

Preplanting Treatments	Shoot length (cm)	
	1990-1991	1991-1992
Control	6.39	6.28
IBA 1000 ppm	10.72	10.77
IBA 2000 ppm	13.06	13.78
IBA 4000 ppm	15.44	16.56
Wounding.	7.61	8.17
+ IBA 1000 ppm	14.11	15.11
+ IBA 2000 ppm	17.11	18.06
+ IBA 4000 ppm	20.06	20.67
L.S.D at 5%	**0.82**	**0.80**

c) Interaction between collecting date and preplanting treatments

Collecting date / Preplanting treatments	1990-1991			1991-1992		
	15/12	15/1	15/2	15/12	15/1	15/2
Control	3.83	9.00	6.33	4.00	8.67	6.17
IBA 1000 ppm	6.67	15.83	9.67	6.00	17.00	9.33
IBA 2000 ppm	8.00	18.50	12.66	9.33	19.17	12.83
IBA 4000 ppm	10.33	18.83	10.17	10.83	21.33	17.50
Wounding	4.67	11.17	7.00	4.83	11.33	8.33
+ IBA 1000 ppm	9.17	20.16	13.00	10.33	22.00	13.00
+ IBA 2000 ppm	10.00	24.33	17.00	12.50	24.33	17.33
+ IBA 2000 ppm	12.50	27.39	20.33	14.33	26.89	20.83
L.S.D at 5%		**1.17**			**1.33**	

IV.1.7. Leaves dry weight per survived rooted cutting:-

Data obtained during both 1990-1991 and 1991-1992 seasons regarding the leaves dry weight gained by rooted cutting of MM.106 apple rootstock in response to the differential collecting dates and preplanting treatments either solely or in combination are tabulated in Table (7).

It is quite evident from Table (7-a) that the response of leaves dry weight gained by the survived rooted cuttings to the specific effect of collecting dates during 1990-1991 and 1991-1992 seasons, that collecting date of MM.106 apple rootstock cuttings on 15th January significantly increased leaves dry weight of the rooted cuttings as compared with two other dates i.e, 15th December and 15th February .

Regarding the specific effect of preplanting treatments on dry weight of leaves per rooted cuttings Table (7-b) shows clearly that wounded cuttings dipped in IBA solution at 4000 ppm was statistically the superior. However, other preplanting treatments of wounding and dipping in various IBA solutions increased statistically leaves dry weight / rooted cutting as compared with control (dipping in water) during 1990-1991 and 1991-1992 seasons. Briefly, (wounding + 4000 ppm. IBA) treatment proved to be the most effective treatment followed by (wounding + 2000 ppm IBA) and (dipping in 4000 ppm IBA without wounding) in a decreasing order during both seasons of study.

As for the interaction effect of collecting date and IBA treatments, data in Table (7-c) indicated that, leaves dry weight showed a significant response in 1990-1991 and 1991-1992 seasons. In other words, all treatments of three collection dates from one side and investigated preplanting treatments (except wounding + dipping in water) increased significantly leaves dry weight of the rooted cutting as compared with control (unwounding) treatment. Shortly, the highest value of leaves dry weight / rooted cutting was gained January 15th collected cuttings received either by (wounding + 4000 ppm IBA) or (wounding 2000 ppm IBA) planting date.

Table (7) : Specific effect of collecgting date (a), preplanting treatments (b) and interaction between collecting date and preplanting treatments (c) on leaves dry weight (After 6 months from transplanting) of M.M. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

a) Specific effect of Collecting date

Collecting date	Leaves D. W. (gm)	
	1989-1990	1990-1991
15/12	0.168	0.183
15/1	0.384	0.376
15/2	0.262	0.267
L.S.D at 5 %	**0.013**	**0.014**

b) Specific effect of preplanting treatments

Preplanting Treatments	Leaves D. W. (gm)	
	1990-1991	1991-1992
Control	0.137	0.128
IBA 1000 ppm	0.219	0.216
IBA 2000 ppm	0.265	0.275
IBA 4000 ppm	0.332	0.339
Wounding.	0.153	0.163
+ IBA 1000 ppm	0.290	0.297
+ IBA 2000 ppm	0.360	0.367
+ IBA 4000 ppm	0.411	0.415
L.S.D at 5%	**0.020**	**0.023**

c) Interaction between Collecting date X preplanting treatments

Collecting date / PreplantingTreatments	1990-1991			1991-1992		
	15/12	15/1	15/2	15/12	15/1	15/2
Control	0.078	0.196	0.137	0.079	0.178	0.126
IBA 1000 ppm	0.136	0.317	0.205	0.130	0.327	0.192
IBA 2000 ppm	0.159	0.389	0.247	0.190	0.384	8.243
IBA 4000 ppm	0.222	0.440	0.335	0.218	0.427	0.373
Wounding	0.086	0.231	0.142	0.088	0.229	0.172
+ IBA 1000 ppm	0.195	0.426	0.250	0.208	0.425	0.258
+ IBA 2000 ppm	0.216	0.507	0.356	0.252	0.478	0.352
+ IBA 4000 ppm	0.252	0.563	0.420	0.299	0.530	0.416
L.S.D at 5%	**0.029**			**0.034**		

IV.1.8. Stem dry weight per survived rooted cutting:-

Regarding the response of stem dry weight of MM.106 apple rootstock rooted cuttings to the different combinations between collecting dates and some preplanting treatments, data obtained during two seasons of 1990-1991 and 1991-1992 are presented in Table (8-a, b and c).

As for the specific effect of collecting date, data obtained in Table (8-a) showed that the 15th January collected cuttings induced significantly the heaviest stem dry weight followed in a decreasing order by those collected on 15th February and 15th December during both seasons of study. On the other hand, it could be concluded that preparing MM.106 apple rootstock cuttings on 15th January induced survived rooted cutting having statistically the greatest value of stem dry weight during both 1990-1991 and 1991-1992 seasons.

With respect to the specific effect of preplanting treatments on stem dry weight / rooted cuttings Table (8-b) shows clearly that the heaviest stem dry weight was resulted by such survived rooted cuttings received the preplanting treatment of dipping in IBA at 4000 ppm with wounding application. Such trend was true during both 1990-1991 and 1991-1992 seasons. Moreover, both preplanting treatments of dipping the wounded and unwounded cuttings in IBA solution at 2000 and 4000 ppm respectively, came in a descending order next to the aforesaid superior one. On the other hand, the lowest stem dry weight of MM.106 apple rootstock rooted cuttings was induced by dipping the unwounded cuttings in water. Moreover, other preplanting treatments revealed a variable degree of efficiency on stem dry weight, but all were in between the previously mentioned two extents, i.e., superior and inferior ones during two seasons of 1989-1990 and 1990-1991.

With regard to the interaction effect where collecting dates were combined with the different preplanting treatments, data in Table (8-c) declared obviously that dipping in IBA

at 4000 ppm or 2000 ppm concentrations for the wounded cuttings collected on 15th January were the most effective combination's during two seasons. Hence, the heaviest stem dry weight was gained by those survived rooted cuttings developed from receiving the aforesaid two combinations followed in a descending order by those collected on the same date and received (wounding + 1000 ppm IBA), (no wounding + 4000 ppm IBA), (no wounding + 2000 ppm IBA) and finally (no wounding + 1000 ppm IBA), while wounding only ranked last. On the contrary, the water dipping of unwounded cuttings regardless of collection dates resulted in inducing survived rooted cuttings having the lightest stem dry weight during two seasons of study. Moreover, other investigated combinations were in between with variable degrees of variations however those of IBA applications tended to be more affective than the remained ones of such category.

Table (8) : Specific effect of collecgting date (a), Preplanting treatments (b) and interaction between collecting date of cutting and preplanting treatments (c) on Stem dry weight (After 6 months from transplanting) of M.M. 106 apple rootstock during 1990-1991 and1991-1992 seasons.

a) Specific effect of Collecting date

Collecting date	Stem D.W. (gm)	
	1990-1991	1991-1992
15/12	0.501	0.568
15/1	1.122	1.775
15/2	0.775	0.802
L.S.D at 5 %	**0.024**	**0.031**

b) Specific effect of preplanting treatments

Preplanting Treatments	Stem. D. W	
	1990-1991	1991-1992
Control	0.395	0.382
IBA 1000 ppm	0.647	0.660
IBA 2000 ppm	0.793	0.878
IBA 4000 ppm	0.943	1.014
Wounding.	0.482	0.501
+ IBA 1000 ppm	0.870	0.916
+ IBA 2000 ppm	1.068	1.112
+ IBA 4000 ppm	1.229	1.251
L.S.D at 5%	**0.039**	**0.051**

c) Interaction between collecting date X preplanting treatments .

Collecting Date / PreplantingTreatments	1990-1991			1991-1992		
	15/12	15/1	15/2	15/12	15/1	15/2
Control	0.230	0.554	0.400	0.242	0.533	0.372
IBA 1000 ppm	0.395	0.962	0.583	0.364	1.034	0.580
IBA 2000 ppm	0.481	1.133	0.768	0.619	1.231	0.782
IBA 4000 ppm	0.641	1.217	0.971	0.675	1.297	1.070
Wounding	0.291	0.664	0.431	0.299	0.890	0.514
+ IBA 1000 ppm	0.571	1.243	0.799	0.649	1.452	0.726
+ IBA 2000 ppm	0.652	1.507	1.044	0.791	1.520	1.022
+ IBA 4000 ppm	0.776	1.699	1.211	0.906	1.663	1.274
L.S.D at 5%		**0.050**			**0.023**	

IV.1.9. Root dry weight per survived rooted cutting :-

Referring specific effect of collecting date of MM.106 apple rootstock cuttings on root dry weight of the survived rooted cuttings, data in Table (9-a) revealed obviously that 15th January collection date induced significantly the heaviest root dry weight per rooted cutting during both 1990-1991 and 1991-1992 seasons. Moreover, preparing on 15th December resulted in the lightest stem dry weight, while 15th February collected cuttings were in between in this concern. Since, differences were significant at the 5% level as any of collection date was compared to the two other ones during two seasons of study.

With regard to the specific effect of the different eight preplanting treatments data in Table (9-b) cleared that preplanting treatments of dipping the cutting base in IBA (1000, 2000 and 400 ppm.) with or without wounding their basis, increased statistically the root dry weight per cuttings over control. However, dipping the wounded cuttings in the IBA at higher concentration (4000 ppm) was statistically the superior treatment for increasing root dry weight in both seasons. On the other hand, dipping in water only with or without wounding induced statistically the lowest value of roots dry weight during 1990-1991 and 1991-1992 seasons. In addition, other preplanting treatments were in between the above mentioned two extents with a variable degree of variance as they were compared each to other during two seasons of study.

With respect to the response to the interaction between collection dates x preplanting treatments, data in Table (9-c) it is quite clear that the rooted cuttings obtained from the combination between 15th January collection date and the preplanting treatment of dipping in IBA at 4000 ppm with wounding application showed statistically the heaviest roots dry weight as compared to the investigated other combinations during two seasons 1990-1991 and 1991-1992 of study. On the other hand, the lowest roots dry weight was statistically obtained by those rooted cuttings produced from dipping the unwounded cuttings in water only (control) irrespective of the collection date of cuttings during two seasons of study. In addition, other treatments (combinations) came in between the above mentoned two extents during both 1990-1991 and 1991-1992 seasons.

Table (9) : Specific effect of collecgting date of (a), Preplanting treatments (b) and interaction between collecting date of cutting and Preplanting treatments (c) on Root dry weight (After 6 months from transplanting) of M.M. 106 apple rootstock during 1990 -1991 and 1991-1992 seasons.

a) Specific effect of Collecting date

Collecting date	Root D.W. (gm)	
	1990-1991	1991-1992
15/12	0.190	0.195
15/1	0.278	0.282
15/2	0.204	0.203
L.S.D at 5 %	**0.009**	**0.009**

b) Specific effect of Preplanting treatments

Preplanting Treatments	Root Dr W. (gm)	
	1990-1991	1991-1990
Control	0.101	0.095
IBA 1000 ppm	0.150	0.149
IBA 2000 ppm	0.206	0.205
IBA 4000 ppm	0.329	0.303
Wounding.	0.107	0.108
+ IBA 1000 ppm	0.190	0.251
+ IBA 2000 ppm	0.301	0.288
+ IBA 4000 ppm	0.407	0.426
L.S.D at 5%	**0.015**	**0.016**

c) Interaction between Collecting date X preplaning treatments

Collecting Date / Preplantig Treatments	1990-1991			1991-1992		
	15/12	15/1	15/2	15/12	15/1	15/2
Control	0.042	0.114	0.047	0.041	0.102	0.040
IBA 1000 ppm	0.133	0.136	0.122	0.125	0.142	0.125
IBA 2000 ppm	0.184	0.233	0.201	0.170	0.242	0.202
IBA 4000 ppm	0.270	0.412	0.307	0.252	0.465	0.250
Wounding	0.077	0.136	0.106	0.089	0.133	0.101
+ IBA 1000 ppm	0.153	0.232	0.186	0.204	0.274	0.211
+ IBA 2000 ppm	0.255	0.413	0.237	0.276	0.368	0.251
+ IBA 4000 ppm	0.337	0.507	0.380	0.354	0.534	0.391
L.S.D at 5%		**0.021**			**0.039**	

IV.1.10. Total plant dry weight of survived rooted cutting:-

Table (10-a, b and c) shows clearly that the response of total plant dry weight of MM.106 apple rootstock rooted cuttings to the different investigated factors, i.e., date of preparing cuttings and some preplanting treatments, as well as their combinations during two seasons of 1990-1991 and 1991-1992.

With respect to the specific effect of collection date it could be noticed clearly that the heaviest plant dry weight was obtained from survived rooted cuttings reproduced by planting the 15th January collected cuttings followed in a descending order by those of 15th February and 15th December. However, the differences between three collecting dates were significant during 1990-1991 and 1991-1992 seasons.

Regarding the specific effect of preplanting application on total plant dry weight of MM.106 apple rootstock rooted cuttings, it is quite evident that the heaviest total plant dry weight was resulted by such survived rooted cuttings received the preplanting treatment of dipping in IBA at 4000 ppm with wounding application. Such trend was true during both 1990-1991 and 1991-1992 seasons. Moreover, both preplanting treatments of dipping the wounded and unwounded cuttings in IBA solution either at 1000 or 2000 ppm respectively came in descending order next to the aforesaid superior one. On the other hand, the lightest total plant dry weight of MM.106 apple rootstock rooted cuttings was induced by dipping the unwounded cuttings in water. However, other preplanting treatments revealed a variable degrees of efficiency on total plant dry weight, but all were in between the previously mentioned two extents, i.e., superior and inferior ones during two seasons of study.

As for the interaction effect between collecting dates that combined with the different preplanting treatments, data in Table (10-c) declared obviously that dipping in IBA at (4000 ppm) concentrations for the wounded cuttings collected on mid of both January and February besides those of 15th January collected cuttings of wounded or

unwounded bases dipped in IBA at 2000 or 4000 ppm respectively were statistically the most effective combination's during 1990-1991 and 1991-1992 seasons. However, the wounded - 15th January collected cuttings after being dipped in 4000 ppm IBA was the superior - combination (treatment) during two seasons of study but differences were still insignificant as compared to the other combinations of the same category. On the contrary, the water dipping of unwounded cuttings regardless of collection dates resulted in inducing survived rooted cuttings having lightest total plant dry weight during two seasons of study. Moreover, other investigated combinations were in between with variable degrees of variations.

Table (10) : Specific effect of collecgting date (a), preplanting treatments (b) and interaction between collecting date of cutting and preplanting treatments (c) on total plant dry weight (After 6 months from transplanting) of M.M. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

a) Specific effect of Collecting date

Collecting Date	Total plant D.W. (gm)	
	1990-1991	1991-1992
15/12	0.859	0.746
15/1	1.784	2.433
15/2	1.241	1.272
L.S.D at 5 %	**0.190**	**0.300**

b) Specific effect of preplanting treatments

Preplanting Treatments	Total plant D.W (gm)	
	1990-1991	1991-1992
Control	0.633	0.605
IBA 1000 ppm	1.016	1.025
IBA 2000 ppm	1.184	1.358
IBA 4000 ppm	1.604	1.656
Wounding.	0.742	0.772
+ IBA 1000 ppm	1.350	1.514
+ IBA 2000 ppm	1.729	1.763
+ IBA 4000 ppm	2.077	2.092
L.S.D at 5%	**0.064**	**0.075**

c) Interaction between Collecting date andpreplanting treatments

Collecting Date / PreplantingTreatments	1990-1991			1991-1992		
	15/12	15/1	15/2	15/12	15/1	15/2
Control	0.350	0.837	0.584	0.362	0.813	0.538
IBA 1000 ppm	0.664	1.415	0.730	0.619	1.503	0.897
IBA 2000 ppm	0.824	1.755	1.216	0.979	1.857	1.226
IBA 4000 ppm	1.133	2.069	1.613	1.145	2.189	1.693
Wounding	0.436	1.031	0.679	0.477	1.252	0.787
+ IBA 1000 ppm	0.919	1.901	1.235	1.061	2.151	1.195
+ IBA 2000 ppm	1.123	2.427	1.637	1.319	2.366	1.625
+ IBA 4000 ppm	1.371	2.769	2.011	1.559	2.733	2.081
L.S.D at 5%		**0.91**			**0.107**	

IV.2. Propagation of apple rootstocks by air-layering :-

The growth measurements determined with air-layering of MM.106 apple rootstock as related to the differential investigated propagation treatments were : rooting percentage, number and average length of developed roots, number of developed leaves / plant, dry weight of three plant organs (leaves, stem and root) as well as total plant dry weight were discussed. Meanwhile, No growth measurements were done for Mc.9 apple rootstock layers because the air-layering of this rootstock failed to root.

IV.2.1 The percentage of rooted air-layers :-

Data obtained regarding the response of rooting percentage of air layers to specific effect of both layering date and prelayering treatments as well as their different combinations, during both 1990-1991 and 1991-1992 seasons are presented in Table (11-a, b and c). Since, two dates of carrying out, air layering were investigated in combinations with three concentrations of IBA (1000 and 2000 ppm IBA) either wounding of layers base was done or not. The layering was carried out either on mid August or September 15th .

Regarding the specific effect of layering date on rooting percentage of air layers, data in Table (11-a) revealed that layering on August 15th exceeded statistically the later date (15th September) during both seasons.

As for the specific effect of prelayering treatments, data in Table (11-b) showed clearly that, there were significant differences among the studied treatments. The highest rooting percentage was recorded for air-layers treated with 2000 ppm IBA + wounding treatment. Such trend was true during both 1990-1991 and 1991-1992 seasons. On the contrary, prepared air-layers and treated with lanolin paste without IBA (control) showed lowest rooting percentage in both 1990-1991 and 1991-1992 seasons. Moreover, both

prelayering treatment of (1000 ppm IBA + wounding) and IBA at 2000 ppm without wounding ranked second, while two other treatments were in between.

Concerning the interaction effect (dates of carring out air-layers x prelayering treatments), data obtained in Table (11-c) revealed obviously that the rooting % was affected significantly by the interaction between various combinations of prelayering treatments x layering dates. In both seasons, air-layers treated with 2000 ppm IBA with or without wounding had the highest rooting percentage in 15th August than in 15th September. Moreover, untreated air-layers (control) had the lowest rooting percentage in 15th September than in 15th August. In addition, the differences among these interactions were significant these may be due to the effect of climate condition.

Table (11) : Specific effect of layering date (a), preplanting treatments (b) and interaction between layering date and prelayering treatments (c) on rooting percentage of layerd shoots (After 4 months from layering) of M.M. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

a) Specific effect of layering date

Layering date	Success %	
	1990-1991	1991-1992
15/8	67.08	67.47
15/9	37.92	39.82
L.S.D at 5 %	**1.57**	**1.67**

b) Specific effect of Prelayering treatments

Prelayering Treatments	Success %	
	1990-1991	1991-1992
Control	26.88	27.5
IBA 1000 ppm	45.63	46.88
IBA 2000 ppm	62.5	63.88
Wounding	41.88	37.45
+ IBA 1000 ppm	61.25	63.75
+ IBA 2000 ppm	76.88	77.52
L.S.D at 5%	**2.72**	**2.89**

c) Interaction between layering date X prelayering treatments

combinations / Prelayering Treatments	Layering date			
	1990-1991		1991-1992	
	15/8	15/9	15/8	15/9
Control	37.50	16.25	36.25	18.75
IBA 1000 ppm	60.00	31.25	61.25	32.50
IBA 2000 ppm	80.00	45.00	78.75	49.00
Wounding	53.75	30.00	47.50	27.40
+ IBA 1000 ppm	77.50	45.00	77.50	50.00
+ IBA 2000 ppm	93.75	60.000	93.79	61.25
L.S.D at 5%	**4.55**		**4.83**	

IV.2.2. Number of developed roots per plant :-

Regarding the effect of layering date, prelayering treatments (application the covered portion of layers with lanolin paste containing IBA at 0.00 (control), 1000 and 2000 ppm (with or without wounding) and their combinations on the number of developed roots / each layer, data obtained during two seasons of 1990-1991 and 1991-1992 are presented in Table (12-a, b and c) and illustrated in Figure (2-a and b).

Concerning the specific effect of layering date of air-layers, it is quite evident that the greatest number of roots was obtained by 15th August prepared air-layers. The increase was significant as compared to those of 15th September during two seasons of 1990-1991 and 1991-1992.

Referring to specific effect of the pre-layering treatments, data obtained during two seasons as shown in Table (12-b) revealed that both pre-layering treatments of layer base in IBA 1000 or 2000 ppm with or without wounding their basis induced statistically the highest number of roots/layer. The highest effect was obtained when IBA applied at 2000 ppm + wounding. The increase was significant in comparison with any of other pre-layers treatments investigated during both seasons. On the other hand, control treatment (neither wounding nor IBA were applied) was statistically the inferior pre-layering treatment during 1990-1991 and 1991-1992 seasons.

With respect to the response to the interaction effect between dates of layering carrying out x pre-layering treatments, it is quite clear that the number of roots pre-layer was affected significantly. In MM.106 apple rootstock, air-layers, treated with 2000 ppm IBA on 15th August had the highest number of roots per layer than in other combination. In addition, all combination of August 15th. resulted in increasing number of roots per layer significantly tham those of September 15th. as each prelayring treatment of a given layering date was compared to the corresponding one of the other date during both 1990/1991 and 1991/1992 seasons.

Table (12) : Specific effect of Layering date (a), Prelayering treatments (b) and interaction between layering date and Prelayering treatments (c) on number of Root (After 4 months from layering) of M.M. 106 apple rootstock during 1990-1991 and 19911992 seasons.

a) Specific effect of layering date

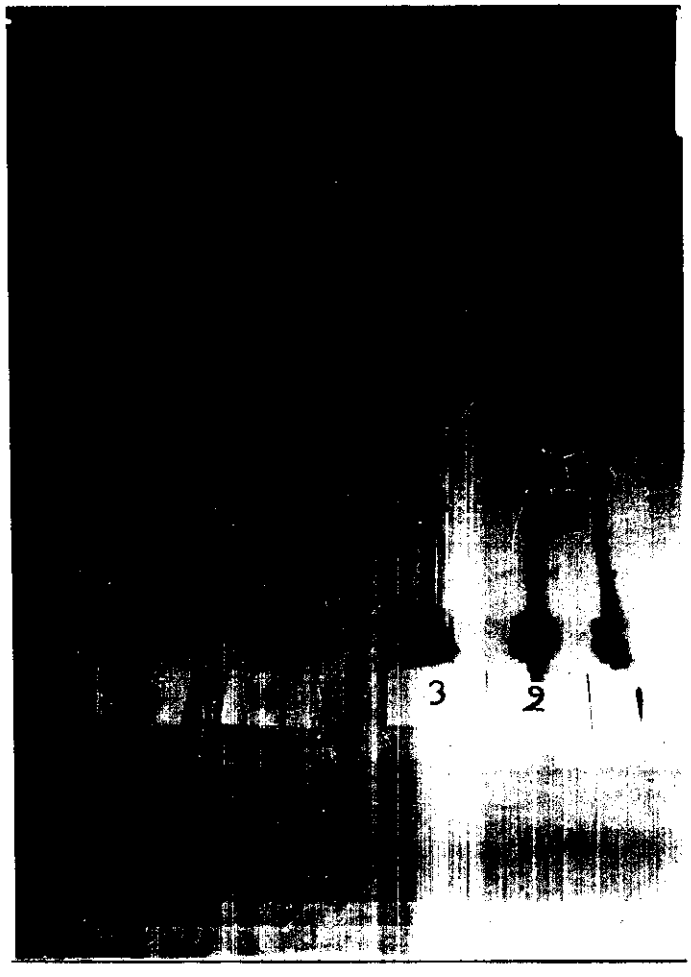
Layering date	Number of roots	
	1990-1991	1991-1992
15/8	4.23	4.37
15/9	2.76	1.54
L.S.D at 5 %	**0.06**	**0.07**

b) Specific effect of prelayering treatments

Prelyering Treatments	Number of roots	
	1990-1991	19911992
Control	1.93	1.88
IBA 1000 ppm	2.90	2.93
IBA 2000 ppm	3.96	4.25
Wounding.	2.65	2.42
+ IBA 1000 ppm	4.18	4.07
+ IBA 2000 ppm	5.31	5.26
L.S.D at 5%	**0.10**	**0.11**

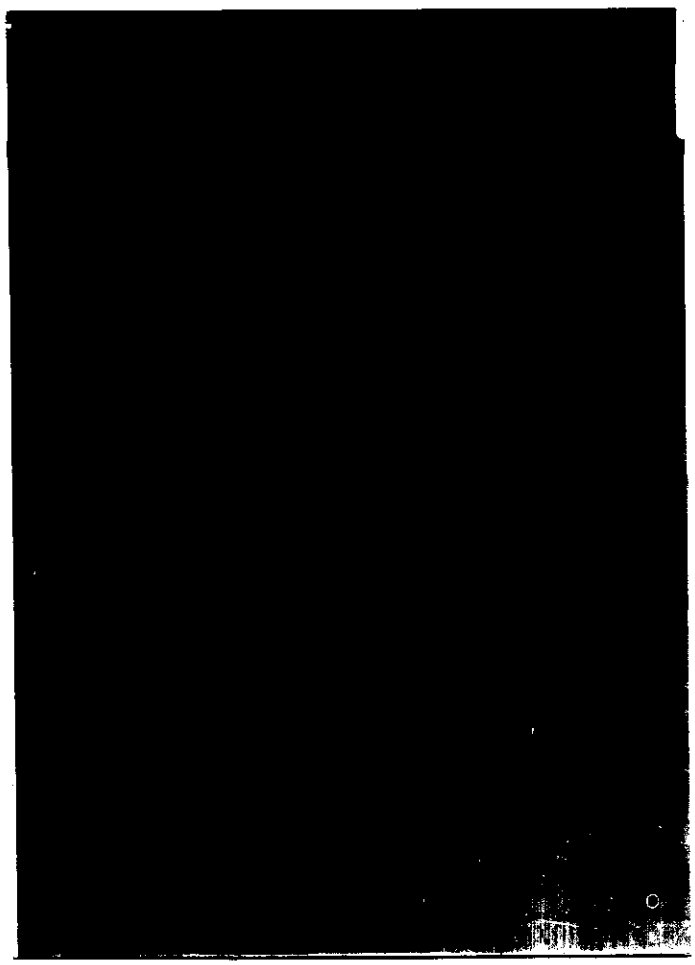
c) Interaction between layering date X Prelayering treatments

Combinations / Prelayering treatments	Layering Date			
	1990-1991		1991-1992	
	15/8	15/9	15/8	15/9
Control	2.20	1.65	2.13	1.63
IBA 1000 ppm	3.40	2.40	3.73	2.13
IBA 2000 ppm	5.03	2.90	5.52	2.98
Wounding	3.00	2.30	2.75	2.09
+ IBA 1000 ppm	5.15	3.20	5.33	2.80
+ IBA 2000 ppm	6.53	4.08	6.77	3.75
L.S.D at 5%	**0.55**		**0.63**	



1. Control.
2. 1000 ppm IBA.
3. 2000 ppm IBA.
4. 1000 ppm IBA + wounding.
5. 2000 ppm IBA + wounding.
6. Wounding only.

Fig (2-A): Air-layering of MM.106 apple rootstock shoots and their rooting under different IBA treatments and wounding preparing in 15th August.



1. Control.
2. 1000 ppm IBA.
3. 2000 ppm IBA.
4. 1000 ppm IBA + wounding.
5. 2000 ppm IBA + wounding.
6. Wounding only.

Fig. (2-B): Air-layering of Mc.9 apple rootstock shoots and their rooting under IBA treatments and wounding preparing in 15th September.

IV.2.3. Root length:-

The average length of roots developed per air-layers of MM.106 apple rootstock after four months from layering as influenced by the differential factors investigated during two seasons of 1990-1991 and 1991-1992, data obtained are tabulated in Table (13-a, b and c) and illustrated in Figure (2-A and B).

Concerning the specific effect of layering date on average root length / air-layer, it is quite evident that the tallest roots were induced by such layers prepared on 15th August, while the 15th September layering date induced statistically the shortest roots in comparison with that in 15th August air-layering date during 1990-1991 and 1991-1992 seasons.

With respect to the specific effect of different 6 pre-layering treatments, data in Table (13-b) cleared that the pre-layering treatment of treated the wounded layer with higher IBA concentration (2000 ppm) resulted in inducing the tallest roots. The increase was significant in comparison with any of the other pre-layering treatments investigated during both seasons. On the contrary, treated air-layers in water only without wounding (control) was the inferior pre-layering treatment, whereas the shortest root length of MM.106 apple rootstock air-layers was obtained during two seasons of study.

As for the interaction effect of (layering date x pre-layering treatments) on the root length of MM.106 apple rootstock air-layers, data obtained in Table (13-c) and Fig (2) showed that the combinations between pre-layering treatment of (IBA at 2000 ppm (irrespective of wounding application) from one side and two investigated layering dates (especially 15th August) from the other was the most effective treatments. Such trend was true during two seasons of study. However, the 15th August layering date which received the pre-layering application of treated in 2000 ppm IBA lanolin paste tended to declare its own relative superiority over the aforesaid other combinations. In addition, other investigated combinations showed a significantly increased root length over the control during 1990-1991 and 1991-1992 seasons.

Table (13) : Specific effect of Layering date (a), prelayering treatments (b) and interaction between layering date and prelayering treatments (c) on Root length (cm) (After 4 months from layering) of M.M. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

a) Specific effect of layering date

Layering date	Root length (cm)	
	1990-1991	1991-1992
15/8	7.06	7.55
15/9	4.56	4.13
L.S.D at 5 %	**0.10**	**0.08**

b) Specific effect of prelayering treatments

Prelayering treatments	Root length (cm)	
	1990-1991	1991-1992
Control	3.10	2.87
IBA 1000 ppm	4.67	4.79
IBA 2000 ppm	6.69	7.00
Wounding.	4.43	4.06
+ IBA 1000 ppm	7.13	6.86
+ IBA 2000 ppm	8.86	9.58
L.S.D at 5%	**0.18**	**0.15**

c) Interaction between layering date X prelayering treatments

Combinations / Prelayering Treatments	Layering Date			
	1990-1991		1991-1992	
	15/8	15/9	15/8	15/9
Control	3.50	2.70	3.41	2.33
IBA 1000 ppm	5.63	3.70	6.20	3.38
IBA 2000 ppm	8.48	4.89	9.10	4.90
Wounding	5.05	3.80	4.78	3.33
+ IBA 1000 ppm	8.90	5.35	8.99	4.72
+ IBA 2000 ppm	10.80	6.92	12.80	6.35
L.S.D at 5%	**0.30**		**0.25**	

IV.2.4. Stem length :-

Regarding the effect of layering date, pre-layering treatments (treated with IBA x wounding or nowounding application) and their combination on the stem length per each layer, data obtained during two seasons of 1990-1991 and 1991-1992 are presented in Table (14-a, b and c) and illustrated in Figure (2-a and b).

Concerning the specific effect of layering date, it is quite evident that the tallest stem length was obtained by 15th August air-layering. The increase was significant as compared to those of 15th September layering date during two seasons of 1990-1991 and 1991-1992.

Referring to specific effect of the pre-layering treatments, data obtained during two seasons of study as shown in Table (14-b) revealed that pre-layering treatment of treated the layer base with lanoline pastle contained IBA at 2000 ppm with wounding their basis induced statistically the highest stem per-layers. On the other hand, treated the base layer with lanoline pastle only without wounding was statistically the inferior pre-layering treatment. Moreover, other investigated treatments were in between with variable degree of variance, however, those of IBA with wounded the base of layers tended to be more effective than the remained ones of such category.

As for the interaction effect of air-layering date x pre-layering treatments on MM.106 apple rootstock, data in Table (14-c) cleared that the stem length of air-layers obtained from the combination between 15th August layering date and the pre-layering treatments of treated with IBA lanoline pastle at 2000 ppm with or without wounding treatment exceeded statistically other combinations during two seasons of 1990-1991 and 1991-1992. On the other hand, the shortest stem length was statistically obtained by those layers produced from treated unwounding layers with lanoline pastle only (control), regardless of layering date during two seasons of study. In addition, other treatments

(combinations) came in between the above mentioned two extents during both 1990-1991 and 1991-1992 seasons.

Table (14) : Specific effect of layering date (a) , prelayering treatments (b) and interaction between layering date and prelayering treatments (c) on stem length (cm) (After 4 months from layering) of MM. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

a) Specific effect of layering date

Leayering date	Stem Length (cm).	
	1990-1991	1991-1992
15/8	20.22	21.38
15/9	13.54	15.59
L.S.D at 5 %	**0.29**	**0.32**

b) Specific effect of prelayering treatments.

Treatments	Stem length (cm)	
	1990	1991
Control	9.42	8.82
IBA 1000 ppm	11.56	13.64
IBA 2000 ppm	19.88	21.26
Wounding	13.25	11.69
IBA 1000 ppm	20.88	20.32
IBA 2000 ppm	26.32	26.19
L.S.D at 5%	**00.50**	**00.55**

c) Interaction between layering date X Perlayering treatments

Combinations / Prelayering Treatments	Layering Date			
	1990-1991		1991-1992	
	15/8	15/9	15/8	15/9
Control	10.58	8.25	10.63	7.00
IBA 1000 ppm	12.00	11.11	16.63	10.65
IBA 2000 ppm	25.25	14.50	27.63	14.88
Wounding	15.13	11.37	13.13	10.25
+ IBA 1000 ppm	25.75	16.00	26.63	14.00
+ IBA 2000 ppm	32.63	20.00	33.63	18.75
L.S.D at 5%	**0.84**		**0.93**	

IV.2.5. Number of leaves per-layer :-

Referring the number of developed leaves after 4 months from layering date in response to the differential treatments investigated during both 1990 -1991and 1991 - 1992 seasons data obtained are tabulated in Table (15-a, b and c).

With regard to the specific effect of layering-date, it is quite evident that the 15th August-layering date induced significantly layers of the highest number of leaves per-layer as compared to 15th September during both seasons of study. In other words it could be concluded that air-layering of MM.106 apple rootstock on 15th August induced layers having statistically the greatest number of leaves during both 1990-1991 and 1991-1992 seasons, Table (15-a).

As for the specific effect of prelayering treatments on number of leaves/layers table (15-b) shows clearly that treatment of (wounding +lanolene paste containing IBA at 2000 ppm) was the superior as induced layers with the greatest number of leaves. Moreover, both prelayering treatments of (applying IBA lanolene paste at 2000 ppm without wounding) and (wounding + IBA at 2000 ppm) were equally of the same effectiveness from one hand and ranked statistically second to the superior from the other during two seasons of study. On the contrary control (neither wounding nor application were done) was the inferior. However, other prelayering treatments were in between the above mentioned two extents during both 1990-1991 and 1991-1992 seasons.

As for the interaction effect of air-layering date x pre-air-layer treatment on MM.106 apple rootstock, data in Table (15-c) declared obviously that, treating with wounding + IBA at 2000 ppm concentration for shoots layered on 15th August was the most effective combination during both 1990-1991 and 1991-1992 seasons. Since the highest number of leaves / air-layer was gained by those air-layer developed from wounded air-layer prepared and treated with IBA at 2000 ppm on 15th August. On the contrary, the water treated of unwounded layers regardless of layering-dates resulted in

inducing air-layers having the lowest number of leaves during two seasons of study. Moreover, other investigated combinations were in between with variable degree of variations, however, those of IBA applications tended to be more affective than the remained ones of such category.

Table (15) : Specific effect of Layering date (a), Prelayering treatments (b) and interaction between layering date and Prelayering treatments (c) on Number of leaves (After 4 months from layering) of M.M. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

a) Specific effect of layering date

Layering date	Number of leaves	
	19901991	1991-1992
15/8	7.00	7.21
15/9	4.13	3.93
L.S.D at 5 %	**0.15**	**0.16**

b) Specific effect of Prelayering treatments

Prelayering treatments	Number of Leaves	
	1990-1991	1991-1992
Control	2.88	2.75
IBA 1000 ppm	4.82	4.82
IBA 2000 ppm	6.37	6.32
Wounding.	4.31	4.25
+ IBA 1000 ppm	6.51	6.5
+ IBA 2000 ppm	8.5	8.79
L.S.D at 5%	**0.25**	**0.27**

c) Interaction between layering date X Prelayering treatments

Combinations / Prelayering treatments	Layering date			
	1990-1991		1991-1992	
	15/8	15/9	15/8	15/9
Control	3.75	2.00	3.62	1.88
IBA 1000 ppm	6.13	3.50	6.25	3.38
IBA 2000 ppm	8.00	4.75	7.75	4.88
Wounding	5.37	3.25	5.75	2.75
+ IBA 1000 ppm	8.13	4.88	8.62	4.38
+ IBA 2000 ppm	10.63	6.37	11.29	6.29
L.S.D at 5%	**0.45**		**0.55**	

IV.2.6. Leaves dry weight . : prelayer:-

Data obtained during both 1990-1991 and 1991-1992 seasons regarding the leaves dry weight gained by air-layers of MM.106 apple rootstock in response to the two layering dates and pre-layering treatments either solely or in combination are tabulated in Table (16-a, b and c).

Referring specific effect of layering date on leaves dry weight of MM.106 apple rootstock, data in Table (16-a) revealed obviously that 15th August layering date induced significantly the heaviest leaves dry weight . Pre layer during both 1990-1991 and 1991-1992 seasons. Moreover, preparing air-layers on 15th September resulted in the lightest leaves dry weight during two seasons of study. Since, differences were significant at the 5% level as two layering date was compared during two seasons of study.

With regard to the specific effect of pre-layering treatments on leaves dry weight of air-layers of MM.106 apple rootstock, data obtained in Table (16-b) during two seasons of study declare that, treated wounded base of air-layers in lanoline paste with IBA at 2000 ppm resulted statistically in the heaviest leaves dry weight followed by those of treated in IBA at both 1000 / 2000 ppm IBA for the wounded and unwounded layers, respectively. Moreover, both pre-layering treatments of treated the unwounded / wounded cuttings in IBA at 1000 ppm, respectively, came statistically next to the above mentioned other treatments from one hand as they were of the same effectiveness from the other side during two seasons of study. In addition, the wounded treatment with lanoline pastle was the least effective ones, treated of unwounded layers in lanoline pastle only (control) came last in the same order during two seasons of study.

As for the interaction effect of layering dates x pre-layering treatments of MM.106 apple rootstock, data in Table (16-c) showed clearly that preparing air layering on 15th August by wounded + treating with paste containing IBA at 2000 ppm was the superior combination (treatment) during two seasons of study.

On the contrary, the lightest leaves dry weight of MM.106 apple rootstock layers was generally produced by such unwounded, layers of no IBA applied regardless of their layering dates. In addition, other combination, were in between the above mentioned two extents.

Generally, it could be concluded that preparing layers of MM.106 apple rootstock on 15th August that treated with IBA at 2000 ppm + wounding was the most effective treatment for increasing the leaves dry weight of air-layers.

Table (16) : Specific effect of Layering date (a), Prelayering treatments (b) and interaction between layering date and prelayering treatments (c) on Leaves dry weight (After 4 months from layering) of M.M. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

a) Specific effect of layering date

Layering date	Leaves dry weight (gm)	
	1990-1991	1991-1992
15/8	0.210	0.218
15/9	0.125	0.116
L.S.D at 5 %	**0.060**	**0.050**

b) Specific effect of prelayering treatments

Prelayering Treatments	Leaves Dry weight (gm)	
	1990-1991	1991-1992
Control	0.083	0.084
IBA 1000ppm	0.142	0.141
IBA 2000 ppm	0.190	0.196
Wounding.	0.126	0.127
+ IBA 1000 ppm	0.200	0.198
+ IBA 2000 ppm	0.264	0.256
L.S.D at 5%	**0.010**	**0.009**

c) Interaction between layering date X Prelayering treatments

Combinations / Prelayering treatments	Layering Date			
	1990-1991		1991-1992	
	1518	1519	1518	1519
Control	0.103	0.064	0.114	0.054
IBA 1000 ppm	0.179	0.105	0.178	0.104
IBA 2000 ppm	0.242	0.140	0.245	0.146
Wounding	0.156	0.095	0.174	0.081
+ IBA 1000 ppm	0.248	0.151	0.259	0.138
+ IBA 2000 ppm	0.335	0.192	0.340	0.173
L.S.D at 5%	**0.011**		**0.010**	

IV.2.7. Stem dry weight prelayer :-

Table (17-a, b and c) show the specific effect of layering dates and prelayering application with lanoline base containing different of IBA concentrations on the dry weight of stem per-layer of MM.106 apple rootstock in both seasons of study.

As for the specific effect of layering date, data obtained in Table (17-a) showed the significant differences among the two studied layering dates during 1990-1991 and 1991-1992 seasons. The results showed that the highest effect was obtained when air-layers was done on 15th August during both seasons of study. Nevertheless, differences between two layering date (15th August and 15th September) was statistically significant.

Regarding the specific effect of pre-layering treatments on stem dry weight, data obtained in Table (17-b) cleared that the heaviest stem dry weight was resulted by air-layers received that pre-layering treatment of lanoline pastle with IBA at 2000 ppm with wounding application. Such trend was true during both 1990-1991 and 1991-1992 seasons. Moreover, both pre-planting treatments of applying the wounded and unwounded layers with IBA either at 1000 or 2000 ppm, respectively came in a descending order next to the aforesaid superior one. On the other hand, the lowest stem dry weight of MM.106 apple rootstock air-layers was induced by that layers of the unwounded bases treated with lanoline paste have not IBA during 1990-1991 and 1991-1992 seasons.

With respect to the interaction effect, Table (17-c) declared obviously that treating the basis of wounded air-layers with IBA at 2000 ppm concentration prepared on 15th August was the most effective combination's during 1990-1991 and 1991-1992 seasons. Hence, the heaviest stem dry weight was gained by air-layers developed from receiving the aforesaid combinations. Moreover, both combinations of layering on the same date (15th August) which received IBA at 2000 ppm without wounding and IBA at 1000 ppm + wounding come second to the aforesaid superior one. On the contrary, treating layers of

the unwounded base with lanoline pastle only treated of unwounded air-layers regardless of preparing dates resulted in inducing plants having the lightest stem dry weight during two seasons of study. Moreover, other investigated combinations were in between with variable degrees of variations during 1990-1991 and 1991-1992 seasons.

Table (17) : Specific effect of Layering date (a), Prelaying treatments (b) and interaction between layering date and Prelayering treatments (c) on Stem dry weight (After 4 months from layering) of M.M. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

a) Specific effect of layering date

Leayering date	Stem dry weight (gm)	
	1990-1991	1991-1992
15/8	0.657	0.682
15/9	0.418	0.390
L.S.D at 5 %	**0.012**	**0.014**

b) Specific effect of Prelayering treatments

Prelayering treatments	Stem D.W. (gm)	
	1990-1991	1991-1992
Control	0.288	0.268
IBA	0.435	0.4500
IBA 2000 ppm	0.636	0.670
Wounding.	0.414	0.366
+ IBA 1000 ppm	0.643	0.628
+ IBA 2000 ppm	0.807	0.835
L.S.D at 5%	**0.022**	**0.025**

c) Interaction between layering X prelayering treatments

Combinations / Prelayering Treatments	Layering Date			
	1990-1991		1991-1992	
	15/8	15/9	15/8	15/9
Control	0.329	0.248	0.316	0.220
IBA 1000 ppm	0.526	0.344	0.582	0.318
IBA 2000 ppm	0.802	0.469	0.891	0.449
Wounding	0.477	0.352	0.412	0.320
+ IBA 1000 ppm	0.791	0.496	0.829	0.427
+ IBA 2000 ppm	1.014	0.601	1.064	0.605
L.S.D at 5%	**0.026**		**0.030**	

IV.2.8. Root dry weight per air-layer:-

Concerning the response of root dry weight of MM.106 apple rootstock air-layer to the different combinations between layering dates and some per-layering treatments, data obtained during two seasons of 1990-1991 and 1991-1992 are presented in Table (18-a, b and c).

Regarding the specific effect of air-layering date, data obtained in Table (18-a) showed that air-layers prepared on 15th August induced air-layers exceeded statistically those of the 15th September in their root dry weight during the two seasons of study.

As for the specific effect of pre-layering treatments on root dry weight, data presented in Table (18-b) show that the highest dry weight of roots was recorded from treating the wounded base of layers with 2000 ppm IBA during first and second seasons, followed by that treated with 1000 ppm IBA + wounding the base. Moreover, both pre-layering treatments of treated the unwounded layers with IBA pastle either at 2000 or 1000 ppm, respectively came in a descending order third and fourth the aforesaid superior one. On the other hand, the lowest root dry weight of MM.106 apple rootstock air-layering was induced by treating shoots of unwounded base treated with lanoline paste containing no IBA during two seasons of 1990-1991 and 1991-1992.

With regard to the interaction effect layering dates x pre-layering treatments, data in Table (18-c) declared obviously that prelayering treatments of August 15th. prepared shoots of MM.106 apple rootstock with 2000 ppm. IBA + wounding had resulted in the heaviest root dry weight per air-layer. On the other hand, layering on August or on 15th September of the unwounded shoot base without IBA had resulted in the lowest value of root dry weight perlayer during both 1990-1991 and 1991-1992. Moreover, other investigated combinations were in between with variable degree of variations, however, those of IBA applications tended to be the more effective than the remained ones of such category.

Table (18) : Specific effect of Layering date (a), prelayering treatments (b) and interaction between layering date and prelayering treatments (c) on Root dry weight (After 4 months from layering) of M.M. 106 apple rootstock during 1990-1991 and 1991-1992 seasons.

a) Specific effect of layering date

Leayering date	Root dry weight (gm)	
	1990-1991	1991-1992
15/8	0.174	0.185
15/9	0.115	0.104
L.S.D at 5 %	**0.005**	**0.004**

b) Specific effect of Prelayering treatments

Prelayering Treatments	Root dry weight (gm)	
	1990-1991	1991-1992
Control	0.076	0.070
IBA	0.122	0.121
IBA 2000 ppm	0.160	0.180
Wounding.	0.110	0.102
+ IBA 1000 ppm	0.175	0.172
+ IBA 2000 ppm	0.225	0.223
L.S.D at 5%	**0.009**	**0.008**

c) Interaction between layering date X prelayering treatments

Combination / prelayering treatments	Layering date			
	1990-1991		1991-1992	
	15/18	15/19	15/18	15/19
Control	0.086	0.066	0.086	0.055
IBA 1000 ppm	0.142	0.102	0.154	0.087
IBA 2000 ppm	0.200	0.120	0.255	0.124
Wounding	0.124	0.096	0.118	0.086
+ IBA 1000 ppm	0.215	0.135	0.277	0.116
+ IBA 2000 ppm	0.280	0.169	0.291	0.155
L.S.D at 5%	**0.010**		**0.009**	

IV.2.9. Total plant dry weight per air-layer:-

Data presented in Table (19-a, b and c) show the response of total plant dry weight of MM.106 apple rootstock developed by air-layering to the different investigated factors, i.e., date of layering and pre-layering treatments as well as their combinations during two seasons of 1990-1991 and 1991-1992.

Referring specific effect of layering dates (Table, 19-a) it could be noticed clearly that layering on August 15th. induced significantly heavier plant dry weight than those of 15th September during both 1990-1991 and 1991-1992 seasons.

With regard to the specific effect of pre-layering treatments on total plant dry weight / air-layers Table (19-b) shows clearly that treating with wounding + IBA at 2000 ppm, MM.106 apple rootstock with IBA at 2000 ppm resulted significantly in inducing the heaviest total plant dry weight during both seasons of study. However, treated unwounded layers with lanoline pastle only induced air-layers of the lowest value of total plant dry weight during the study. In addition, other investigated pre-layering treatments were statistically in between the above mentioned two extents during both 1990-1991 and 1991 -1992 seasons.

As for the interaction effect of (layering date x pre-layering treatments) on the total plant dry weight of MM.106 apple rootstock layerings, data obtained in Table (19-c) showed that the combinations between pre-layering treatments with IBA at 1000/2000 ppm (irrespective of wounding application) from one side and two investigated pre-layering dates (especially 15th August) from the other, all were the most effective treatments. Such trend was true during two seasons of study, however, the 15th August pre-layering date which received wounding + 2000 ppm. IBA tended to declare its own relative superiority over the aforesaid other combinations. In addition, the increase of total plant dry weight was significant in comparison with the other investigated combinations during both 1990-1991 and 1991-1992 seasons.

Table (19) : Specific effect of prelayering Layering date (a), prelayering treatments (b) and interaction between layering date and prelayering treatments (c) on Total plant dry weight (After 4 months from layering) of M.M. 106 apple rootstock during 1990-1991and1991-1992 seasons.

a) Specific effect of layering date

Leayering date	Total plant dry weight (gm)	
	1990-1991	1991-1992
15/8	1.024	1.098
15/9	0.658	0.610
L.S.D at 5 %	**0.050**	**0.029**

b) Specific effect of prelayering treatments

Prelayering Treatments	Total plant dry weight (gm)	
	1990-1991	1991-1992
Control	0.398	0.428
IBA	0.699	0.712
IBA 2000 ppm	0.986	1.046
Wounding.	0.650	0.595
+ IBA 1000 ppm	1.018	0.998
+ IBA 2000 ppm	1.296	1.314
L.S.D at 5%	**0.086**	**0.050**

c) Interaction between layering date X prelayering treatments

Combinations / Prelayering Treatments	Layring Date			
	1990-1991		1991-1992	
	15/18	15/19	15/18	15/19
Control	0.418	0.378	0.516	0.329
IBA 1000 ppm	0.847	0.552	0.914	0.509
IBA 2000 ppm	1.244	0.729	1.391	0.719
Wounding	0.757	0.543	0.704	0.487
+ IBA 1000 ppm	1.254	0.782	1.365	0.681
+ IBA 2000 ppm	1.629	0.962	1.695	0.933
L.S.D at 5%	**0.101**		**0.059**	

Generally, it could be concluded that MM.106 apple rootstock propagation by air-layering without the use of IBA was unsuccessful. Yet by treated the girded area of the layers by IBA in lanoline, successful results were obtained. The best effect was obtained when IBA was applied at the concentration of 2000 ppm with wounding the base of layers. Moreover, the use of IBA increased rooting %, number of roots, root length, shoot length, number of leaves / layer and dry weight of plant organs (Leaves, stem and roots) as well as total plant dry weight.

The results are in according with the findings of **Sriva Stav (1961)** on mango, **Verma et al., (1970), Bhujabal (1973),** on guava, **Fontanazza (1973)** on **Zewail (1976)** on Casia nodosa, and **Eid (1980)** on guava. They all found that treating the girdled area of marcoots by using IBA increased rooting percentage especially at the high concentration (1000 ppm) in mango, 3000 ppm and 7000 ppm in guava, 3000 ppm in Hazel and 4000 ppm in Casia nodosa). Moreover the same treatments increased the number, length, fresh and dry weight of roots per marcot.

Regarding the propagation time, the results are in harmony with **Rao (1958)** on cashew, who found that rooting successfully initiated at any month except June and July. Moreover, he found that the best results were obtained when propagation take place from August to April.

Anatomical study :-

Anatomy of apple cuttings and air-layering :-

Firstly, it is worthy to mention that microscop scrutinization showed that there are no differences between the behaviour of both air-layering and cuttings in the rooting process.

Based on results obtained in the first part of this study, we have going, in the second one, to determine some anatomical factors which have been reported to be effective in rooting pattern.

Anatomical structure of apple rootstock :-

Figs (3 and 4, a and b) show the cross sections of one-year-old wood of MM.106 and Mc.9 apple rootstocks, respectively. It is clear that the outer layer was covered by periderm (pr) which was composed of several phylum layers. A thick layer of cork was observed, followed inward to the phellum layer there was the cortex mainly consisted of about 6-8 layers (in width) of parenchymatic cells. In the cortex, it was observed scleroids (s) and continuous sclerenchmatic sheath. The vascular system was found inside the cortex. The phloem composed of sieve tubes, companion cells, phloem parenchyma and fibers.

It is worthy to mention that results of this study lead us to conclude that MM.106 and Mc.9 apple rootstocks, are in general difficult to root. Also, no relationship was distinctly observed between the endogenous root promoting substances or nutritional status of shoots and their ability to root.

Thus, suggestion could be introduced from the other side of view, that there are some endogenous factors other than those previously investigated, mainly may affect the rooting potential of MM.106 and Mc.9 apple rootstocks. One of these factors is the anatomical structure. Studying such anatomical factors may shed more light on the apple

stem, to root. Moreover, stone cells were found in secondary phloem. A complete layer of cambium ring separating the phloem from the xylem.

Xylem was found to be mainly consists of fibers which appeared to be covered more than 50% of the wood structure. Xylem rays in MM.106 rootstock showed the multiserial type and was uniseriate type in Mc.9. In addition; it is obvious that the xylem rays Join the pith with the cortex and mainly consist of parenchyma cells.

Root initiation :-

During this study root primordia were initiated from different tissues of MM.106 apple rootstocks performed root initials, cambium and the pith. As for Mc.9, the cambium was the only tissue that resumed its activity, to produce root primordia, that may explain the high percentage of rooting in MM.106 than those in Mc.9 apple rootstock. The growth of root primordia continued and penetrated through different tissues. Even that stage the continuous sclerenchymatic sheath and the compact tissue in Mc.9 prevent the growth of the root primordia and stopped it to penetrate outward. It was also found that some of root primordia were surrounded by sclerieds of the compact tissues, which acted as mechanical and non permeable layer, such layer, stopped their development outward (Figs. 3 and 4d) this lead to suggest that the low percentage of Mc.9 to root may be due to the presence of continuous scleronchymatic sheath which played as mechanical barrier. Moreover, compactness of tissue of Mc.9 may act as nonpermeable as hard layer for the development of some root primordia.

Wounding were greatly affected in rooting process of MM.106 which rapured the continuous sheath of sclerieds to facilitate the penetrate and development of adventions root through different tissues of the shoot.

The aforementioned anatomical structure of apple rootstocks, is nearly the same to what had been previously reported for different members of family Rosaceae described by **Metcalf and Chalk (1950).**

On the other hand, suggestion previously introduced in this study for high percentage and low percentage to root is agreed with the findings of **Cimpl and Gellini (1958).** They mentioned that the main reason for the difficulty in rooting of olive cuttings appeared to be the presence of a more or less continuous sheath of pericycle fibers which induce a mechanical barrier to the emergence of the newly formed rootslets. Moreover; these findings coincide those found by **Makarem (1985).**

Also; **Wally et al., (1980)** working on pecan found that root primordia were initiated from pith parenchyma and that the hard structure of the xylem was found to exert mechanical barrier which inhibit developing of roots.

From the aforementioned results, it is obvious that the one-year-old shoot air-layering of Mc.9 rootstock are difficult to root mainly due to some anatomical factors. Moreover; the high percentage of rooting in MM.106 than those of Mc.9 due to that root primordia were initiated from performed root initial, cambium and pith in MM.106 and from only the cambium zone in Mc.9.

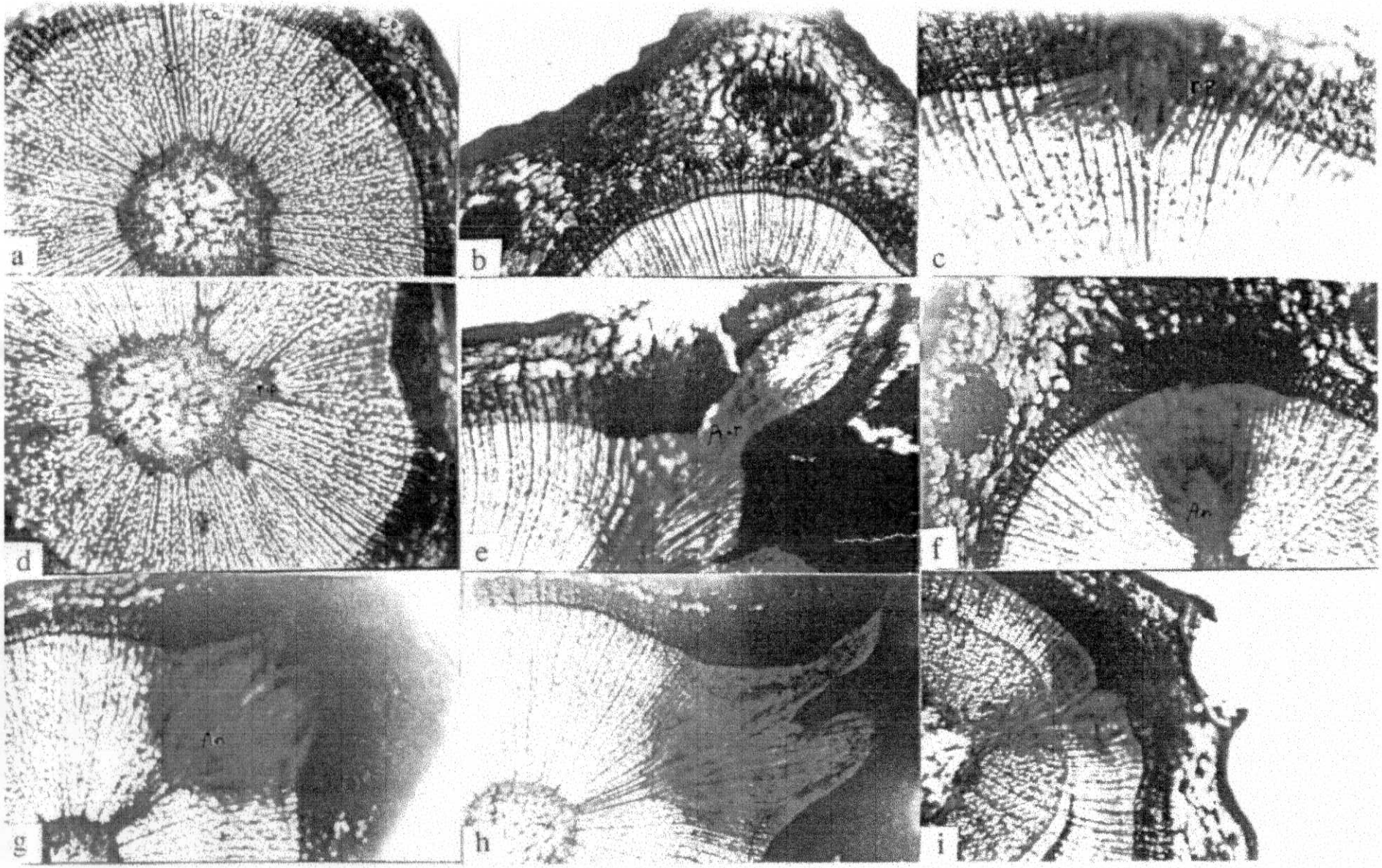


Fig. (3) Show the steps of adventitious root formation of MM 106 apple air-layering as affected by root promoting substances and wounding; a) Cross section of MM 106 apple showing different tissues. b, c and d) different root primordia which originated from performed root initials (b), from cambium zone (c) and from pith (d) e and f) The development of adventitious roots from cambium and pith. I) The effect of wounding on adventitious root penetrating. x = 40.

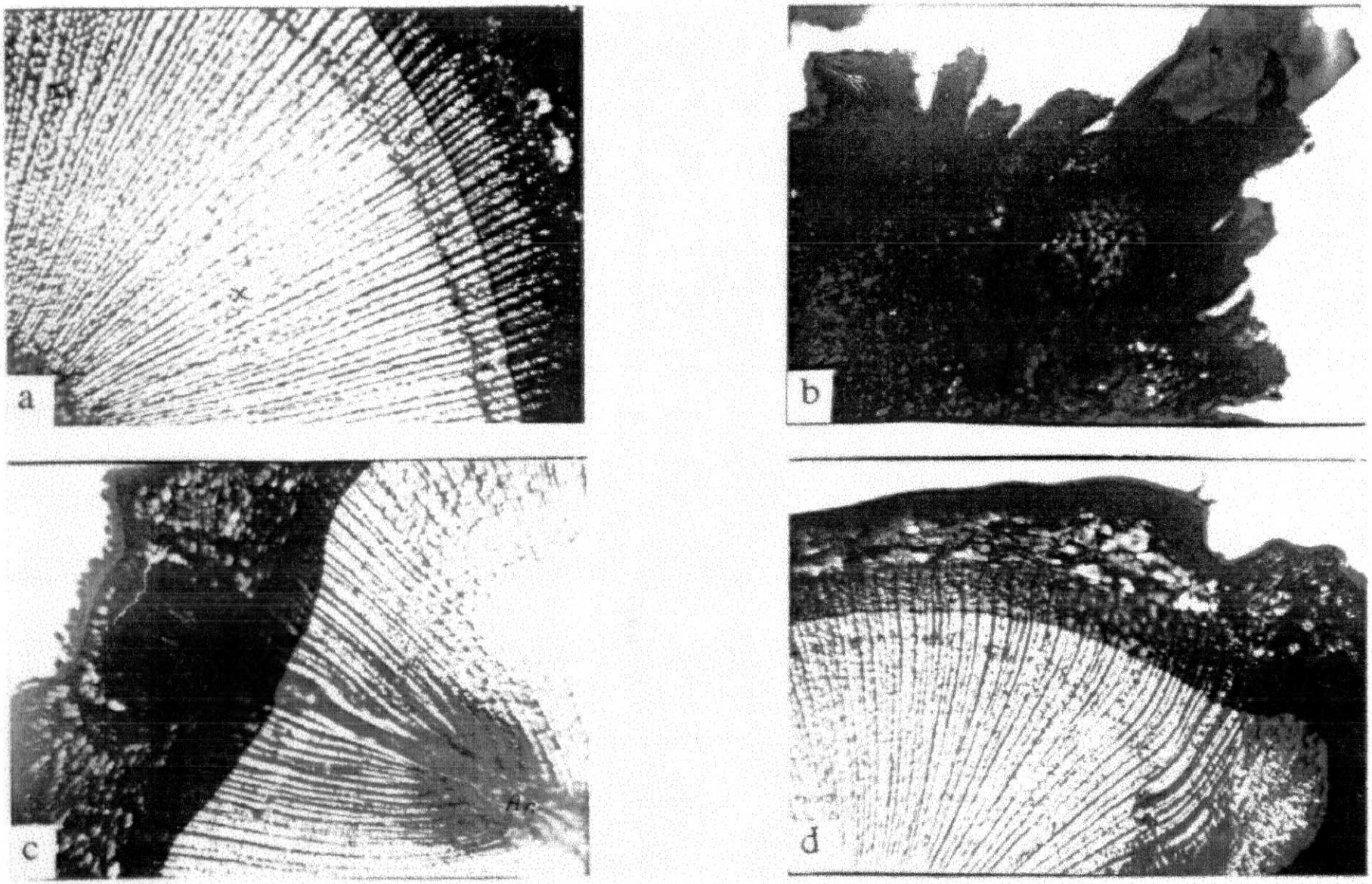


Fig. (4) Show the steps of adventitious root formation of Mac 9 apple air-layering as affected by root promoting substance wounding; a) Cross section of Mac 9 apple showing different tissues.
b) Formation of callus tissue. c) Formation of adventitious root. d) The effect of wounding on adventitious.