STUDIES ON THE VEGETATIVE PROPAGATION OF ALMOND

RESULTS AND DISCUSSION

Table (1): Response of Marianna 2624 plum softwood cuttings planted under mist to wounding and some growth regulators treatments (prepared in May, 1992 & 1993).

Treatment	Rooting (%)		Survival (%)		Shoot length (cm.)		Shoot diameter (mm.)		No. of lateral shoots / transplant		No. of leaves / transplant		Total root length (cm.)		No. of lateral roots / transplant		Shoot dry weight (g.)		Root dry weight (g.)	
	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
Tap water (control)	16.10 a	19.60 a	11.47 a	11.57 a	12.47 a	11.87 a	2.43 a	2.23 a	1.30 a	1.07 a	5.00 a	3.27 a	9.13 a	8.40 a	1.27 a	1.07 a	0.37 a	0.90 a	0.53 a	1.40 a
Wounding (W)	35.47 b	37.93 b	33.60 b	29.53 b	45.30 f	38.53 h	2.40 a	3.70 bc	1.43 ab	2.50 c	8.87 b	9.53 b	26.93 e	24.97 e	1.43 a	4.57 b	0.80 b	2.10 b	1.00 b	3.10 b
(W)+ 3000 ppm IBA	77.07 g	79.97 fg	63.20 e	68.17 f	47.03 g	35.78 g	4.20 b	5.97 d	2.53 d	3.13 d	17.43 e	16.80 d	19.00 c	27.17 f	2.53 cd	12.33 c	1.77 d	3.93 d	1.90 d	5.07 d
(W)+ 6000 ppm IBA	99.10 I	99.47 h	88.63 g	92.83 h	61.27 I	56.63 j	8.73 e	11.03 f	4.13 f	5.20 g	29.47 h	34.43 h	29.60 f	35.73 g	3.93 e	30.30 g	2.80 f	5.73 f	3.47 g	7.67 e
(W)+ 9000 ppm IBA	84.43 h	85.63 g	73.50 f	76.50 g	53.37 h	42.93 I	7.07 d	7.10 e	3.07 e	4.07 f	21.53 g	21.90 f	21.90 d	26.63 ef	2.86 d	17.93 e	2.23 e	4.33 e	2.40 e	5.47 d
(W)+ 1000 ppm NAA	52.93 d	56.63 d	40.93 c	46.40 d	30.13 d	23.78 e	6.20 c	3.67 bc	2.27 cd	2.40 bc	15.13 d	19.80 e	20.40 cd	11.77 b	2.63 cd	12.30 c	1.80 d	2.46 bc	1.87 d	3.10 b
(W)+ 2000 ppm NAA	61.83 e	66.10 e	52.00 d	55.43 e	35.90 e	29.13 f	7.10 d	5.87 d	2.53 d	3.63 e	19.80 f	27.07 g	25.80 e	20.27 d	2.43 c	17.70 e	1.86 d	3.50 d	2.20 e	4.47 c
(W)+ 4000 ppm NAA	42.73 c	44.87 c	31.77 b	35.03 c	16.90 b	15.47 b	3.80 b	3.23 b	2.11 c	2.43 bc	12.37 c	13.40 c	14.63 b	14.00 b	1.90 b	5.97 b	0.60 b	2.17 b	1.10 b	3.00 b
(W)+ 250 ppm PP_{333}	72.03 f	77.57 f	60.97 e	65.43 f	21.80 c	21.50 d	7.23 d	7.33 e	3.07 e	4.30 f	21.30 g	26.83 g	18.83 c	17.33 c	3.13 d	20.43 f	2.07 e	4.43 e	2.70 f	5.30 d
(W)+ 500 ppm PP_{333}	54.43 d	57.83 d	40.97 c	43.70 d	20.47 c	20.90 d	5.97 c	4.77 c	2.63 d	2.57 c	18.73 ef	19.83 e	18.56 c	16.87 c	2.67 cd	14.43 d	1.80 d	2.93 c	2.30 e	3.43 b
(W)+1000 ppm PP_{333}	45.73 c	44.10 bc	32.37 b	28.40 b	16.03 b	18.67 c	3.77 b	4.27 c	1.77 b	2.00 b	12.40 c	15.57 f	15.43 b	16.40 c	1.90 b	12.50 c	1.33 c	2.47 bc	1.60 c	3.17 b

Means followed by same letter (s) within each column are not significantly different from each other at 5% level.

Table (2): Response of Okenawa peach softwood cuttings planted under mist to wounding and some growth regulators treatments (prepared in May, 1992 & 1993).

Treatment	Rooting (%)		Survival (%)		Shoot length (cm.)		Shoot diameter (mm.)		No. of lateral shoots / transplant		No. of leaves / transplant		Total root length (cm.)		No. of lateral roots / transplant		Shoot dry weight (g.)		Root dry weight (g.)	
	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
Tap water (control)	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
Wounding (W)	14.90 b	16.33 b	13.23 b	9.23 b	13.27 b	15.40 b	3.27 b	2.73 b	1.43 b	1.57 b	4.00 b	5.03 b	11.87 b	13.60 bc	1.43 b	4.20 b	0.77 b	1.03 b	0.87 b	1.27 b
(W)+ 3000 ppm IBA	69.33 e	72.50 f	41.73 d	51.20 g	21.03 c	25.13 d	4.60 c	4.20 d	2.37 bc	3.43 d	9.07 d	13.20 d	17.00 c	18.57 d	5.87 c	9.77 d	2.23 d	2.10 d	2.40 d	2.60 d
(W)+ 6000 ppm IBA	91.00 g	89.30 h	60.37 f	61.90 h	34.27 f	34.27 f	8.20 h	10.17 h	4.97 d	6.20 f	22.13 g	37.03 h	32.20 f	35.53 f	13.90 f	24.33 h	3.57 f	4.33 g	3.80 f	4.50 g
(W)+ 9000 ppm.IBA	76.23 f	73.83 f	43.73 d	48.47 g	32.53 e	25.00 d	6.57 f	7.93 g	3.43 c	4.13 e	11.53 e	24.40 g	27.63 e	23.70 e	9.00 d	18.73 g	2.77 e	2.43 e	2.90 e	3.20 e
(W)+ 1000 ppm NAA	15.17 b	22.17 c	13.40 b	16.27 d	20.33 c	18.67 c	5.40 d	3.30 c	2.56 c	1.77 bc	8.00 c	8.67 c	17.07 c	13.20 bc	5.77 c	6.00 c	1.60 c	1.80 c	1.77 c	2.03 c
(W)+ 2000 ppm NAA	38.00 c	44.90 e	31.33 c	32.90 e	26.67 d	28.20 e	6.07 e	5.03 e	3.23 c	3.07 d	12.87 f	17.27 e	19.73 d	17.57 d	10.30 e	12.37 ef	1.73 c	2.53 e	2.33 d	2.50 d
(W)+ 250 ppm PP_{333}	64.33 d	77.07 g	47.00 e	44.10 f	15.20 b	15.40 b	7.20 g	6.90 f	3.83 c	4.10 e	17.37 h	22.33 f	15.00 b	14.20 bc	9.87 de	19.43 g	2.83 e	2.87 f	2.97 e	3.63 f
(W)+ 500 ppm PP_{333}	--	29.23 d	--	18.57 d	--	15.60 b	--	4.07 d	--	3.34 d	--	12.10 d	--	13.30 bc	--	13.43 f	--	2.10 d	--	2.67 d
(W)+1000 ppm PP_{333}	--	25.57 cd	--	15.57 c	--	14.93 b	--	3.07 c	--	2.15 c	--	8.33 c	--	12.90 b	--	11.30 e	--	1.63 c	--	1.90 c

Means followed by same letter (s) within each column are not significantly different from each other at 5% level.

concentration of IBA up to 6000 ppm and NAA up to 2000 ppm, respectively then decreased with higher levels of IBA and NAA. However, paclobutrazol pp_{333} caused a decrease in rooting, survival percentages and values of different growth parameters with increasing the level from 250 ppm up to 1000 ppm. Such effect was true for all growth measurements recorded in this study concerning Marianna 2624 plum, except the data of shoot and root lengths of Okenawa peach cuttings where the values of these parameters were not significantly different with increasing the level of pp_{333} up to 1000 ppm.

Comparing the three growth regulators used, it is obvious that IBA treatments for softwood cuttings of Marianna 2624 plum and Okenawa peach surpassed NAA and pp_{333} treatments in their effect on the different parameters studied.

At all events, rooting and survival percentages, as well as, growth parameters of shoot and root growth of cuttings gave the best values when bases of wounded cuttings were dipped in 6000 ppm IBA while the 4000 ppm NAA treatment took the other way around in this concern for Marianna 2624 plum. However, Okenawa peach cuttings failed to show any positive response for all other growth parameters under study to the 4000 ppm NAA treatment. Furthermore, response to the remaining treatments could be arranged in a descending order as follows, 9000 ppm IBA, 250 ppm pp_{333}, 3000 ppm IBA, 2000 ppm NAA, 500 ppm pp_{333} and finally 1000 ppm pp_{333}.

In conclusion, under similar conditions of the experiment, Marianna 2624 plum and Okenawa peach could be clonally propagated by softwood cuttings prepared in May with survival percentages reaching (88.6 & 92.8) for Marianna 2624 plum and (60.4 & 61.9) for Okenawa peach in the first and second seasons, respectively. Furthermore, softwood cuttings prepared in July (pre-treated with wounding followed by a quick dip in 6000 ppm IBA before planting), and planted under mist irrigation gave survival percentages ranging from (78 to 85%) for Marianna 2624 plum, (56 to 57%) for Okenawa in both seasons. It is also interesting to notice that dipping wounded cuttings in 250 ppm PP_{333} resulted in increasing the regeneration process in both Marianna 2624 plum and Okenawa peach softwood cuttings. On the other hand, 4000 ppm NAA exhibited the lowest response among the growth regulator treatments used. All remaining treatments under study lied in between in this concern.

Furthermore, data presented in Tables (3 & 4) for the response of Marianna 2624 plum and Okenawa peach cuttings prepared in July and cultured under mist irrigation system, show that wounding treatment was successful in improving rooting and survival percentages, as well as, values of all studied growth parameters over the control.

Moreover, treating wounded cuttings with different growth regulators had further increased rooting and survival percentages as well as values of different growth parameters used over wounding cuttings solely except for 4000 ppm NAA treatment for Okenawa peach softwood cuttings.

Concerning each growth regulator alone, it was found that rooting and survival percentages as well as values of different

Table (3): Response of Marianna 2624 plum softwood cuttings planted under mist to wounding and some growth regulators treatments (prepared in July, 1992 & 1993).

Treatment	Rooting (%)		Survival (%)		Shoot length (cm.)		Shoot diameter (mm.)		No. of lateral shoots / transplant		No. of leaves / transplant		Total root length (cm.)		No. of lateral roots / transplant		Shoot dry weight (g.)		Root dry weight (g.)	
	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
Tap water (control)	10.47 a	12.17 a	7.23 a	9.00 a	10.34 a	11.50 a	2.20 a	2.33 a	1.20 a	1.07 a	4.07 a	2.25 a	8.33 a	8.53 a	1.73 a	1.07 a	0.23 a	0.50 a	0.33 a	1.00 a
Wounding (W)	30.93 b	33.67 b	31.03 c	27.10 b	20.07 g	31.63 g	3.11 b	3.57 b	1.43 a	1.87 b	7.13 b	9.50 c	17.77 ef	21.17 e	3.03 b	3.87 b	0.67 bc	1.63 b	0.83 c	2.50 bc
(W)+ 3000 ppm IBA	62.10 f	63.57 d	48.03 e	52.30 d	20.30 ef	28.77 f	4.57 cd	5.33 c	2.60 cd	2.77 c	11.70 d	13.47 de	17.23 d	21.37 e	6.43 c	9.83 e	1.40 d	3.03 e	2.10 f	4.33 e
(W)+ 6000 ppm IBA	95.90 I	86.63 f	85.63 g	78.23 f	29.43 h	46.93 I	8.10 g	9.70 e	3.93 f	4.83 e	21.13 h	24.13 g	30.53 g	29.43 g	16.70 g	23.76 I	2.67 f	4.77 g	3.23 h	6.80 g
(W)+ 9000 ppm IBA	74.13 h	70.37 e	65.87 f	61.13 e	21.57 f	33.53 h	6.10 e	6.37 d	2.76 d	3.33 d	13.47 e	17.73 f	19.17 e	26.00 f	12.97 ef	15.50 g	1.70 e	3.07 e	2.60 g	5.36 f
(W)+ 1000 ppm NAA	40.96 cd	43.63 c	40.70 d	37.93 c	17.10 d	16.70 bc	4.60 d	3.47 b	2.63 cd	2.57 c	12.43 e	13.61 de	14.27 cd	11.20 b	9.70 d	8.30 d	1.20 d	2.20 cd	1.70 e	3.37 d
(W)+ 2000 ppm NAA	55.17 e	58.67 d	49.47 e	51.37 d	17.47 d	22.73 e	6.10 e	5.30 c	2.43 c	3.13 d	16.37 f	15.33 e	21.34 f	18.27 d	13.23 f	13.97 f	1.83 e	2.87 e	1.60 e	4.53 e
(W)+ 4000 ppm NAA	32.63 bc	36.73 b	23.43 b	28.43 b	15.23 c	11.90 a	3.07 b	2.53 ab	1.97 b	1.17 a	9.70 c	6.43 b	14.17 c	12.17 b	5.63 c	6.00 c	0.57 b	1.97 c	0.63 b	2.13 b
(W)+ 250 ppm PP_{333}	68.98 g	70.67 e	62.87 f	58.67 e	11.90 b	15.10 b	6.73 f	6.23 d	3.23 e	3.17 d	18.43 g	18.77 f	12.13 b	13.57 c	12.13 e	17.53 h	1.73 e	3.63 f	1.97 f	4.43 e
(W)+ 500 ppm PP_{333}	44.13 d	43.90 c	38.30 d	37.60 c	15.90 cd	18.33 c	4.37 cd	5.10 c	2.67 cd	1.87 b	15.50 f	14.60 e	17.57 de	13.80 c	9.67 d	10.47 e	1.23 d	2.37 d	1.60 e	2.91 c
(W)+1000 ppm PP_{333}	36.80 c	37.20 b	27.20 bc	26.27 b	19.77 e	20.47 d	4.00 c	3.10 b	2.10 b	1.87 b	10.33 cd	12.50 d	16.03 d	13.77 c	5.60 c	7.57 d	0.80 c	2.20 cd	1.11 d	2.73 c

Means followed by same letter (s) within each column are not significantly different from each other at 5% level.

Table (4): Response of Okenawa peach softwood cuttings planted under mist to wounding and some growth regulators treatments (prepared in July, 1992 & 1993).

Treatment	Rooting (%)		Survival (%)		Shoot length (cm.)		Shoot diameter (mm.)		No. of lateral shoots / transplant		No. of leaves / transplant		Total root length (cm.)		No. of lateral roots / transplant		Shoot dry weight (g.)		Root dry weight (g.)	
	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
Tap water (control)	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
Wounding (W)	9.67 b	12.10 b	6.00 b	8.17 b	16.50 b	12.47 b	1.40 b	1.37 b	3.20 b	3.10bc	6.50 b	3.77 b	12.00 b	11.67 b	3.10 b	2.90 b	1.10 b	0.73 b	1.20 b	0.90 b
(W)+ 3000 ppm IBA	53.50 f	58.57 f	42.60 f	42.30 g	16.93 b	17.07 c	3.03 d	3.17 d	3.03 b	5.20 d	7.27 b	10.63 e	13.60 b	15.47cd	3.17 b	7.93 d	1.33 b	1.97 e	1.70 c	2.17 d
(W)+ 6000 ppm IBA	71.00 h	74.90 g	56.43 h	57.57 h	28.90 d	35.77 e	4.37 e	5.00 f	7.67 f	9.63 f	21.63 f	25.10 g	31.93 f	31.77 f	13.03 f	22.46 g	3.20 f	4.00 g	3.23 f	3.50 f
(W)+ 9000 ppm IBA	51.33 f	60.30 f	43.00 g	42.77 g	21.53 c	22.70 d	3.17 d	3.97 e	5.33 d	7.00 e	16.17 e	16.40 f	25.20 e	23.27 e	7.33 d	12.40 f	2.30 d	2.37 f	2.50 e	2.67 e
(W)+ 1000 ppm NAA	28.00 d	27.07 d	18.43 d	17.27 d	16.50 b	13.21 b	2.27 c	1.80 b	3.27 b	3.80 c	8.07 b	5.77 c	17.63 c	13.83 c	4.63 c	6.50cd	1.25 b	1.20 c	1.33 b	1.43 c
(W)+ 2000 ppm NAA	39.67 e	40.70 e	27.90 e	28.70 e	21.50 c	18.40 c	2.67 c	2.70 c	4.27 c	4.67 d	11.90 c	16.27 f	22.50 d	17.57 d	7.67 d	10.33 e	1.70 c	2.30 f	2.20 d	2.23 d
(W)+ 250 ppm PP_{333}	61.70 g	57.80 g	33.87 f	39.47 f	17.50 b	13.53 b	3.11 d	4.23 e	7.70 f	5.27 d	17.07 e	17.17 f	15.20 b	12.50 b	10.00 e	13.03 f	2.73 e	2.20 f	2.67 e	2.80 e
(W)+ 500 ppm PP_{333}	17.23 c	21.40 c	12.00 c	16.37 d	16.20 b	12.50 b	2.60 c	2.33 c	6.10 e	3.67 c	14.17 d	9.40 d	14.70 b	12.20 b	7.67 d	7.00 d	2.20 d	1.70 d	2.50 e	1.77 c
(W)+1000 ppm PP_{333}	- -	18.23 c	- -	12.10 c	- -	13.20 b	0.00 a	1.67 b	- -	2.50 b	0.00 a	6.87 c	- -	12.00 b	- -	6.33 c	- -	1.20 c	- -	1.47 c

Means followed by same letter (s) within each column are not significantly different from each other at 5% level.

growth parameters were mostly increased with increasing the concentration of IBA up to 6000 ppm and NAA up to 2000 ppm then decreased with the high levels of IBA and NAA. Nevertheless paclobutrazol induced a reduction in rooting and survival percentages and values of growth parameters with increasing the level from 250 ppm up to 1000 ppm. Such effect was true for all grown measurements recorded in this study regardless of shoot and root lengths of Marianna 2624 plum cuttings. However, the values of these parameters were decreased with increasing the level of pp_{333} up to 1000 ppm for Okenawa peach cuttings.

Comparing the three growth regulators used, it is obvious that the effect of IBA treatments on softwood Marianna 2624 plum and Okenawa peach cuttings surpassed the effect of NAA and pp_{333} treatments in improving the rooting and survival percentages and also the different growth parameters tested.

In this respect, rooting and survival percentages as well as all growth parameters studied for Marianna 2624 plum scored the highest level when wounded cuttings were dipped in 6000 ppm IBA. Whereas 4000 ppm NAA treatment took the other way around. However, Okenawa peach cuttings were not able to survive under the same NAA treatment (4000 ppm). Anyhow, the effect of all remaining treatments on the softwood cuttings could be arranged descendingly as follows, 9000 ppm IBA, 250 ppm pp_{333}, 3000 ppm IBA, 2000 ppm NAA, 1000 ppm NAA, 500 pp_{333} and finally 1000 ppm pp_{333}.

Generally, the obtained data show that wounding the basal inch of the cuttings significantly improved rooting and subsequent survival as well as, all parameters of shoot and root growth over the non-wounded ones. Such wounding effect my be due to improved contact-area between the cuttings and media and can potentially improve absorption of rooting compounds **(Hartmann** and **Kester, 1992).**

Anyhow, these results are in harmony with those found by **Hartmann** and **Kester, (1975); Yodav** ***et al.*****, (1974); El-Tomi** ***et al.*****, (1974); Ibrahim** ***et al.*****, (1976); Mackenziec, (1978); Howard** and **Blasco, (1978); Gorecki, (1979); Couvillon** and **Ercz, (1980); Howard** and **Harrison, (1982)** and **Sen** and **Couvillon, (1983).**

Besides, untreated Okenawa peach cuttings failed to root. Furthermore, regeneration process was greatly enhanced when wounding was conducted followed by a quick dip in a solution containing the different concentrations of IBA, NAA and pp_{333}.

These results are in line with those found by **(Hassan** ***et al.*****, 1993).** They reported that the endogenous IAA concentration was higher in IBA treated cuttings than in untreated ones and increased during the rooting period. The GA/ABA and phenoles concentrations decreased during rooting.

In addition, the obtained results of IBA are in harmony with the findings of **Znajdek** ***et al.*****, (1978);** Pandey and **Pathak, (1981); Kaundal** and **Bindra, (1984); Prizhmonlas, (1991).**

Moreover, results of NAA coincided with the findings of **Spiegel, (1955); Chauhan** and **Pundir, (1972); Znajdek** ***et al.*****, (1978); Arora** and **Yamdagni, (1985); Pereira** ***et al.*****, (1986); Zora Singh** and **Sandhu, (1987); Debnath** ***et al.*****, (1988),** and **Briccoli-Bati, (1991).**

Anyhow, the role of auxins such as, indole butyric acid, naphthalene acetic acid in enhancing rooting of cuttings could by interpreted by the fact that endogenous auxin or artificially applied is necessary for adventitious root initiation.

In this respect, root initiation and development was found to occur in two basic stages:

1- An initiation stage in which root initials are formed. this stage could be further divided into:

   (a) An auxin-active stage, lasting about four days, during which auxin must be supplied continuously for roots to form, coming either from a terminal bud or from applied auxin. This stage is followed by.

   (b) An-auxin inactive stage. Withholding auxin during this stage (which lasts about four days) does not adversely affect root formation.

2- A root elongation and growth stage, during which the root tip grows outward through the cortex, finally emerging from the epiderms of the stem. A vascular system then develops in the new root primordia and becomes connected to adjacent vascular bundles. At this stage, there is no response to applied auxin **(Hartmann** and **Kester, 1992).**

The obtained response to paclobutrazol pp_{333} is in agreement with those mentioned earlier by **Wiesman *et al.*, (1989).** They found that Paclobutrazol at relatively low concentrations increase rooting percentage, number of roots per cutting and root : shoot ratio.

Besides, adventitious roots initiation can be stimulated by auxin, but in difficult-to-root species, auxin generally fails to promote rooting. Several trizole compounds have demonstrated growth regulator properties and have been introduced as growth retardants affected stem elongation **(Wample and Culuer, 1983).** These growth effects have been associated with inhibition of gibberellic acid biosynthesis. **(Geneve, 1990)** Low concentrations of trizole growth retardants such as paclobutrazol, uniconazol and triadimefan, have stimulated root formation **(Davis *et al.*., 1985).**

Specific Effect of Preparation Time of Softwood Cuttings:

It is clear that, softwood cuttings prepared in May gave significantly better rooting and survival percentages than those prepared in July for both Marianna 2624 plum and Okenawa peach rootstocks, (Table-5).

Generally, early May proved to be the proper time for the preparation and planting of softwood cuttings of Marianna 2624 plum and Okenawa peach cuttings. Successful rooting of cuttings prepared during a certain period of the year may reflect plant

Table (5): Specific effect of softwood cuttings preparation time on the rooting and survival percentages of Okenawa peach and Marianna 2624 plum (average of two years 1992 & 1993).

Time	Marianna 2624		Okenawa peach	
	Rooting	Survival	Rooting	Survival
May	59.60 **b**	49.22 **b**	39.74 **b**	25.72 **b**
July	50.45 **a**	42.97 **a**	32.72 **a**	23.09 **a**

Means followed by same letter (s) within each column are not significantly different from each other at 5% level.

response to the prevailing environmental conditions at that time which may be helpful in starting adventitious root initiation (**Hartmann** and **Kester, 1992**).

Moreover, increasing rooting percentage in specific period may be due proportionally to the presence of amino acids and a certain soluble indoles / phenols ratio, as well as, to the movement of carbohydrates and some nutrient elements to the cutting base. (**Abou-El-Azayem, 1982**).

4-1-1-2- Hardwood Cuttings:

It is clear from Tables (6 & 7) that wounding treatment for hardwood Marianna 2624 plum and Okenawa peach cuttings, prepared in December significantly improved callusing and subsequent rooting and survival percentages as well as all parameters of shoot and root growth over the non-wounded Marianna 2624 plum and Okenawa peach hardwood cuttings.

Moreover, treating wounded cuttings with different concentrations of IBA, NAA and pp_{333} improved callusing, rooting and survival percentages as well as values of different growth parameters under study over wounding only-except the 4000 ppm NAA treatment of Okenawa peach hardwood cuttings.

Concerning each growth regulator solely it is found that callusing, rooting and survival percentages as well as values of different growth parameters were mostly increased with increasing the concentration of IBA and NAA up to 6000 ppm and 2000 ppm, Table (6): Response of Marianna 2624 plum hardwood cuttings to wounding and some growth regulators treatments (prepared in December, 1992 & 1993).

Treatment	Callusing (%)		Rooting (%)		Survival (%)		Shoot length (cm.)		Shoot diameter (mm.)		No. of lateral shoots / transplant		No. of leaves / transplant		Total root length (cm.)		No. of lateral roots / transplant		Shoot dry weight (g.)		Root dry weight (g.)	
	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93
Tap water (control)	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
Wounding (W)	34.60 b	31.47 b	30.10 bc	25.17 bc	25.80 bc	18.47 b	23.70 b	22.47 b	3.36 b	3.33 bc	1.47 bc	2.20 c	12.67 b	10.10 bc	18.43 c	23.10 c	3.83 b	6.33 c	1.80 b	1.97 b	2.77 b	2.67 b
(W) + [illegible] ppm IBA	52.80 e	32.50 e	43.30 d	41.57 c	36.63 d	31.73 d	41.00 e	40.67 g	4.60 c	4.60 c	1.77 cd	2.90 d	19.50 d	15.67 d	21.87 d	28.07 d	5.93 c	6.60 d	2.70 de	2.97 cd	3.50 c	3.77 d
(W) + 6000 ppm IBA	75.93 h	70.97 g	53.90 f	56.73 g	50.23 f	50.93 f	68.77 g	59.85 I	8.80 g	10.53 f	3.30 f	4.97 g	32.70 g	30.83 h	33.07 f	37.23 e	14.87 g	22.63 I	4.37 h	5.40 g	6.23 f	6.50 f
(W) + 8000 ppm IBA	68.63 g	63.47 g	50.77 e	54.30 fg	44.83 e	42.63 e	51.90 f	55.30 h	6.76 e	6.90 e	2.27 e	2.90 d	20.60 d	23.93 f	24.27 e	30.67 d	11.30 e	13.67 g	3.83 g	4.10 f	4.67 e	5.23 e
(W) + 1000 ppm NAA	39.73 c	37.17 c	34.63 c	28.17 c	23.27 bc	21.83 c	21.27 b	27.73 d	7.13 e	4.00 c	1.87 d	2.37 c	15.07 c	12.00 c	19.77 cd	17.53 b	7.87 d	6.70 d	2.90 e	2.27 b	3.43 c	2.77 b
(W) + 2000 ppm NAA	40.27 c	46.83 d	30.03 bc	36.47 d	26.87 c	30.97 d	35.47 d	37.83 f	8.27 f	5.30 d	1.60 c	3.33 e	24.70 e	18.93 e	21.53 d	22.80 c	10.10 e	7.87 e	3.17 ef	2.80 cd	3.63 c	4.10 d
(W) + 4000 ppm NAA	34.63 b	31.90 b	28.70 b	21.90 b	24.57 bc	17.90 b	29.20 c	23.63 c	5.77 d	3.23 b	1.33 b	1.80 b	12.27 b	9.70 b	16.87 b	17.60 b	7.33 d	4.20 b	2.00 bc	2.03 b	2.73 b	2.80 b
(W) + 250 ppm PP_{333}	65.70 g	66.70 g	51.97 ef	52.53 f	48.33 ef	42.30 e	22.27 b	25.63 c	9.07 g	7.17 e	2.23 e	4.03 f	27.43 f	26.00 g	18.22 c	18.57 b	11.53 f	17.47 h	3.20 f	3.60 e	4.07 d	4.93 e
(W) + 500 ppm PP_{333}	59.63 f	58.97 f	41.83 d	41.90 e	34.63 d	32.07 d	24.43 b	28.03 d	7.36 e	5.37 d	1.87 d	2.40 c	23.47 e	17.17 de	19.70 c	19.73 bc	8.17 d	9.80 f	2.60 d	3.00 d	3.40 c	3.20 c
(W) + 1000 ppm PP_{333}	45.53 d	43.20 d	32.27 c	30.90 c	22.96 b	23.33 c	25.67 b	30.67 e	6.10 d	4.37 c	1.43 bc	2.50 c	20.47 d	12.87 c	19.23 c	21.60 bc	6.57	8.60 e	2.20 c	2.70 c	3.03 bc	2.77 b

Means followed by same letter (s) within each column are not significantly different from each other at 5% level.

Table (7): Response of Okenawa peach hardwood cuttings to wounding and some growth regulators treatments (prepared in December, 1992 & 1993).

Treatment	Callusing (%)		Rooting (%)		Survival (%)		Shoot length (cm.)		Shoot diameter (mm.)		No. of lateral shoots / transplant		No. of leaves / transplant		Total root length (cm.)		No. of lateral roots / transplant		Shoot dry weight (g.)		Root dry weight (g.)	
	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93	1991/92	1992/93
Tap water (control)	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
Wounding (W)	7.67 b	12.33 b	5.67 b	9.03 b	0.67 a	6.47 b	14.20 b	13.20 b	3.50 b	2.73 b	1.07 b	1.27 b	6.50 b	4.50 b	12.23 b	13.57 b	2.07 b	2.80 b	0.53 b	0.90 b	0.87 b	1.20 b
(W) + 3000 ppm IBA	39.90 d	43.56 f	32.90 d	37.53 f	10.77 c	21.57 e	22.20 c	23.67 cd	5.27 c	5.23 d	2.20 c	3.57 de	13.00 e	13.57 e	17.63 c	23.37 d	8.07 c	10.63 d	1.80 c	2.20 d	2.60 c	2.33 cd
(W) + 6000 ppm IBA	74.33 f	77.97 h	65.67 f	69.63 h	41.33 f	42.30 g	45.63 f	42.80 e	11.10 f	12.63 h	3.73 e	6.45 f	28.77 f	33.00 h	34.57 e	40.87 f	16.90 f	23.33 g	3.40 g	4.27 g	3.60 e	4.63 f
(W) + 9000 ppm IBA	50.77 e	58.23 g	43.43 e	50.43 g	21.57 e	33.43 f	35.47 e	26.97 d	7.67 d	8.77 g	3.43 e	3.23 d	18.13 d	17.93 f	23.43 d	28.70 e	10.10 d	18.00 f	2.87 f	2.92 f	2.97 d	2.80 d
(W) + 1000 ppm NAA	9.77 b	22.63 c	6.50 b	17.13 c	0.00 a	7.77 bc	0.00 a	13.70 b	0.00 a	3.03 b	0.00 a	1.33 b	0.00 a	6.93 c	0.00 a	16.63 c	0.00 a	9.73 cd	0.00 a	1.70 c	0.00 a	2.23 c
(W) + 2000 ppm NAA	24.50 c	33.93 e	20.00 c	29.17 e	8.77 b	19.20 e	28.17 d	23.40 c	6.00 c	4.00 c	2.87 d	1.97 c	20.17 e	11.57 d	24.53 d	22.20 d	8.47 c	12.30 e	2.17 d	2.20 d	2.40 c	2.63 d
(W) + 250 ppm PP_{333}	46.50 e	58.10 g	43.00 e	50.70 g	20.07 d	33.70 f	14.50 b	17.80 b	8.80 e	7.93 f	3.03 d	3.80 e	21.20 e	22.00 g	13.50 b	17.50 c	13.57 e	16.90 f	2.47 e	2.60 e	2.73 d	3.53 e
(W) + 500 ppm PP_{333}	--	29.80 d	--	26.46 d	--	13.97 d	--	14.20 b	--	6.50 e	--	2.20 c	--	15.80 e	--	15.30 b	--	12.67 e	--	2.20 d	--	2.63 d
(W) + 1000 ppm PP_{333}	--	26.50 cd	--	16.47 c	--	9.93 c	--	13.70 b	--	4.63 c	--	2.10 c	--	12.87 de	--	13.60 b	--	9.20 c	--	1.40 c	--	2.07 c

Means followed by same letter (s) within each column are not significantly different from each other at 5% level.

respectively then decreased with high levels of IBA and NAA. Nevertheless, paclobutrazol (pp_{333}) induced a reduction in rooting and survival percentages and values of growth parameters with increasing the level up to 1000 ppm. Such effect was true for all growth measurements used in this study regardless of shoot and root lengths of Marianna 2624 plum cuttings where the values of these parameters were generally increased with increasing the level of pp_{333} up to 1000 ppm.

Comparing the three growth regulators used in this study. It is obvious that IBA treatments for hardwood Marianna 2624 plum and Okenawa peach cuttings surpassed the NAA and pp_{333} treatments in their effect on the callusing, rooting and survival percentages and different growth parameters studied.

In this respect, callusing, rooting, survival percentages as well as, all parameters of shoot and root growth of cuttings scored the highest level when cuttings bases were dipped in 6000 ppm IBA.

On the other hand, 4000 ppm NAA took the other way around in this concern with Marianna 2624 plum hardwood cuttings while, Okenawa peach hardwood cuttings failed to respond to the same treatment. Furthermore, response to the remaining treatments could be arranged descendingly as follows, 9000 ppm IBA, 250 ppm pp_{333} 3000 ppm IBA, 2000 ppm NAA, 500 ppm pp_{333}, 1000 ppm pp_{333} and finally the 1000 ppm NAA.

Lastly the present data showed that wounding the basal inch of the hardwood cuttings of Marianna 2624 plum and Okenawa peach improved callusing and subsequent, rooting, survival, as well as, all parameters of shoot and root growth over non-wounded ones. These results are in harmony with those found by **Howard** and **Shepherd, (1981); Gemma** ***et al.,*** **(1982); Haward** ***et al.,*** **(1983).**

Furthermore, the regeneration process was enhanced when wounding was conducted followed by a quick dip in a solution containing the different concentrations of IBA, NAA and pp_{333}.

Besides, the obtained results of IBA go in line with the findings of **Hartmann** and **Hansen, 1968; Doud** and **Carlson, (1972); Nicotra** and **Damino, (1975); Ibrahim** ***et al.,*** **(1976); Zyl** and **Carreiro, (1977); Shizard** and **Miles, (1978); Znajdek** ***et al.,*** **(1978); Issel** and **Chalmers, (1979); Robitaille** and **Yu, (1980); Erez** and **Yobowitz, (1981); Erez, (1984); Mehlenbacher, (1986); Ranna** and **Chdha, (1992); Salama** ***et al.,*** **(1993); Edriss** ***et al.,*** **(1993)** and **Abd Alhamed** ***et al.,*** **(1993).**

Moreover, results of NAA agree with the findings of **Znajdek** ***et al.,*** **(1978)** and **Arora Yamdagni, (1985).**

The results of paclobutrazol (pp_{333}) coincided with those mentioned earlier by **Davis** ***et al.,*** **(1985);** and **Rieger** and **Scalabrelli, (1990).** They found that (pp_{333}) at relatively low concentrations increased rooting percentage, number of roots per cutting and root : shoot ratio.

Finally, it is easy to conclude that, Marianna 2624 plum and Okenawa peach could be clonaly propagated with survival percentages reaching (50.2 & 50.9) for Marianna 2624 plum and

4-1-2- Anatomy of Adventitious Root Origin:

Figures (1, 2, 3) show cross sections in Marianna 2624 plum, Okenawa peach and bitter almond cuttings. Different tissue layers in the cross section are, the periderm consisting of a limited number of layers followed by the cortex which often consists of several layers of chloroplast parenchymatic cells. The phloem is composed of sieve tubes, companion cells, phloem parenchyma and fibers. A complete cambium ring between the phloem and the xylem. The pith is located in the core of the stem. It is divided into two zones and composed of parenchymatic cells. The cells of the outer zone are small and compact with narrow intercellular spaces, whereas, those of the inner zone are large with intercellular spaces.

The aforementioned anatomical structure of Marianna 2624 plum, Okenawa peach and bitter almond stem cuttings is nearly the same as what had been previously reported for different members of the Rosaceae family **(Metcalf and Chalk, 1950)**.

Furthermore, Figs. (4, 5, 6) show that root initials, started from cambial zone of Marianna 2624 plum and Okenawa peach, whereas bitter almond shows root initials starting from both cambial and pith zones. Differences between cultivars in anatomical structure was mentioned earlier by **Mittemprgher,**

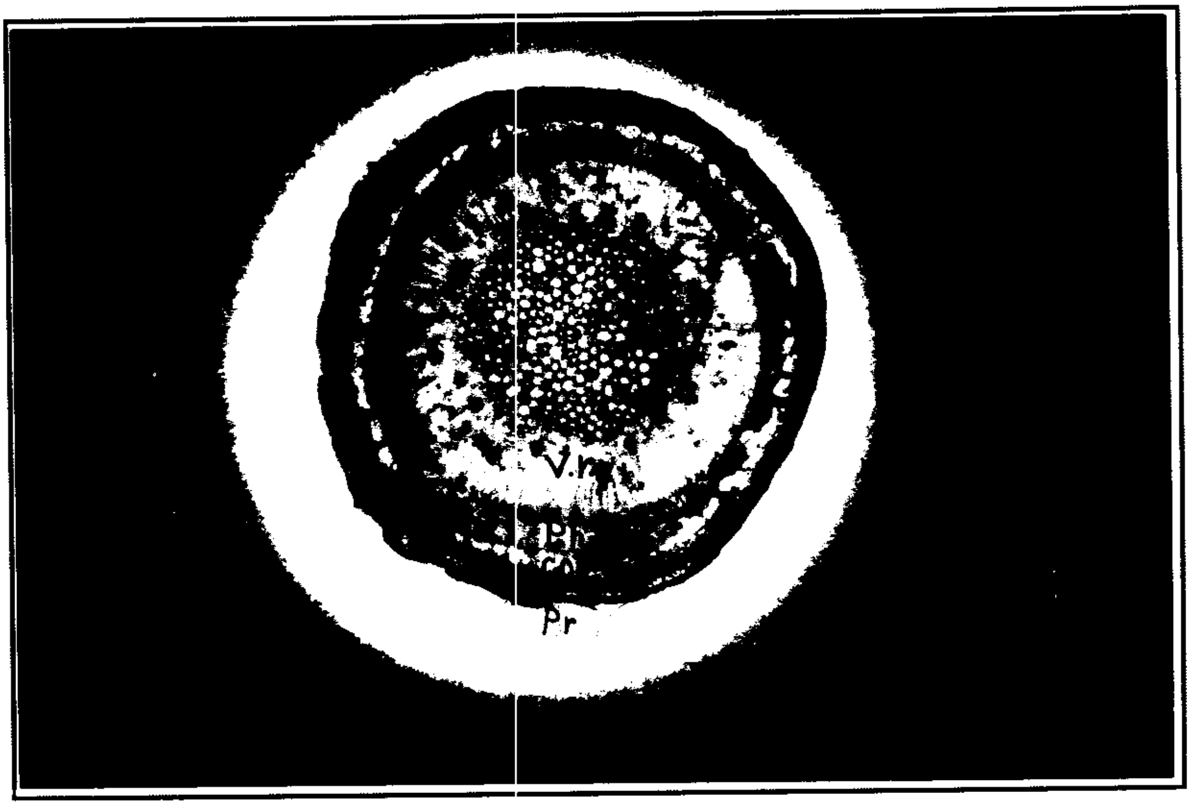

Fig. (1) A cross section in Marianna 2624 plum stem cutting showing the different tissues.

Pr. = Periderm

Ph. = phloem

P. = Pith

Cor. = Cortex

V.R. = Vascular ray

X = 32

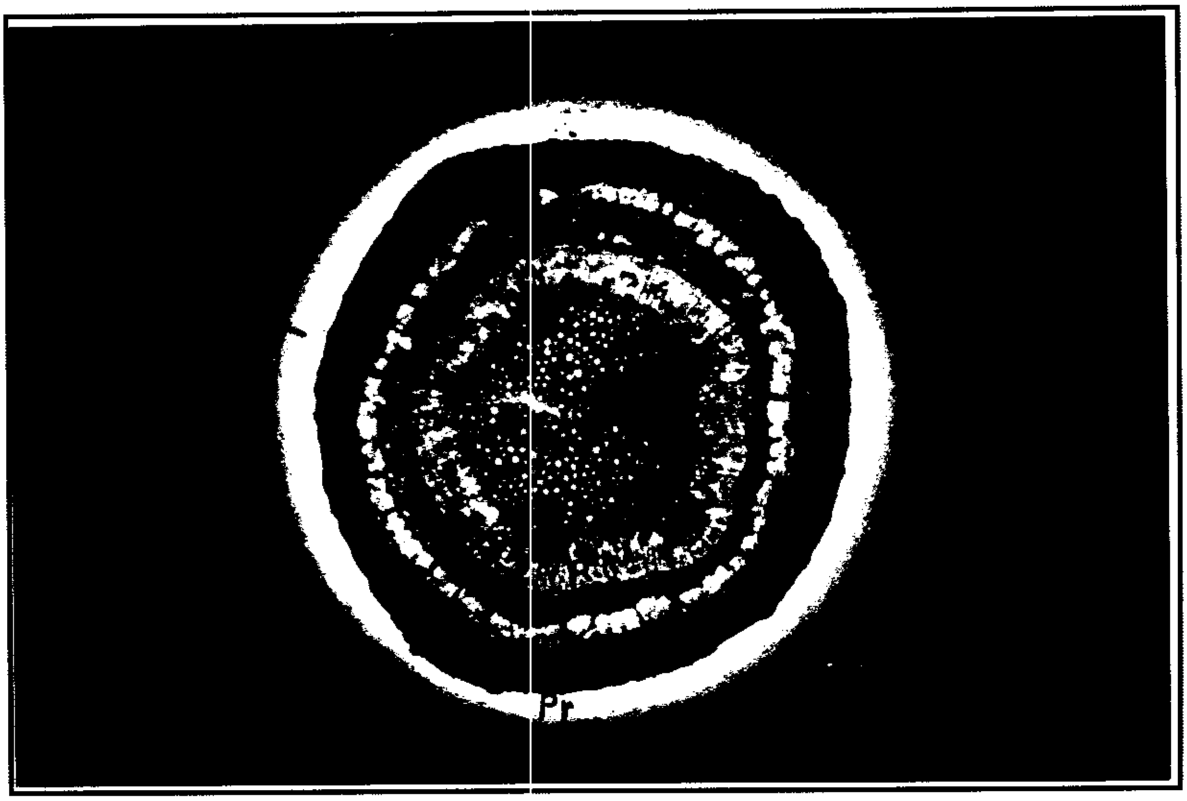

Fig. (2): A cross section in Okenawa peach stem cutting showing the different tissues.

Pr. = Periderm
Ph. = phloem
P. = Pith
Cor. = Cortex
V.R. = Vascular ray

X = 32

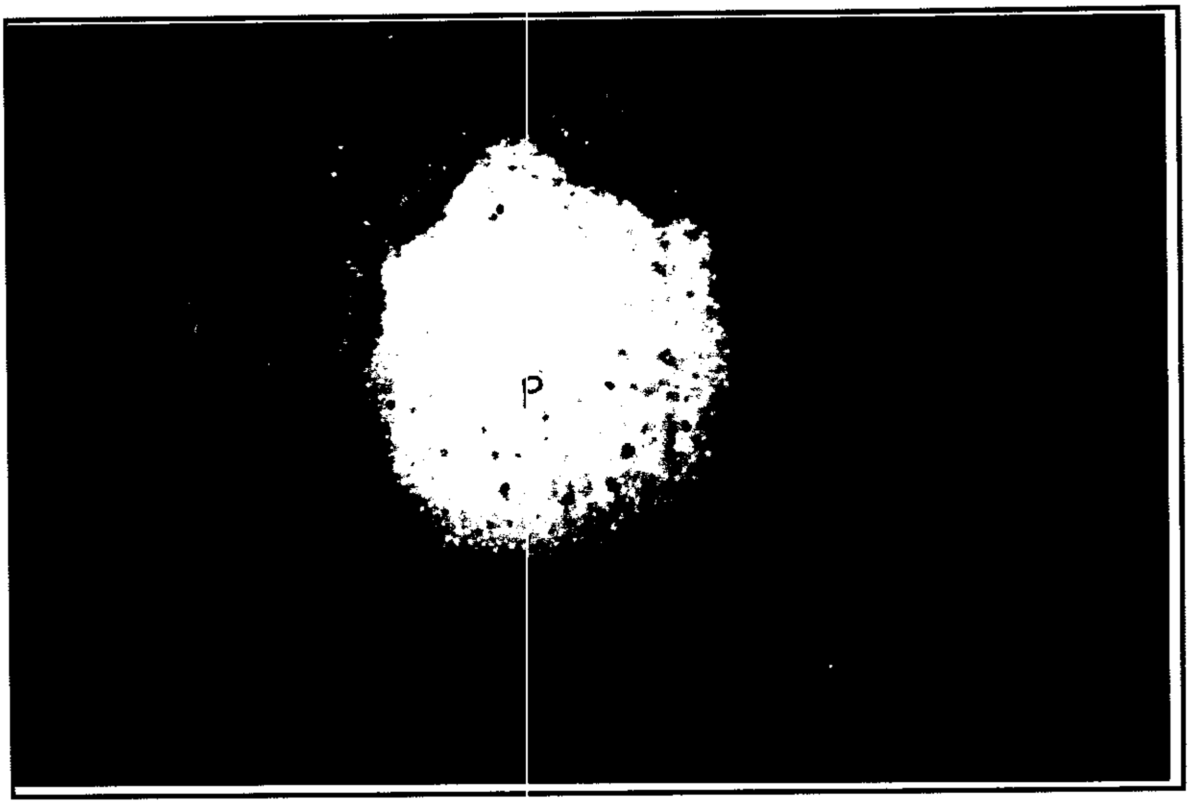

Fig. (3): A cross section in bitter almond stem cutting showing the different tissues.

Pr. = Periderm

Ph. = phloem

P. = Pith

Cor. = Cortex

V.R. = Vascular ray

X = 32

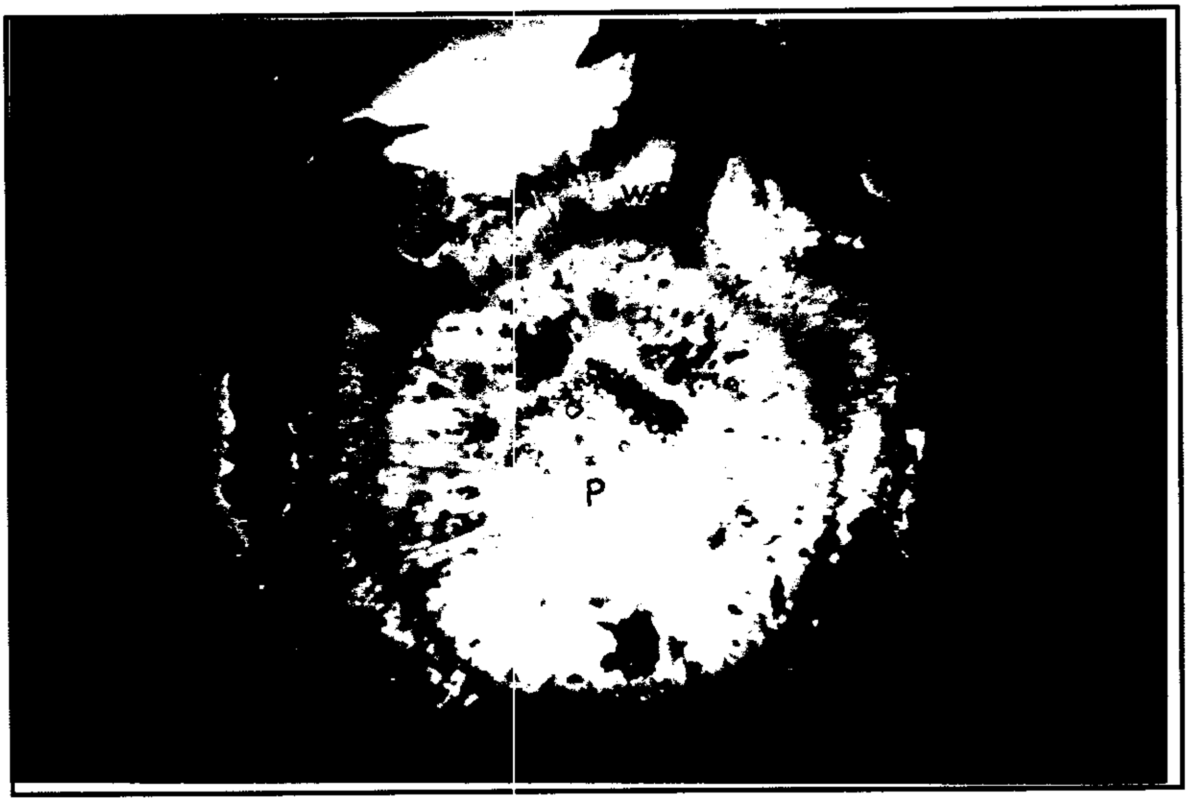

Fig. (4): A cross section in Marianna 2624 plum stem cutting showing.

R.P. = Root primordia.

W.R. = Well developed root periphery initiated from the cambial zone.

p. = Pith

X = 32

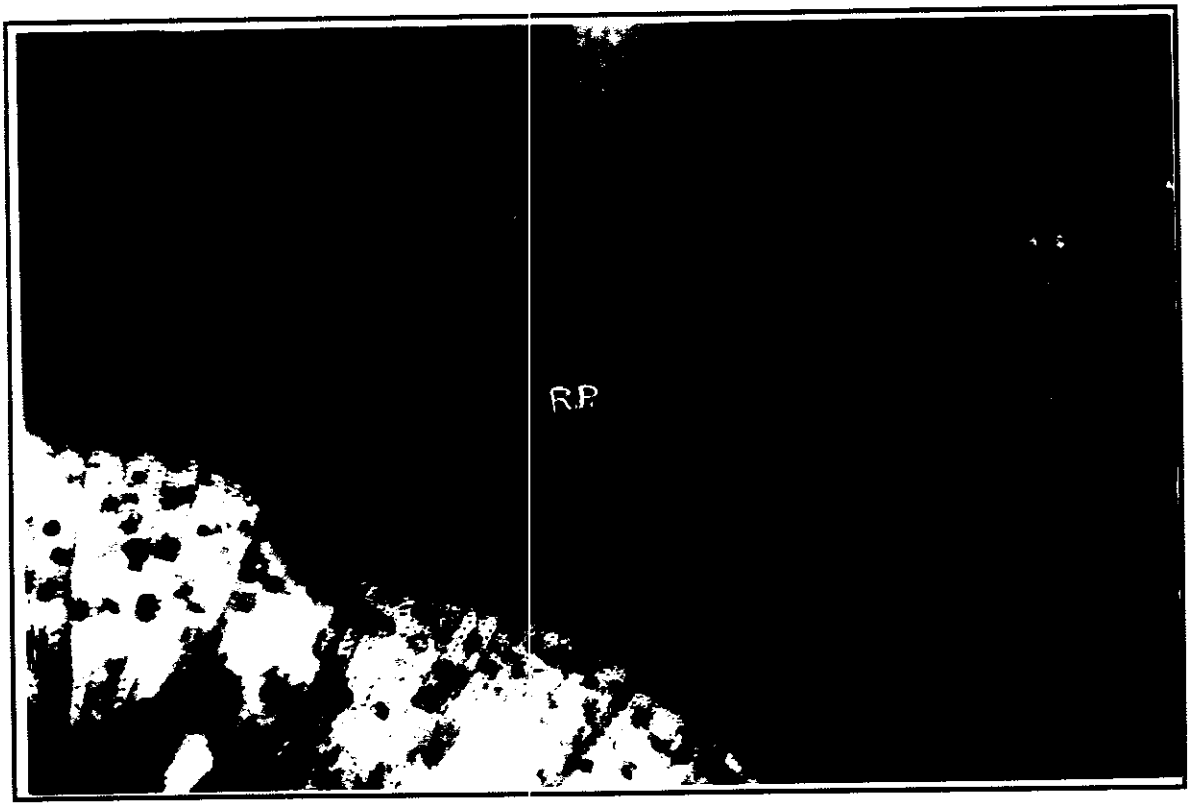

Fig. (5): A cross section in Okenawa peach stem cutting showing early stage of root primordia periphery initiated from the combial zone.

R.P. = Root primordia.

X = 250

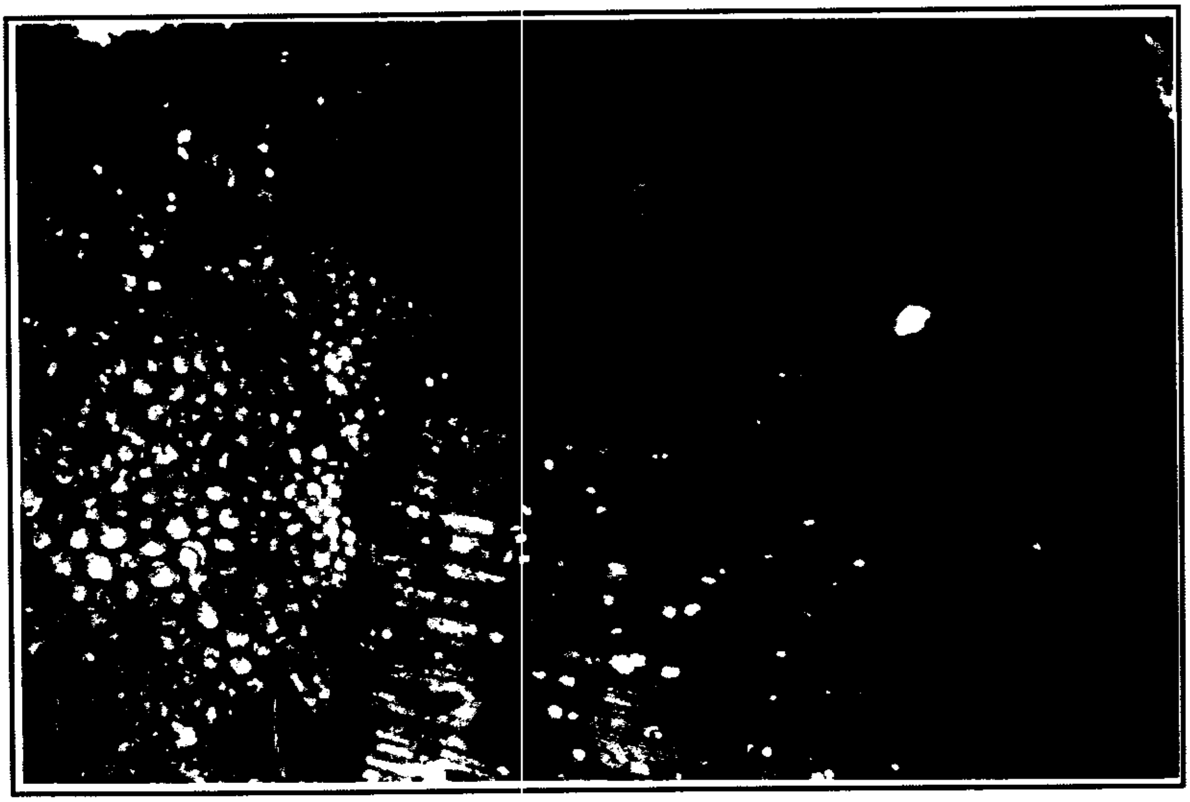

Fig. (6): A cross section in bitter almond stem cutting showing an early stage of root primordia periphery initiated from the combial zone and pith.

R.P. = Root primordia.

X = 125

(1964); Deidde, (1970); El-Fakharani, (1986); Avanzato and **Cappellini, (1988); Salama** ***et al.*****, (1993).**

Moreover, **Satoo, (1956)** stated that, in most plants adventitious roots are originated in the vicinity of differentiating vascular tissue. These places the young root close to xylem and phloem and facilitates rapid establishment of a vascular connection. He added that roots formed on cuttings are initiated in four different ways:

(1) From cambium and regions of ray tissues.

(2) From leaf and branch traces.

(3) From irregularly arranged patches of parenchyma.

(4) From callus tissues.

Concerning the development of adventitious roots on almond rootstocks i.e. Marianna 2624 plum and Okenawa peach, it is clear from Figs. (7 & 8) that cambium cells were activated by growth regulators treatments to form root primordia particularly by IBA. Meanwhile, untreated cuttings (control) showed no appreciable activity in cambium tissue Figs. (1, 2, 3). These results go in line with the findings of **Abou-Omera (1976); Wally** ***et al.*****, (1981), Youssef** ***et al.*****, (1991)** on guava and **Salama** ***et al.*****, (1994)** on apricot.

The cross section in Marianna 2624 plum Fig.(7) shows the beginning of vesicular bundles connection between the adventitious roots and those of the cutting.

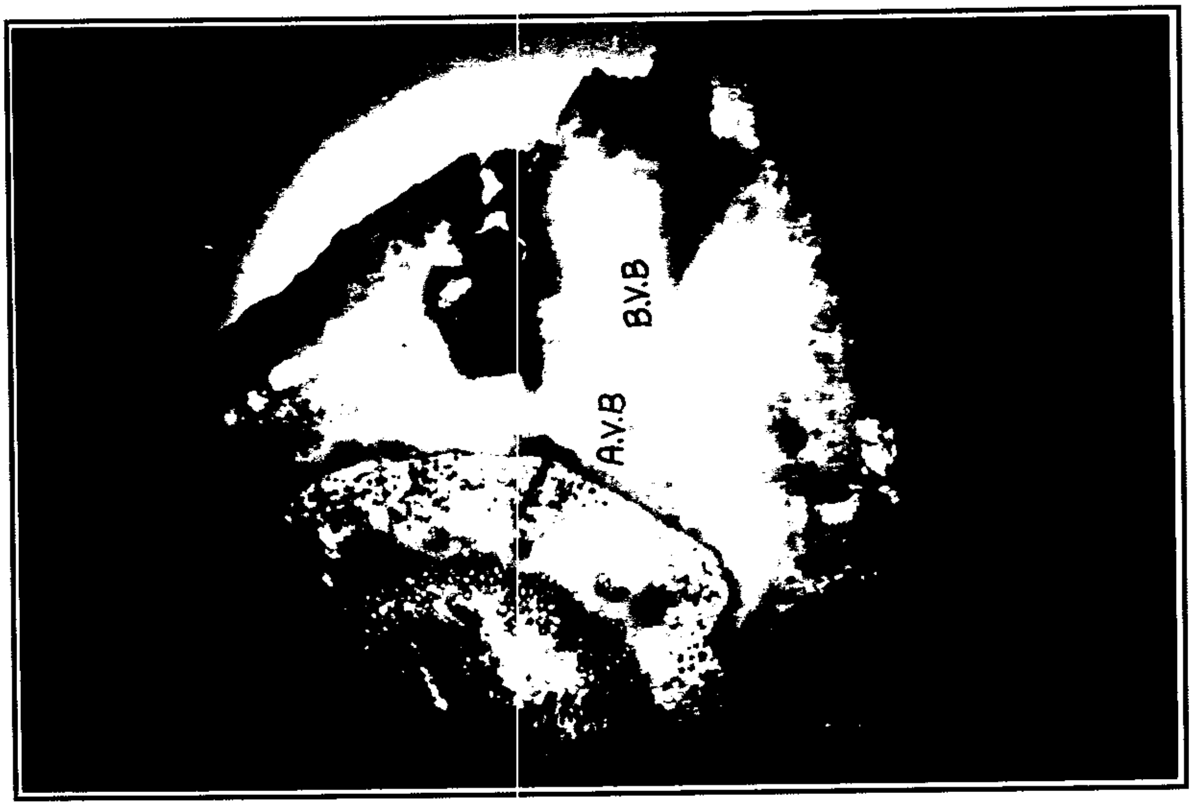

Fig. (7): A cross section in Okenawa peach stem cutting showing the beginning of vascular bundle connection between the adventitious root and corresponding tissues of the cuttings.

A : V.B. = Vesicular bundles tissue of the stem cutting.

B : V.B. = Vesicular bundle of adventitious root.

X = 32

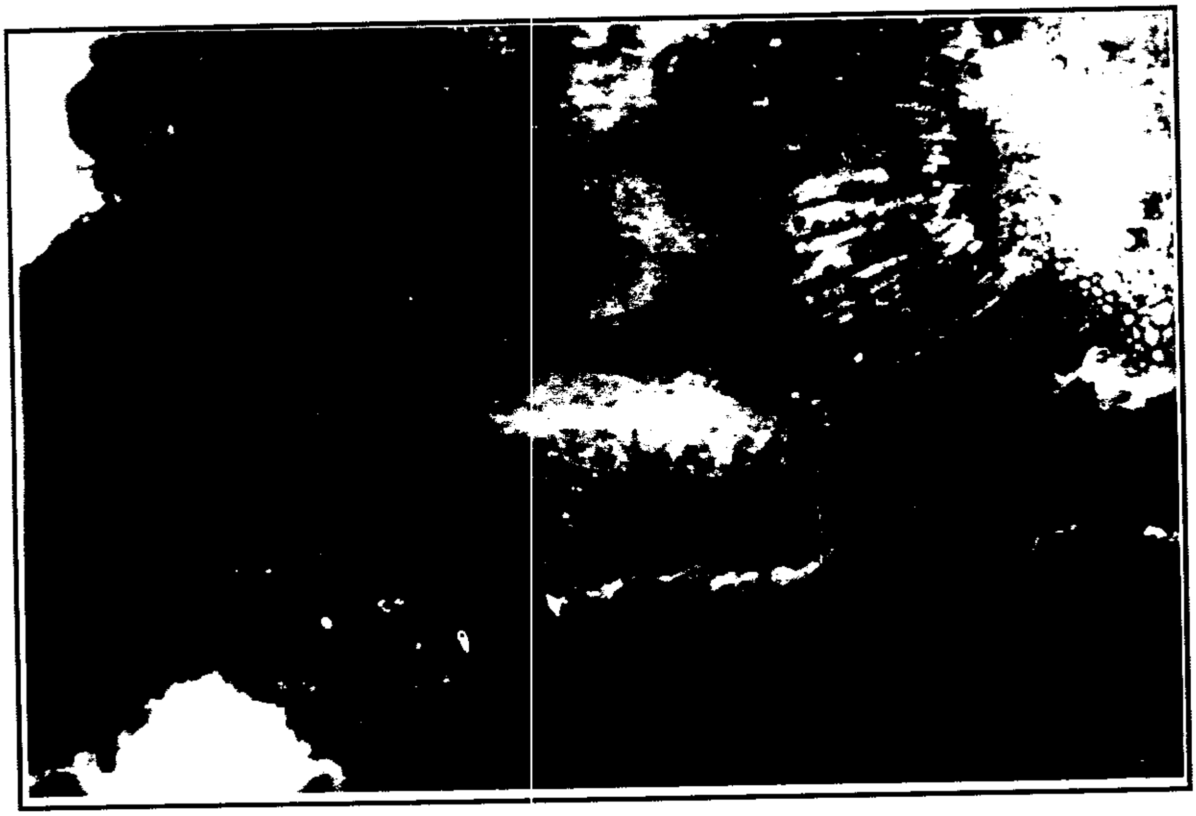

Fig. (8): A cross section in Okenawa peach stem cutting showing the penetration of adventitious root through the cutting tissues and its connection with the main conductive tissues.

(Ph and Xy)

Ph = Phloem.

Xy. = Xylem.

X =125

The cross section in Okenawa peach stem cutting Fig.(8) shows the penetration of adventitious roots through the cutting tissues and its connection with the main conductive tissue of phloem and xylem.

Thereafter, the cambium tissue resumed its activity by cell division and gave rise to the different layers of tissue which formed root initials and primordia of Marianna 2624 plum and Okenawa peach Figs. (7 & 8). Shortly after that, root primordia of Marianna 2624 plum and Okenawa peach continued development to become more detectable.

Thereafter, the development of adventitious root primordia took place through the phloem tissue, cortex and periderm followed by the development of vascular system of these roots that became in contact with main vessel of the stem Fig. (9 & 10). Finally, the adventitious root appear on or near the base of cuttings of Marianna 2624 plum and Okenawa peach Fig. (9 & 10).

These results agree with those found by **Mittemprgher, (1964); Deidde, (1970)** on almond; **Abou-Amera, (1976); Wally *et al.*, (1981); Makharni, (1985)** on pear; **El-Fakharani, (1986)** on peach; **Avanzato** and **Cappellini, (1988)** on walnut; **Youssef *et al.*, (1991)** on guava; and **Salama *et al.*, (1994)** on apricot.

On the other hand, bitter almond cuttings failed to develop root primordia. The anatomical studies of non rooted cuttings, showed that the cross sections of the basal portion of almond cuttings did not show any barriers that could possibly prevent root

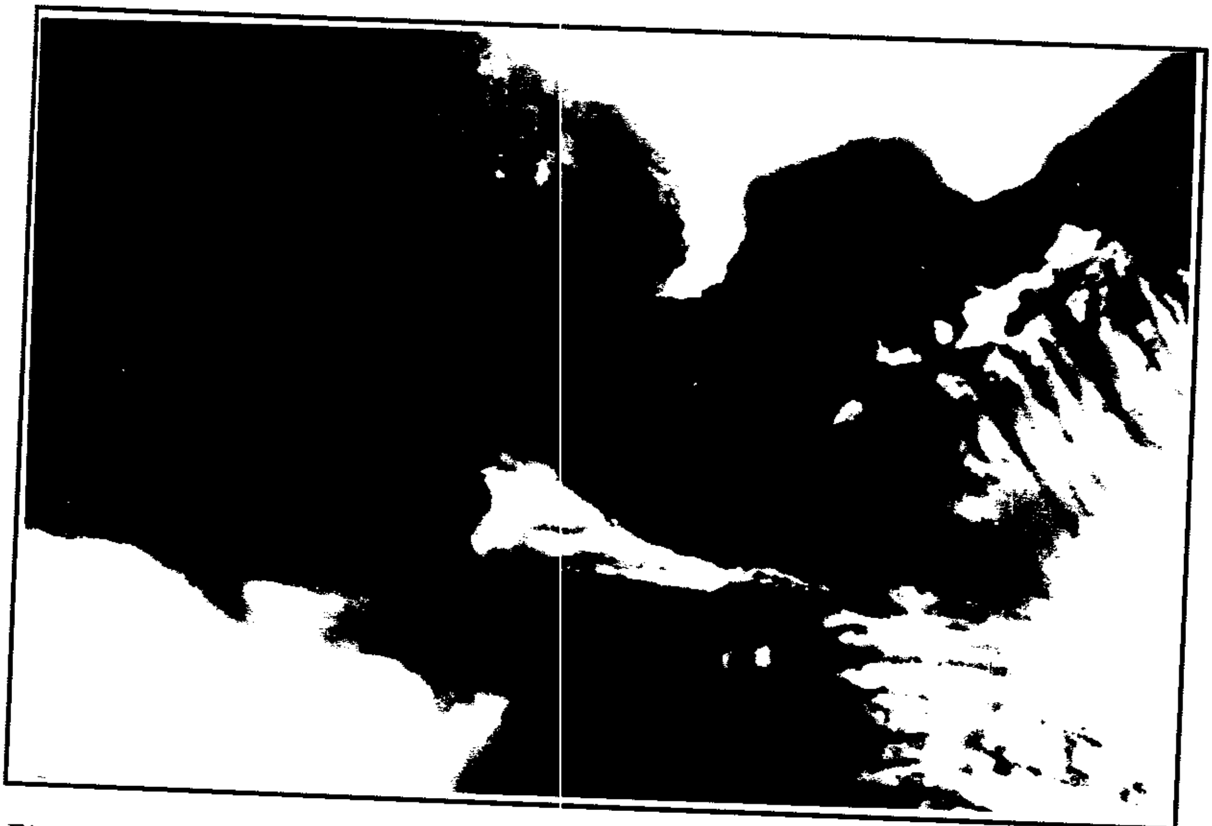

Fig. (9): A cross section in Marianna 2624 plum stem cutting showing a well developed adventitious roots and their penetration throughout the cutting tissues.

W.R. = Well developed roots.

X = 125

Fig. (10): A cross section in Okenawa peach stem cutting showing a well developed adventitious roots and their penetration throughout the cutting tissues.

W.R. = Well developed roots.

X = 32

initiation, however, in some individual sections, root primordia were found but seems to be not able to continue their development and this may be due to, inhibitors accumulated in the shoots, that interfere with root formation. On the other hand, it seems that cultivars whose cuttings rooted easily had generally lower level of such inhibitors **(Hartmann,** and **Kester. 1992.).**

4-2- Propagation by Budding:

4-2-1-a-Effect of Rootstock and Time of Budding on Growth of Ne Plus Ultra Almond Budlings:

Growth of Ne Plus Ultra almond budlings as affected by rootstocks and time of budding is shown in Table (8).

In regard to bitter almond and Okenawa peach rootstocks, it is clear that survival percentage, scion length, stem girth (ten cm. under and above union zone) were significantly affected by time of budding. The same trend was also noticed for total root length, number of main roots / plant, and dry weight of top and roots. All parameters reached the highest level when budding took place in mid-July, followed by mid-August. Mid-September budding scored the lowest level of growth parameters under study. All differences were significant.

Referring to the effect of budding time on growth parameters as Marianna 2624 plum was concerned, it is quite evident that growth parameters took the opposite trend to that of both bitter almond and Okenawa peach rootstocks. Thus, mid-July budding gave the lowest values for all growth parameters while mid-September budding gave the highest value in this respect. mid-August budding, however was in between. All differences were statistically obvious.

Table (8): Growth of Ne Plus Ultra almond budlings as affected by rootstocks and time of budding, (1992 & 1993).

Time of budding	Survival (%)	Scion length (cm.)	Stem girth (m.m) 10 cm above union zone	Stem girth (m.m) 10 cm below union zone	Total root length (cm)	No. of main roots / plant	Top dry weight (gm.)	Root dry weight (gm.)	Budlings dry weight (gm.)
Bitter Almond									
Mid-July	80.60	39.50	9.80	10.80	38.80	22.20	35.80	48.40	84.20
Mid-August	72.30	32.90	7.40	7.80	33.20	17.30	29.30	42.60	71.8
Mid-September	60.80	31.10	5.20	5.90	27.0	12.20	21.10	33.50	54.6
L.S.D at 0.05	2.40	1.20	0.30	0.40	2.10	0.80	1.20	1.20	2.60
L.S.D at 0.01	3.40	1.70	0.40	0.50	3.00	1.10	1.70	1.80	3.70
Okenawa Peach									
Mid-July	70.20	47.30	10.60	12.50	33.90	32.70	43.70	52.00	95.70
Mid-August	55.00	39.70	8.20	9.90	28.00	24.60	34.90	47.20	82.10
Mid-September	50.40	36.70	6.70	8.40	22.40	19.40	27.80	34.50	62.30
L.S.D at 0.05	3.10	1.90	0.30	0.50	1.00	1.50	1.20	1.40	1.50
L.S.D at 0.01	4.50	2.80	0.50	0.70	1.50	2.20	1.80	2.00	2.20
Marianna 2624 plum									
Mid-July	43.00	58.70	8.00	9.90	35.60	29.10	35.00	46.60	81.60
Mid-August	51.60	62.60	10.10	12.00	41.90	35.00	44.50	61.20	105.70
Mid-September	62.10	74.90	12.10	16.10	48.60	37.00	53.00	59.50	122.50
L.S.D at 0.05	1.90	2.40	0.40	0.50	1.80	1.50	1.10	2.30	4.00
L.S.D at 0.01	2.70	3.50	0.60	0.70	2.60	2.10	1.60	3.40	5.70

Concisely, from the previous results it is easy to say that, mid-July for budding almond on bitter almond and Okenawa peach and mid-September for Marianna 2624 plum gave the best results in this respect.

4-2-1-b-Specific Effect of Rootstocks on the Performance of Ne Plus Ultra Almond Budlings:

Table (9) Shows nursery performance of Ne Plus Ultra almond budded on different rootstocks. It is found that there were significant differences in the effect of different rootstocks used on the performance of Ne Plus Ultra almond budlings as indicated by survival and growth parameters tested.

It is interesting to note that Ne Plus Ultra scion survived best on bitter almond stock more than on either Okenawa peach or Marianna 2624 plum rootstocks in a descending order.

The same findings were obtained by **(Felipe, 1970)** on almond scion i.e. Ne Plus Ultra and Nonpareil budded on bitter almond, peach, apricot, *Prunus mume*, St. Julien, Damas, Marianna and Myrobalan plum. **Popk, (1981)** declared that *Prunus* hybrid seedlings as rootstock produced better take for several almond scion Cvs. than peach or almond control rootstocks. Moreover, the obtained results are also in line with the findings of **(Graselly, 1969)** and **(Hartmann and Kester, 1975)**. They found that almond scion of Ne Plus Ultra are compatible with Marianna 2624 plum rootstock.

Table (9): Nursery performance of Ne Plus Ultra almond budded on different rootstocks.

Rootstocks	Survival (%)	Scion length (cm.)	Stem girth (m.m)		Total root length (cm)	No. of main roots / plant	Top dry weight (gm.)	Root dry weight (gm.)	Budlings dry weight (gm.)
			10 cm above union zone	10 cm below union zone					
Bitter almond	71.2	35.5	7.5	10.3	28.1	17.2	28.2	41.5	69.7
Okenawa peach	58.6	41.2	8.5	11.3	33.0	25.6	35.5	44.2	79.7
Marianna 2624	52.2	65.4	10.1	12.7	42.0	33.7	44.2	59.1	103.3
L.S.D at 0.05	1.4	0.9	0.3	0.7	0.9	0.5	1.4	1.0	2.3
L.S.D at 0.01	2.0	1.3	0.4	0.9	1.3	0.7	2.1	1.4	3.3

On the contrary, the present results disagree with those recorded by **(Marwad, 1989)** on almond scion cv. Ne Plus Ultra budded on bitter almond, apricot, common marianna and Marianna 2624.

On the other hand, Marianna 2624 plum gave the highest values for all growth measurements under study i.e. (scion length, stem girth 10 cm. above and below union zone, total length, number of main roots / plant, root thickness 10 cm. below soil surface, scion dry weight, stock portion dry weight and buddling dry weight).

Bitter almond rootstock, on the other hand, took the other way around in this sphere. Okenawa peach rootstock was in between. The effect of rootstocks on growth vigour is in harmony with those found by **(Grasely, 1969)** who tested varieties and inter specific hybrids of *P. cerasifera* Ehih. as rootstocks for some almond cvs. He concluded that vigorous trees were obtained with Marianna 2624 plum. Besides, **Marwad, (1989)** worked on some rootstocks for Ne Plus Ultra almond and found that vigorous trees were obtained on Marianna 2624 plum more than on either bitter almond or apricot. The same findings were found by **(Webster and Werthein, 1993)** worked on plum.

However, **Sinha *et al.*, (1976)** tested grafting of almond on four different rootstocks. They found that growth was best on apricot. In addition, **Jaynes (1979)** reported that almond trees grown on Marianna 2624 plum stock were smaller than on either almond or peach seedlings by at least one third. **Popok, (1981)** found that ten *Prunus* hybrids as rootstocks for some almond scion cvs. gave transplants of better status than on other peach or almond control rootstocks. Such confection of reports might be due to soil as well as other environmental differences. **(Indenko, 1965).**

Results concerning root growth parameters i.e. root length, number of main root and root dry weight partially coincided with the results of **Gretsinger** and **Gortanova, (1971)** on almond; **Skirtach (1976)** on peach; **Miljkovic, (1982)** on pear and **Revyakina, (1984)** on sour cherries. They found that rootstocks markedly affected root growth of the tree.

Moreover, present results go in line with the findings of **Marwad, (1989)** on almond rootstocks.

4-2-2- Performance of Unbudded Stock:

Table (10) shows the nursery performance of bitter almond, Okenawa peach and Marianna 2624 plum nurselings as indicated by top and root growth parameters.

The data clearly indicate that there were highly significant differences between the tested rootstocks concerning all vegetative and root characteristics, under the environmental conditions of the experiment. Marianna 2624 plum proved to be the most vigorous stock where it scored the highest values for all growth measurements under study, i.e. (stem length, stem girth and dry weight as well as number of main roots, girth of main roots, root length and dry weight). However, bitter almond had the lowest values for all parameters used. Okenawa peach was in-between in this respect.

Table (10): Nursery performance of unbudded rootstock nurslings.

Rootstocks	Stem length (cm.)	Stem girth (mm.)	Top dry weight (gm.)	Root dry weight (gm.)	Number of main roots plant	Girth of main root (mm.)	Root length (cm.)
Bitter almond	98.4	14.0	52.2	46.7	22.2	20.4	45.4
Okenawa peach	125.3	17.1	76.1	73.8	30.1	22.2	51.7
Marianna 2624	172.9	18.1	97.2	84.5	43.3	25.1	61.9
L.S.D at 0.05	1.8	0.3	1.7	1.6	1.2	1.0	1.4
L.S.D at 0.01	2.6	0.4	2.5	2.3	1.7	1.5	2.0

4-2-3 Leaf Elements Content:

4-2-3-1- Budded Plants:

4-2-3-1-a- Effect of Rootstocks and Time of Budding on Elements Content of Ne Plus Ultra Almond Budlings:

The effect of different rootstocks and time of budding on the major nutrient elements in leaves of Ne Plus Ultra almond scion is shown in Table (11) and Fig. (11). Concerning leaf N, P, K, Ca and Mg levels of Ne Plus Ultra budded on either bitter almond or Okenawa peach, it is clear that such nutrients were significantly affected by the time of budding, being highest in mid-July, followed descendingly by mid-August and mid-September. Anyhow, all differences were obviously significant.

Nevertheless, the picture was changed when Marianna 2624 plum rootstock was used since the level of all nutrient elements under study took an opposite trend to that of both bitter almond and Okenawa peach rootstocks where mid-July budding gave the lowest levels of N, P, K, Ca and Mg. On the contrary, mid-September budding scored the highest levels of all elements under study. Mid-August budling came in between in this concern. However, the differences were highly significant.

Table (11) : Leaf nutrient elements content of Ne Plus Ultra almond budlings as affected by rootstocks and time of budding.

Time of Budding	Element Percentage in Dry Leaves				
	N	P	K	Ca	Mg
Bitter Almond					
Mid-July	1.78	0.28	1.99	3.17	0.21
Mid-August	1.36	0.22	1.74	3.07	0.19
Mid-September	1.20	0.20	1.64	2.83	0.17
L.S.D. at 0.05	0.03	0.01	0.02	0.04	0.02
L.S.D. at 0.01	0.04	0.02	0.03	0.06	0.03
Okenawa peach					
Mid-July	1.91	0.28	1.67	2.95	0.19
Mid-August	1.73	0.21	1.56	2.77	0.18
Mid-September	1.55	0.19	1.47	2.66	0.17
L.S.D. at 0.05	0.04	0.01	0.02	0.04	0.04
L.S.D. at 0.01	0.06	0.02	0.03	0.05	0.05
Marianna 2624 Plum					
Mid-July	1.64	0.17	1.22	2.14	0.14
Mid-August	1.88	0.21	1.27	2.27	0.14
Mid-September	2.11	0.24	1.35	2.37	0.17
L.S.D. at 0.05	0.02	0.01	0.02	0.03	0.02
L.S.D. at 0.01	0.03	0.02	0.03	0.04	0.03

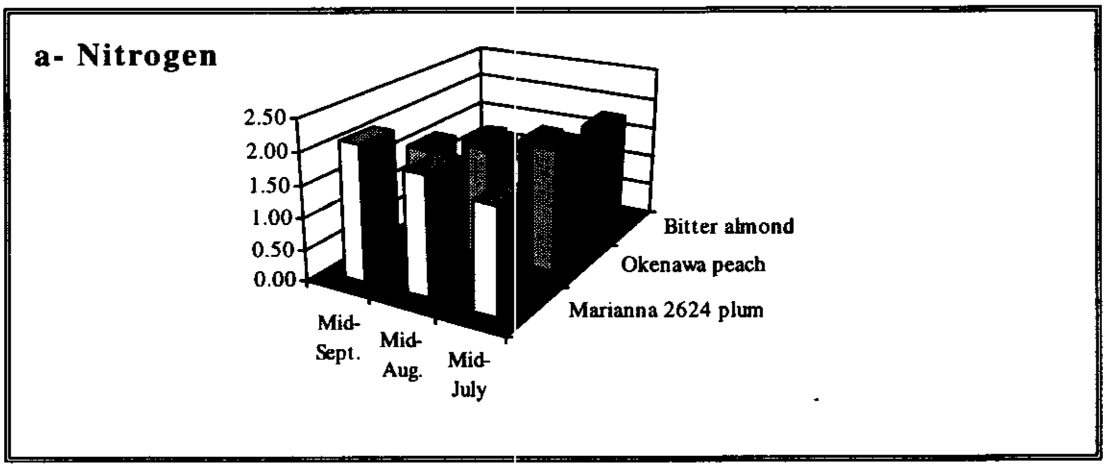

Fig. (11-a): Effect of rootstocks and time of budding on elements content of Ne Plus Ultra almond budlings.

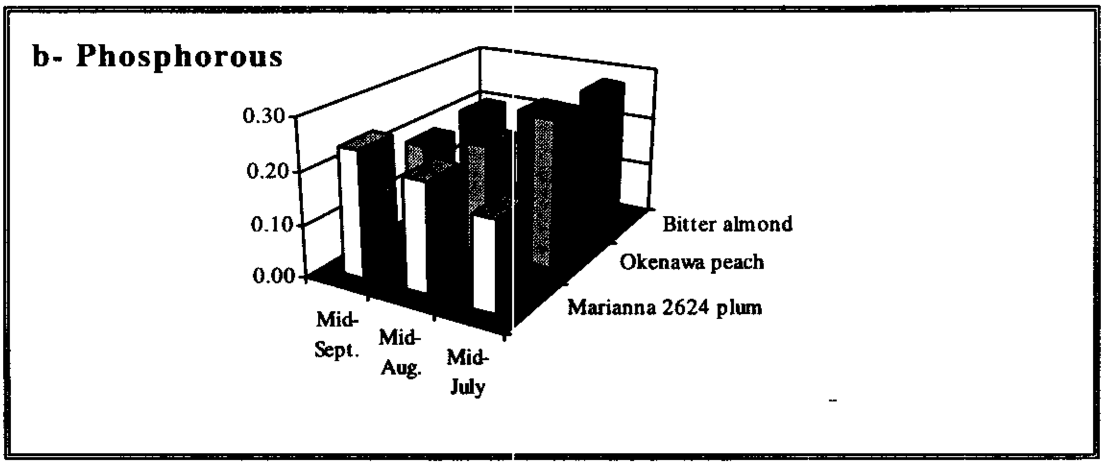

Fig. (11-b): Effect of rootstocks and time of budding on elements content of Ne Plus Ultra almond budlings.

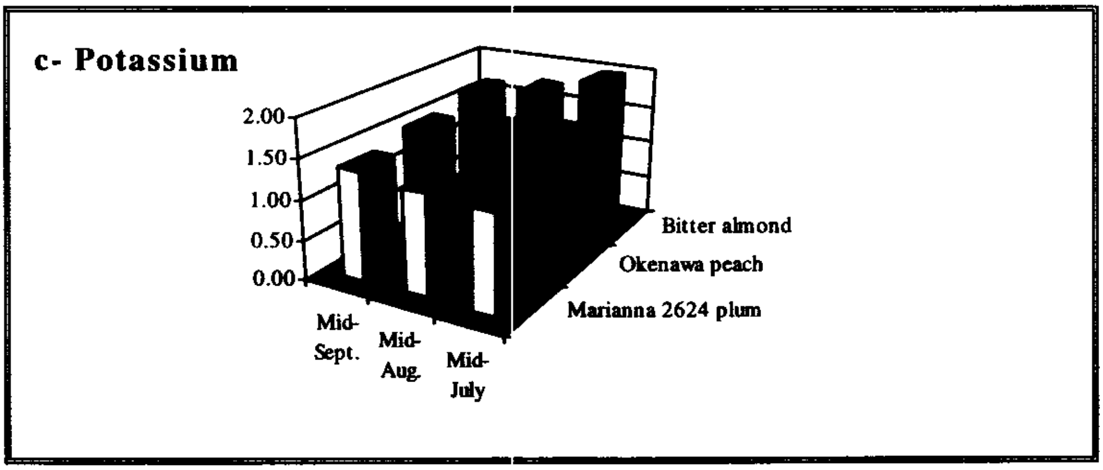

Fig. (11-c): Effect of rootstocks and time of budding on elements content of Ne Plus Ultra almond budlings.

Continued Fig. (11)

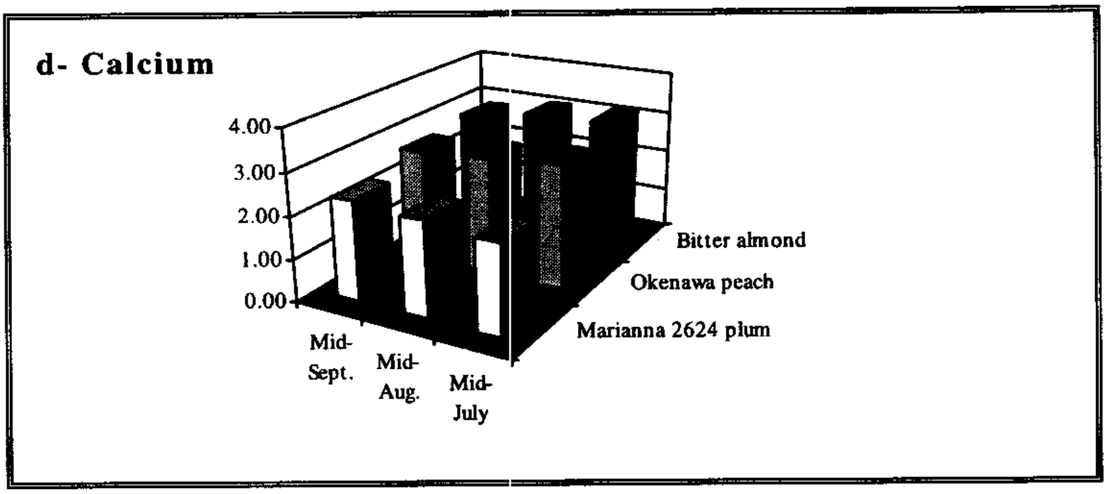

Fig. (11-d): Effect of rootstocks and time of budding on elements content of Ne Plus Ultra almond budlings.

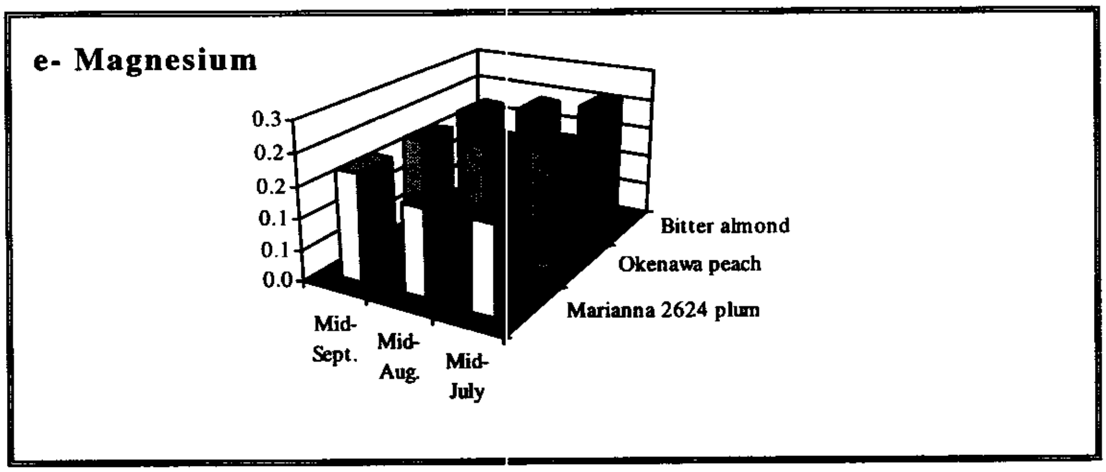

Fig. (11-e): Effect of rootstocks and time of budding on elements content of Ne Plus Ultra almond budlings.

4-2-3-1-b- Specific Effect of Rootstocks on the Macro-Elements Content in Leaves of Ne Plus Ultra Almond Budlings.

Table (12) indicates the specific effect of rootstocks on leaf macro elements content of Ne Plus Ultra almond budlings.

It is clear that Marianna 2624 plum gave the highest foliar nitrogen content followed descendingly by Okenawa peach and bitter almond. Anyhow, significant differences between the three stocks were obviously noticed.

These results are in harmony with the previous reports on almond rootstocks **(Marwad, 1989)** and apple rootstocks **{(Turk *et al.*, 1962); (Carlson, 1965)** and **(El-Fakharani, 1986)}**. On the other hand, the reports of **(Dzamic *et al.*, 1966)** and **(Vitanova, 1982)** working on plums; **(Kenawy, 1979)** on apple and **(Koleva, 1986)** on cherry, did not detect any remarkable effect of various rootstocks on leaf nitrogen content of the scion.

Furthermore, present results show that the invigorating rootstock Marianna 2624 plum increased leaf nitrogen content of the budling in comparison to other tested rootstocks. Such increase in foliar nitrogen content in turn enhanced the growth of Ne plus Ultra budlings.

Concerning scion leaf phosphorus, potassium, calcium and magnesium content, it is quit evident that there were highly significant differences between the three rootstocks under study.

Table (12): Specific effect of rootstock on leaf macro-nutrient elements content of Ne Plus Ultra budlings. (1992/1993).

Rootstocks	N %	P %	K %	Ca %	Mg %
Bitter almond	1.44	0.23	1.79	3.02	0.19
Okenawa peach	1.73	0.22	1.52	2.79	0.18
Marianna 2624	1.87	0.20	1.28	2.26	0.16
L.S.D at 0.05	0.02	0.01	0.06	0.02	0.01
L.S.D at 0.01	0.03	0.02	0.09	0.03	0.02

Meanwhile, bitter almond had the highest level of the previous nutrients followed by Okenawa peach and Marianna 2624 plum in a descending order.

The results of scion leaf phosphorus, go in line with the findings of **(Mitasov, *et al.*, (1973)** and **(Marwad, 1989)** on almond; **(Dzamic *et al.*, 1966)**; **(Modic, 1968)** and **(Vitanova, 1982)** on plum; **(Breen and Muraoka, 1983)** on plum and peach; **(Tukey *et al.*, 1962)**; **(Sypel, 1966)**; and **(El-Fakharani, 1986)** on apples. On the other hand, the reports of **(Koleva, 1986)** on cherries, **(Cline, 1960)** and **(Kenawy, 1979)** on apples did not show any significant effect of various rootstocks on phosphorous content.

Moreover, the results concerning scion leaves of potassium are in agreement with previous reports on almond rootstocks **(Marwad, 1989)**; plum **(Dzamic *et al.*, 1966)** and **(Vitanova, 1982)**; cherry **(Katzfuss, 1957)**; apple **(Kenawy, 1979)** and **(El-Fakharani, 1986)**.

In addition, the results concerning calcium content of leaf scion are in accordance with reports of **(Marwad, 1989)** on almond rootstocks; **(Vitanova, 1982)** on plum; **(Katzfuss, 1957)** on cherry; **(Molanov, 1968)**; **(Kenawy, 1979)** and **(El-Fakharani, 1986)** on apple. All clarified that rootstocks exerted obvious effect on leaf calcium content of the scion.

With respect to leaf scion magnesium content, the obtained data are in harmony with those found by **(Tukey *et al.*, 1962)**; **(Molanov, 1968)** and **(El-Fakharani, 1989)** on apples. They declared that rootstocks exerted clear effect on leaf magnesium content of the scion.

4-2-3-2- Unbudded Stock Plants:

Table (13) shows nitrogen, phosphorus, potassium, calcium and Magnesium percentages in leaves of unbudded stock plants in 1992/93 season.

It is clear that Marianna 2624 plum showed the highest foliar nitrogen content followed descendingly by Okenawa peach and finally bitter almond. The differences between stocks were significant.

Moreover, the highest phosphorous level existed in bitter almond leaves, while the picture was changed to the reverse when Marianna 2624 plum was concerned. Okenawa peach rootstock was in between in this respect.

Besides, leaf potassium, calcium and magnesium content of tested rootstocks showed appreciable differences. In this sphere, Okenawa peach had the highest values of K, Ca & Mg followed by bitter almond, and Marianna 2624 plum in a descending order.

Differences between unbudded rootstock plants under study in leaf N, P, K, Ca and Mg were previously reported by **(Marwad, 1989)** on almond rootstocks, **(Avent, 1957)**; **(Tukey *et al.*, 1962)**; **(Tilus and Choshed, 1963)**; **(Kenawy, 1979)** and **(El-Fakharani, 1986)** on apple rootstocks. Anyhow, such differences are quite

Table (13): Leaf macro nutrient elements content of rootstock nurslings. (1992/1993).

Rootstocks	N %	P %	K %	Ca %	Mg %
Bitter almond	1.63	0.31	1.56	2.09	0.20
Okenawa peach	1.90	0.26	1.90	3.05	0.22
Marianna 2624	2.06	0.20	1.30	1.85	0.17
L.S.D at 0.05	0.04	0.01	0.02	0.07	0.02
L.S.D at 0.01	0.06	0.02	0.03	0.10	0.03

expected since the tested rootstocks belong to different botanical species.

4-2-4- Anatomy of Bud-union Zone:

Fig. (12) shows a cross section in the bud-union zone of Ne Plus Ultra almond grown on bitter almond rootstock at the end of the first growing season after budding.

Concerning almond / bitter almond combination the obtained section show a clean and smooth connection between scion and stock.

Generally, present data showed that bitter almond gave the highest survival percentages among tested rootstocks.

It is worthy to mention that samples for anatomical study had been taken among already survived budlings. Therefore, observation on structure features of the budding union precisely coincide with the results of take and survival percentages.

Moreover, Fig. (13) shows a cross section in the bud-union zone between Ne Plus Ultra almond and Okenawa peach rootstock at the end of the growing season.

With respect to almond / Okenawa peach the obtained section reveals a distinct dark line (Fig. 13). It is worth to notice that, Okenawa peach occupied the second rank among tested rootstocks in survival percentage.

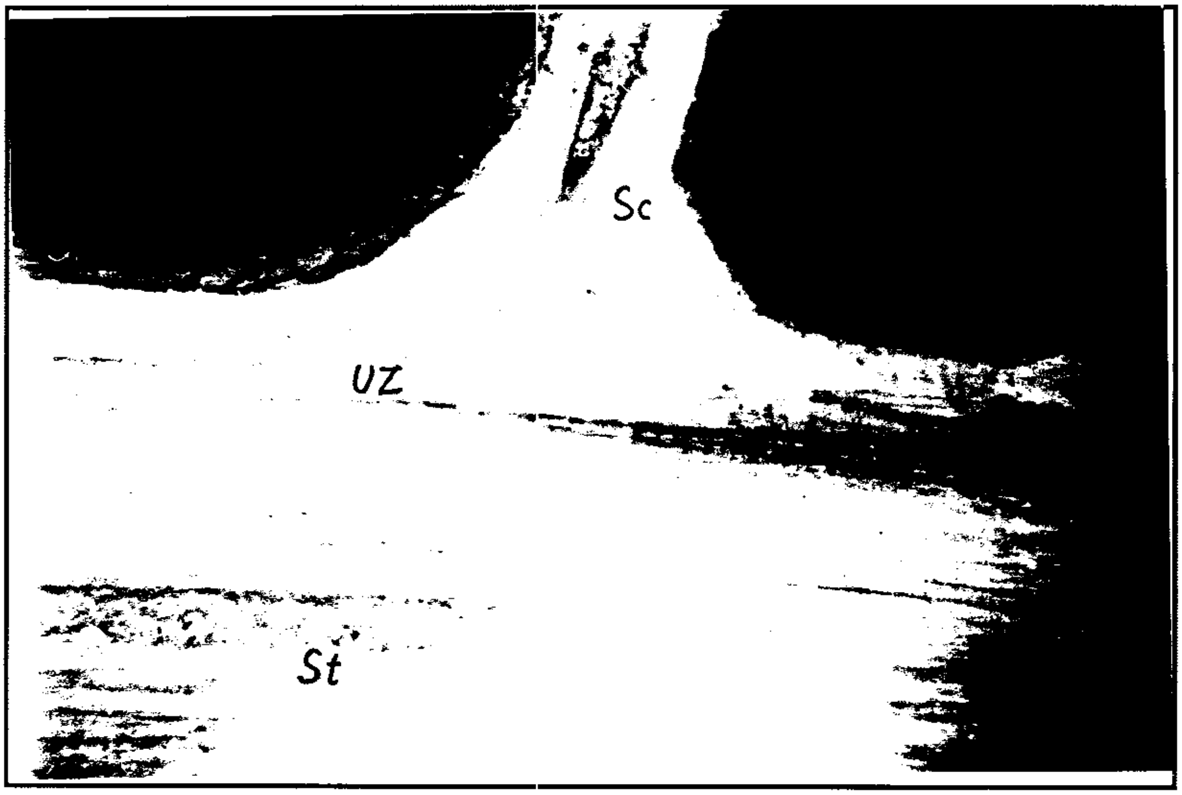

Fig. (12): A longitudinal section in the bud-union of Ne Plus Ultra almond grown on bitter almond rootstock. Complete healing.

(prepared at the end of the growing season)

Sc. = Scion.

St. = Stock.

U.Z. = Union zone.

X = 10

Dark line

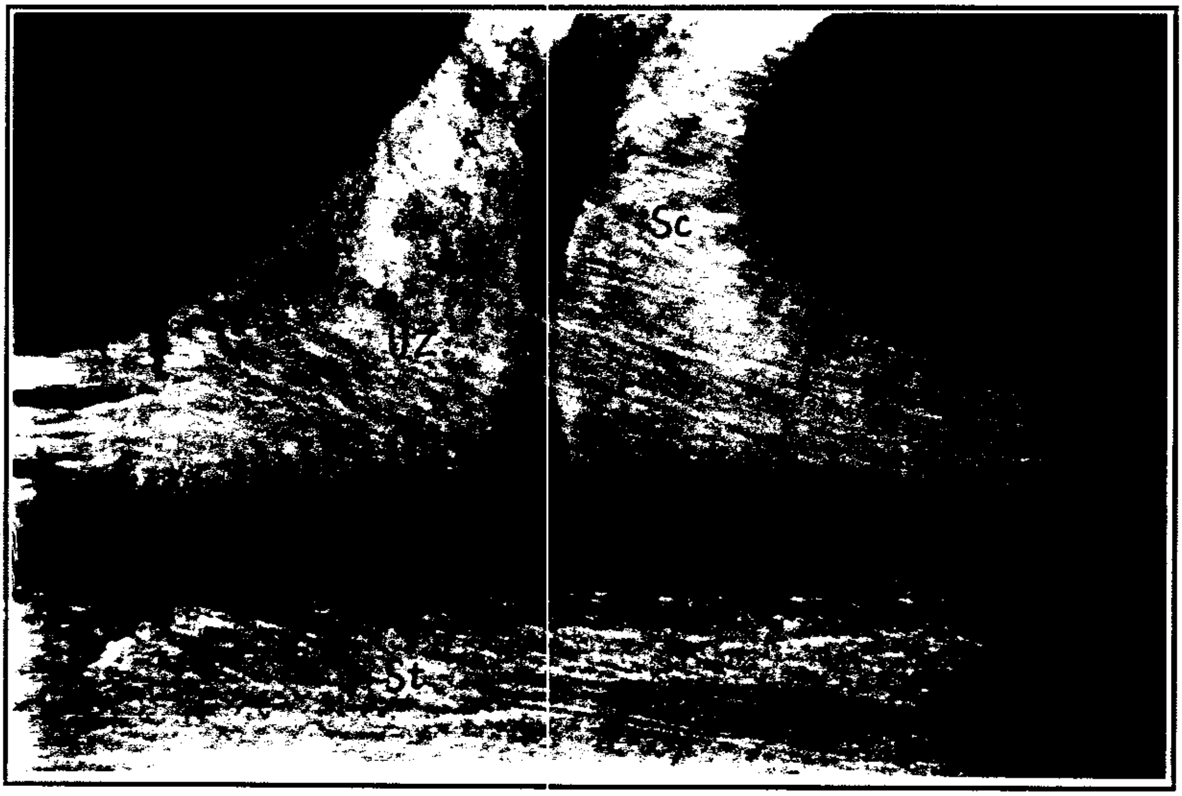

Fig. (13): A longitudinal section in the bud-union of Ne Plus Ultra almond grown on Okenawa peach rootstock, good healing with thin dark line (prepared at the end of the growing season). (cracking in the dark area was due to mechanical damage during the preparation of the section).

Sc. = Scion.

St. = Stock.

U.Z. = Union zone.

X = 10

Fig. (14) show a cross section in the bud-union zone of Ne plus Ultra almond grown on Marianna 2624 plum.

Concerning almond/Marianna 2624 plum combination, the obtained section also reveal that the dark line was thicker than the corresponding one appeared in the almond / Okenawa peach section. Such observation coincide with low survival percentage among tested rootstocks.

From the data of survival percentage, it is clear that Ne Plus Ultra almond budded on bitter almond rootstock gave the highest survival percentage over the other two rootstocks, followed by Okenawa peach and Marianna 2624 plum in a descending order.

These results are in agreement with those of **Kester *et al.*, (1965); Hartmann** and **Kester, (1986)** and **Marwad, (1989)** on almond rootstocks for almond and plum.

The almond / almond combination showed the highest degree of compatibility expressed by the highest percentage of survival, since cross section of the union zone exhibited the best healing. Leaves of Ne Plus Ultra almond/ bitter almond gave the highest percentages of nutrient elements except nitrogen and the trees were healthy.

Okenawa peach could also be considered promising as a rootstock for the almond cv. Ne Plus Ultra. Okenawa peach rootstock ranked the second regarding take and survival

Dark line

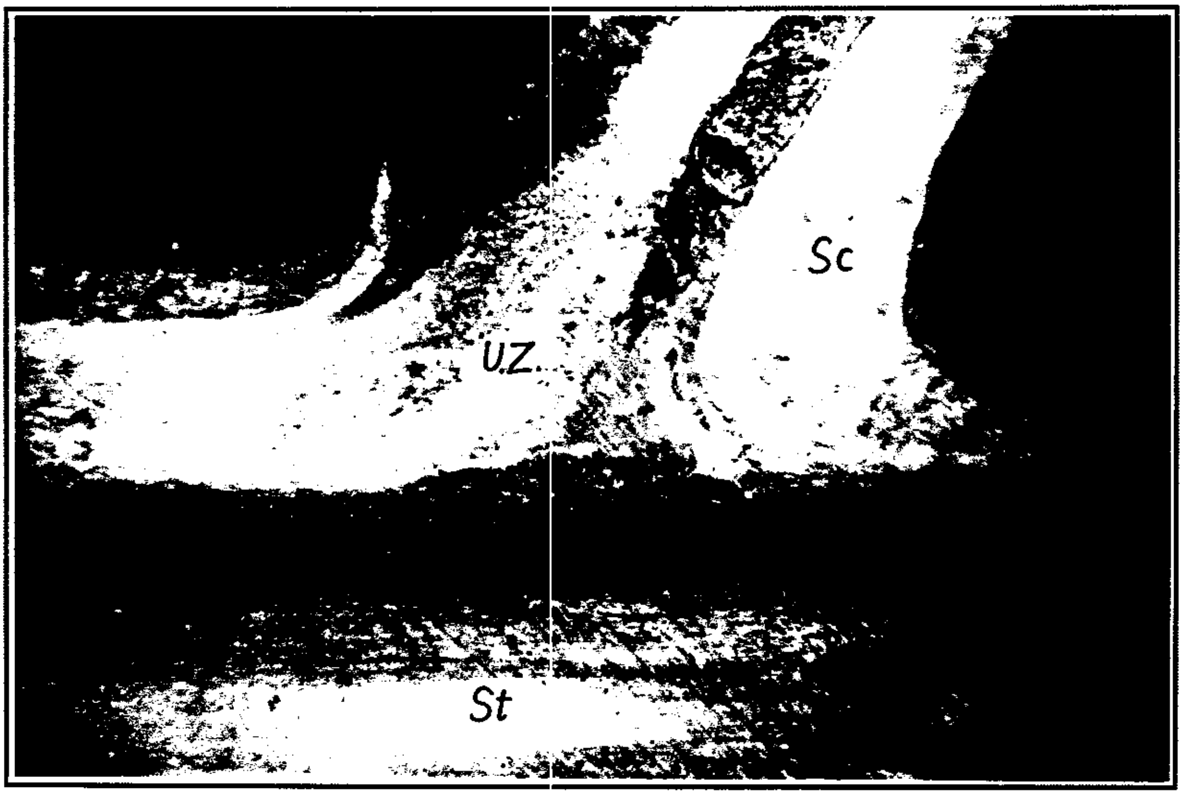

Fig. (14): A longitudinal section in the bud union of Ne Plus Ultra almond grown on Marianna 2624 plum. successful healing. (Prepared at the end of the growing season).

Sc. = Scion.

St. = Stock.

U.Z. = Union zone.

X = 10

percentages since it produced moderate scion vigour compared to the other two rootstocks used in this study.

Moreover, the union-zone of almond / Okenawa peach revealed a lower degree of compatibility compared with almond / bitter almond combination but it still was better than almond / Marianna 2624 plum.

Leaves of Ne Plus Ultra almond / Okenawa peach contained moderate amounts of elements.

Marianna 2624 plum rootstock, had a relatively low take and survival percentages but produced the best root system in the clay loam soil and in turn it encouraged top growth, since clay loam soil is more appropriate for Marianna 2624 plum. On the other hand, union zone of almond / Marianna 2624 plum had a lower degree of compatibility if compared with bitter almond and Okenawa peach rootstocks. Besides, Marianna 2624 plum rootstock was superior in increasing N level whereas it depressed P, K, Ca and Mg levels in the leaves of Ne Plus Ultra almond budlings. Such results could be related to the degree of compatibility between scion and stocks in the studied combinations.

4-3- Tissue Culture Studies:

4-3-1- Effect of Explant Preparation Time on the Performance of Shoot-tip and One-Node Cuttings of Three Almond Rootstocks:

4-3-1-1- Establishment Stage:

Data presented in Table (14) and illustrated in Fig. (15) show the effect of explant types prepared at different times on survival percentage, shoot length and number of leaves per explant of almond rootstocks i.e. bitter almond, Okenawa peach and Marianna 2624 plum grown on modified liquid MS medium free from hormone.

Explants prepared in April, whether as shoot tips or one node cuttings, gave best survival percentage as well as shoot length and number of leaves per explant for all rootstocks used. On the other side, such parameters were decreased profoundly as explants preparation was delayed during the season. Thus, explants taken in August gave statistically the least survival percentage, shoot length and number of leaves per explant.

In this respect, survival, shoot length and number of leaves per plant could be arranged descendingly as follows, bitter almond, Okenawa peach and Marianna 2624 plum.

Table (14) : Effect of explant preparation time on the performance of shoot-tip and one-node cuttings during the *establishment stage of three almond rootstocks.

Month	Shoot Tip			One Node Cutting		
	Survival (%)	Shoot length (cm)	No. of leaves / explant	Survival (%)	Shoot length (cm)	No. of leaves / explant
Bitter Almond						
April	79.00 **e**	3.85 **e**	5.73 **e**	90.93 **e**	3.13 **e**	4.10 **e**
May	63.50 **d**	3.28 **d**	4.40 **d**	83.50 **d**	2.60 **d**	3.30 **d**
June	47.75 **c**	2.88 **c**	3.43 **c**	78.25 **c**	2.13 **c**	2.28 **c**
July	29.25 **b**	2.35 **b**	2.43 **b**	51.50 **b**	1.72 **b**	1.83 **b**
August	18.50 **a**	1.83 **a**	1.63 **a**	23.75 **a**	1.35 **a**	1.20 **a**
Okenawa peach						
April	83.75 **e**	3.25 **d**	8.00 **e**	93.50 **e**	2.95 **e**	5.75 **e**
May	72.18 **d**	3.05 **d**	6.70 **d**	78.50 **d**	2.58 **d**	4.78 **d**
June	59.25 **c**	2.70 **c**	3.80 **c**	68.50 **c**	2.08 **c**	2.98 **c**
July	31.75 **b**	1.95 **b**	2.30 **b**	43.00 **b**	1.65 **b**	2.02 **b**
August	25.50 **a**	1.00 **a**	0.00 **a**	31.50 **a**	1.00 **a**	0.00 **a**
Marianna 2624 Plum						
April	42.88 **e**	2.85 **e**	4.75 **e**	68.88 **e**	2.73 **e**	3.40 **e**
May	33.33 **d**	2.65 **d**	3.98 **d**	63.50 **d**	2.35 **d**	3.13 **d**
June	18.50 **c**	2.13 **c**	3.20 **c**	48.75 **c**	1.65 **c**	2.35 **c**
July	15.13 **b**	1.53 **b**	2.75 **b**	30.80 **b**	1.22 **b**	1.93 **b**
August	9.25 **a**	1.00 **a**	0.00 **a**	18.50 **a**	1.00 **a**	0.00 **a**

* Explants were grown on modified MS medium free from hormone.

Means followed by same letter (s) within each column are not significantly different from each other at 5% level.

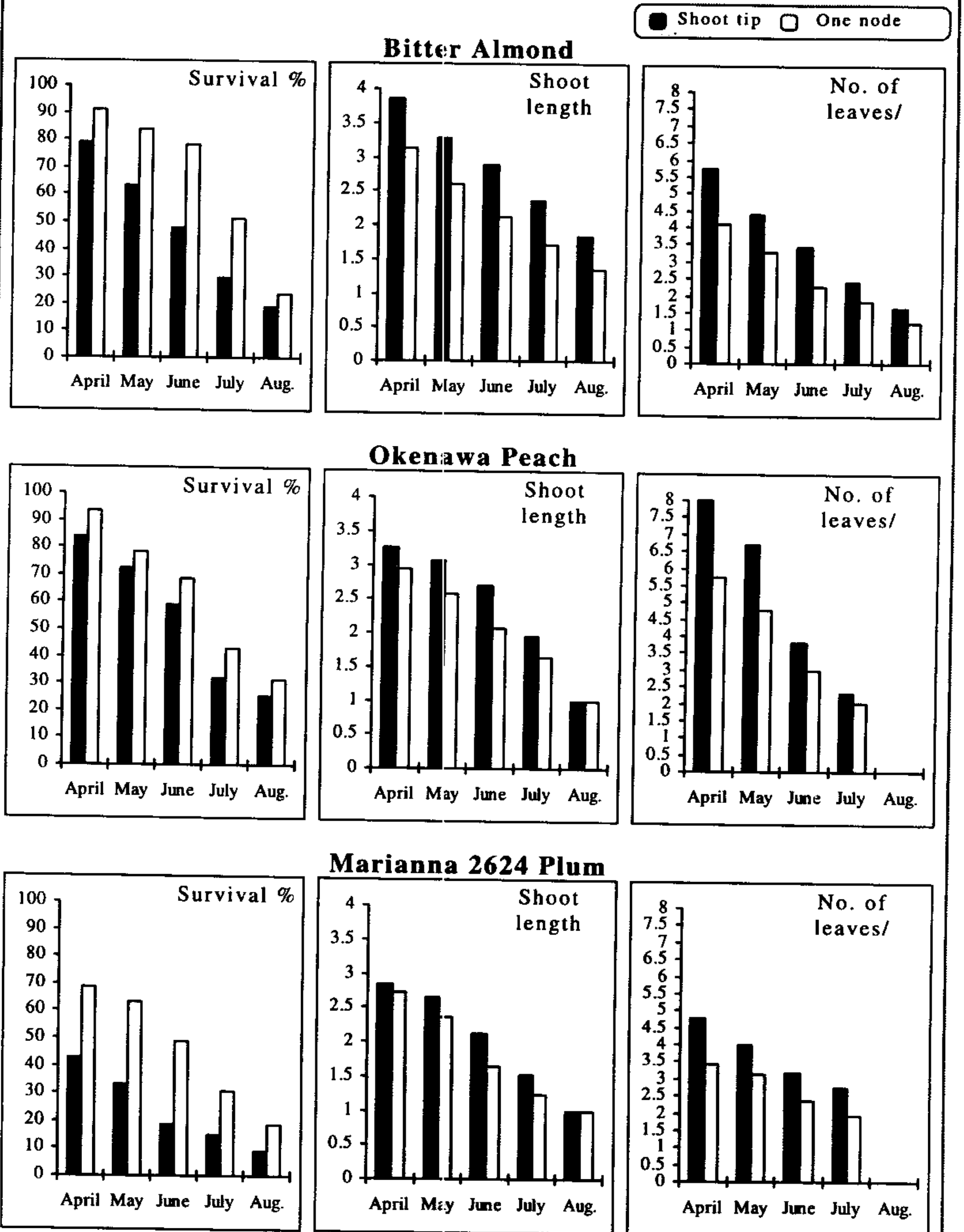

Fig. (15): Effect of explant preparation time on the performance of shoot-tip and one-node cuttings grown on modified MS medium free from hormone during establishment stage of three almond rootstocks.

Fig. (16): Shoot-tip of bitter almond in **Establishment Stage.**

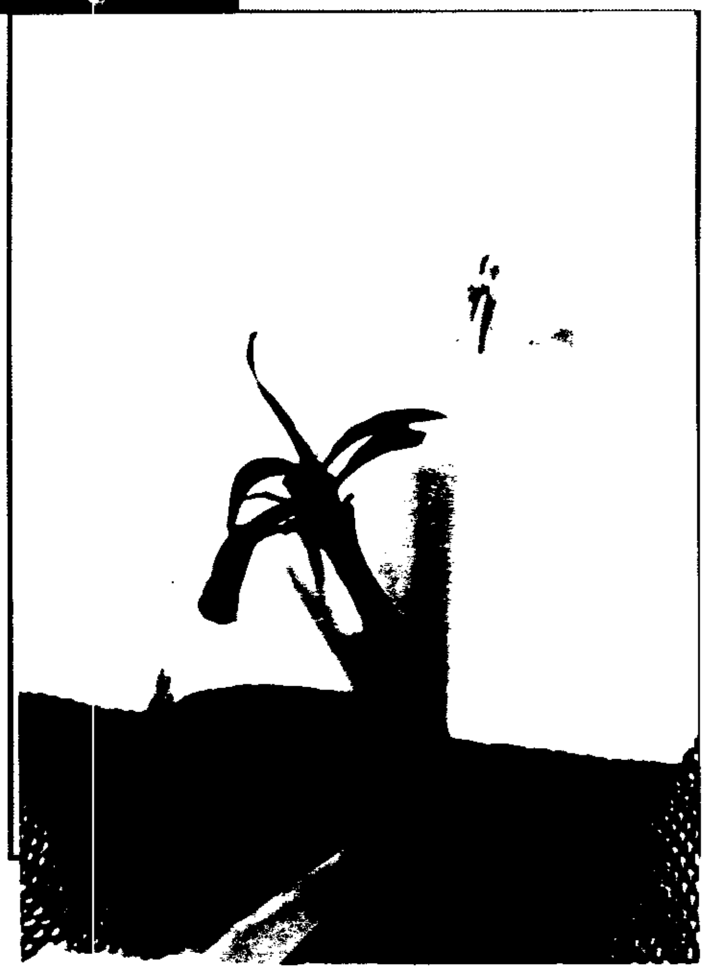

Fig.(17): One-node cutting of bitter almond in **Establishment Stage.**

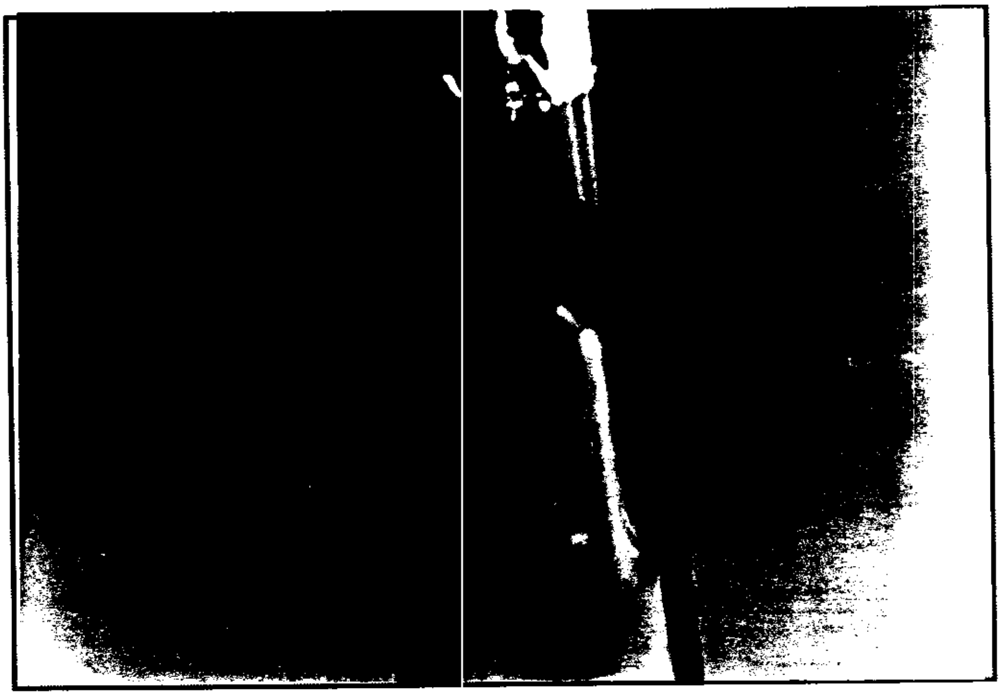

Fig. (18): Shoot-tip of Okenawa peach in
Establishment Stage.

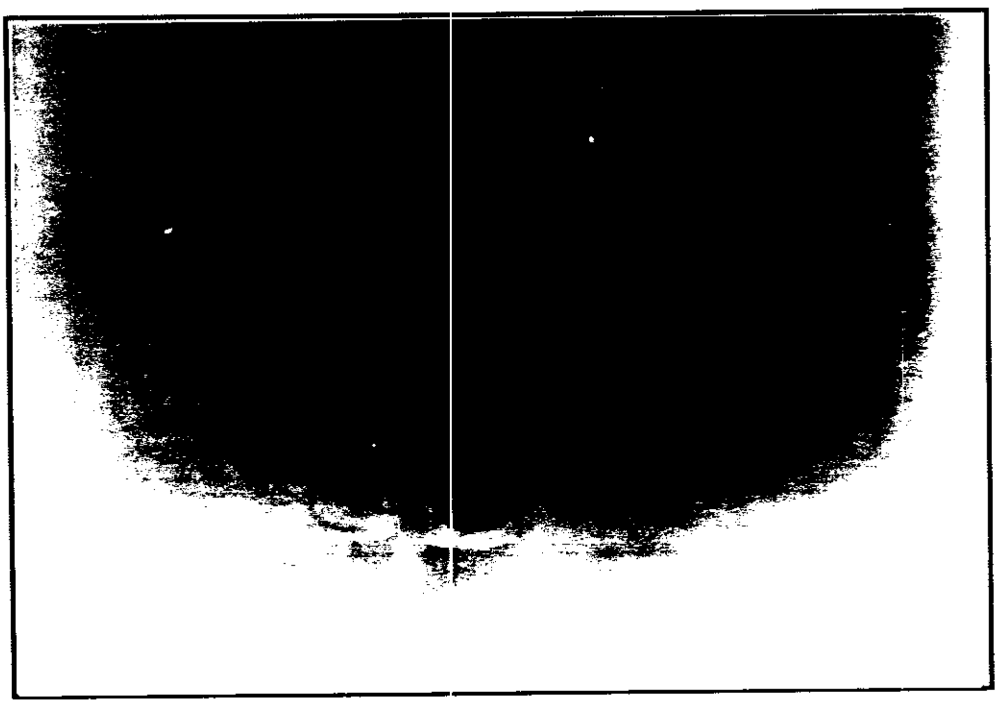

Fig. (19): One-node cutting of Okenawa peach in
Establishment Stage.

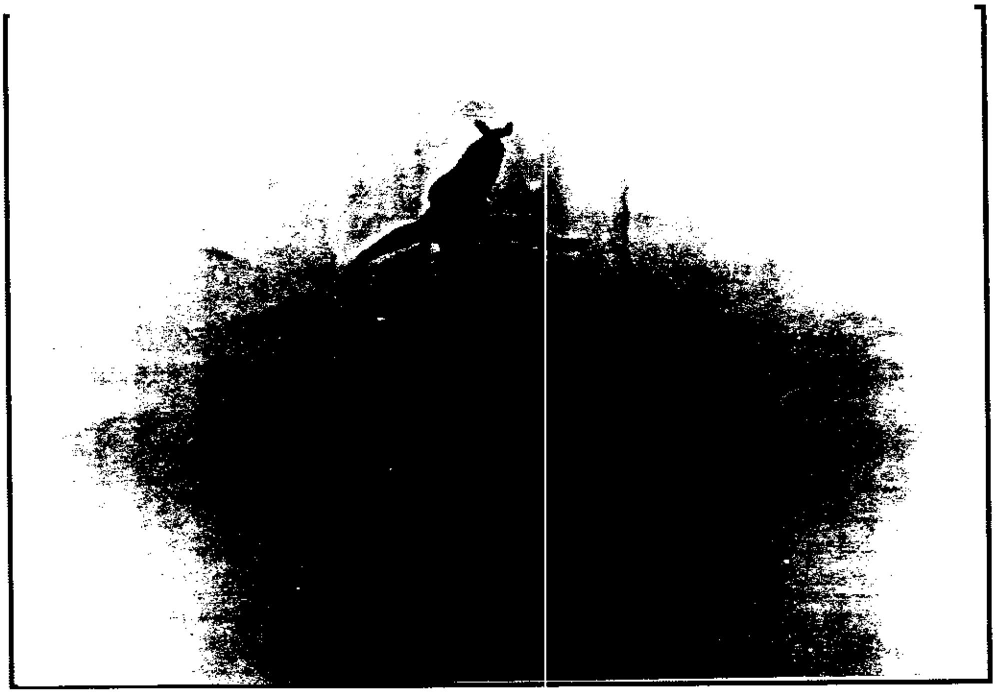

Fig. (20): Shoot-tip of Marianna 2624 plum in **Establishment Stage.**

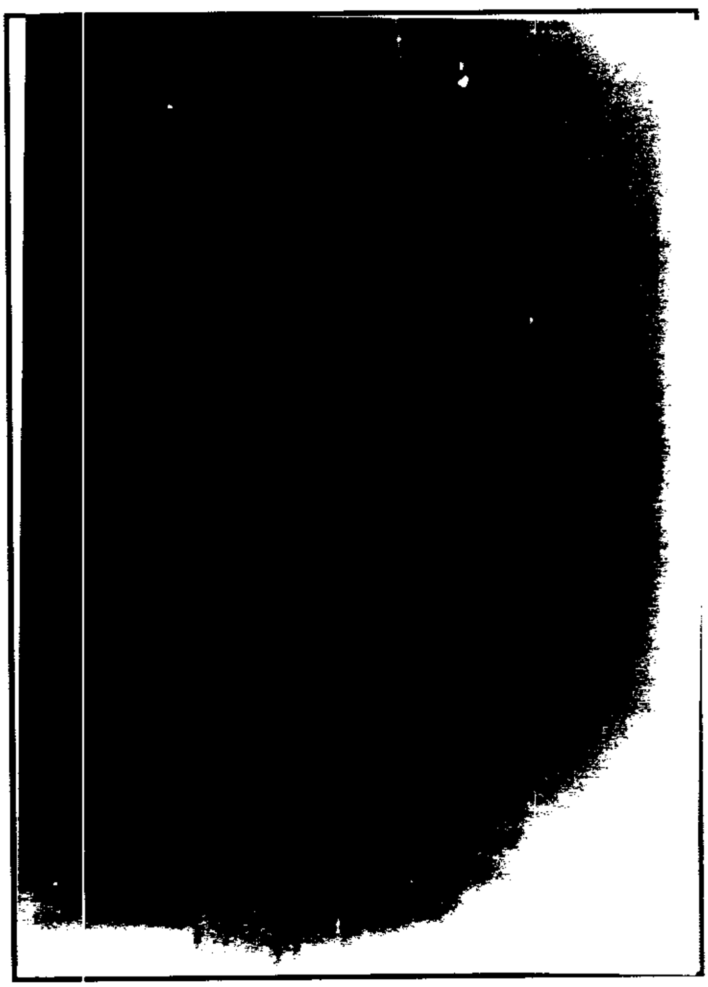

Fig. (21): One-node cutting of Marianna 2624 plum in **Establishment Stage.**

On the other hand, shoot tip explants recorded lower percentages of survival as compared with one-node cuttings. Shoot length and number of leaves per explant, showed an opposite trend, where shoot tip explants gave higher shoot length and number of leaves per plant than one-node cuttings.

These results go in line with those obtained by previous investigators working on almond, Peach and plum rootstocks using shoot-tip and one-node cutting such as {(**Rosati** ***et al.*****, 1980)**; **(Hammerschlag, 1981, 1982)**; **(Rugini** and **Verma, 1983)**; **(Ochatt** and **Caso, 1983)**; **(Pietropaolo** and **Reish, 1984)**; **(Allam** and **El-Rayes, 1991)** and **(Ambrozic Turk, 1992)**}.

Anyhow, under the conditions of this study, April was the best time for explant preparation. Such result coincided with the findings of **(Rugini** and **Verma, 1983)** working on almond. However, **(Joung** and **Ko, 1983)** and **(Kim** ***et al.*****, 1982)** mentioned that mid-May was the optimum time for shoot-tip collection of M-7, M-16 and M-106 apple rootstocks.

Besides, **James, (1984)** reported that aseptic culture of Northern spy could be established at any time during the year although both mid-Spring and summer were the best.

On the contrary, cultivars of Stanely plum' was more difficult in October than in June. **(Pietropaolo** and **Reish, 1984)**.

4-3-1-2- Proliferation stage:

Data tabulated in Table (15) and demonstrated in Fig. (22) disclose the number of shoots produced from shoot-tip and one-node cutting prepared at different times for almond rootstocks i.e. bitter almond, Okenawa peach and Marianna 2624 plum grown on modified MS medium with 1 mg/L BAP.

In this respect, explants prepared in April gave the highest number of shoots in the first, second and third subcultures for all rootstocks used in the two types of explants. On the other hand, number of shoots were significantly reduced by the delay in the preparation of explants during the season. Thus, explants prepared in August gave the least number of shoots and were significantly lower than those prepared during earlier months. Meanwhile, explants prepared in May, June, July came descendingly in between.

Besides, the rootstocks used could be arranged descendingly according to the number of shoots produced as follows, bitter almond, Okenawa peach and Marianna 2624 plum.

Moreover, it seems that, the delay in preparation of explants during the season caused a general drop in growth vigour of deciduous fruit trees that may be due to the increase in the level of inhibitory compounds in buds i.e. (phenols, abscisic acid, phloroglucinol, coumarin ...etc). Furthermore, nutrient elements and growth promoters are transferred by vascular tissues from the buds to storage tissues of the tree in order to enter the period of dormancy.

Table (15) : Effect of explant preparation time on the performance of shoot-tip and one-node cuttings during the *proliferation stage of three almond rootstocks.

Month	No. of Shoots / Explant					
	Shoot Tip			One Node Cutting		
	First sub-culture	Second sub-culture	Third sub-culture	First sub-culture	Second sub-culture	Third sub-culture
Bitter Almond						
April	17.25 e	13.02 e	11.40 e	12.90 e	10.91 e	10.35 e
May	15.15 d	9.97 d	9.30 d	10.95 d	8.98 d	8.90 d
June	11.18 c	6.90 c	5.25 c	8.85 c	7.70 c	6.65 c
July	5.92 b	4.95 b	3.35 b	4.85 b	4.55 b	3.78 b
August	2.70 a	1.79 a	1.31 a	1.78 a	1.13 a	1.00 a
Okenawa peach						
April	13.42 e	10.95 e	8.60 e	9.85 e	9.20 e	7.68 e
May	10.88 d	8.93 d	7.98 d	8.08 d	7.35 d	6.55 d
June	8.15 c	7.20 c	6.70 c	6.07 c	5.85 c	4.78 c
July	4.62 b	4.67 b	3.68 b	3.85 b	3.83 b	2.85 b
August	1.75 a	1.00 a	1.00 a	1.28 a	1.00 a	1.00 a
Marianna 2624 Plum						
April	7.13 e	6.20 e	5.58 e	5.58 e	4.98 e	4.48 e
May	6.03 d	5.25 d	4.75 d	4.60 d	3.85 d	3.58 d
June	5.36 c	4.15 c	3.78 c	4.03 c	3.30 c	3.05 c
July	4.37 b	3.35 b	2.85 b	3.30 b	2.73 b	2.48 b
August	1.00 a	1.00 a	1.00 a	1.00 a	1.00 a	1.00 a

* Explants were grown on modified MS medium with 1 mg/L BA.

Means followed by same letter (s) within each column are not significantly different from each other at 5% level.

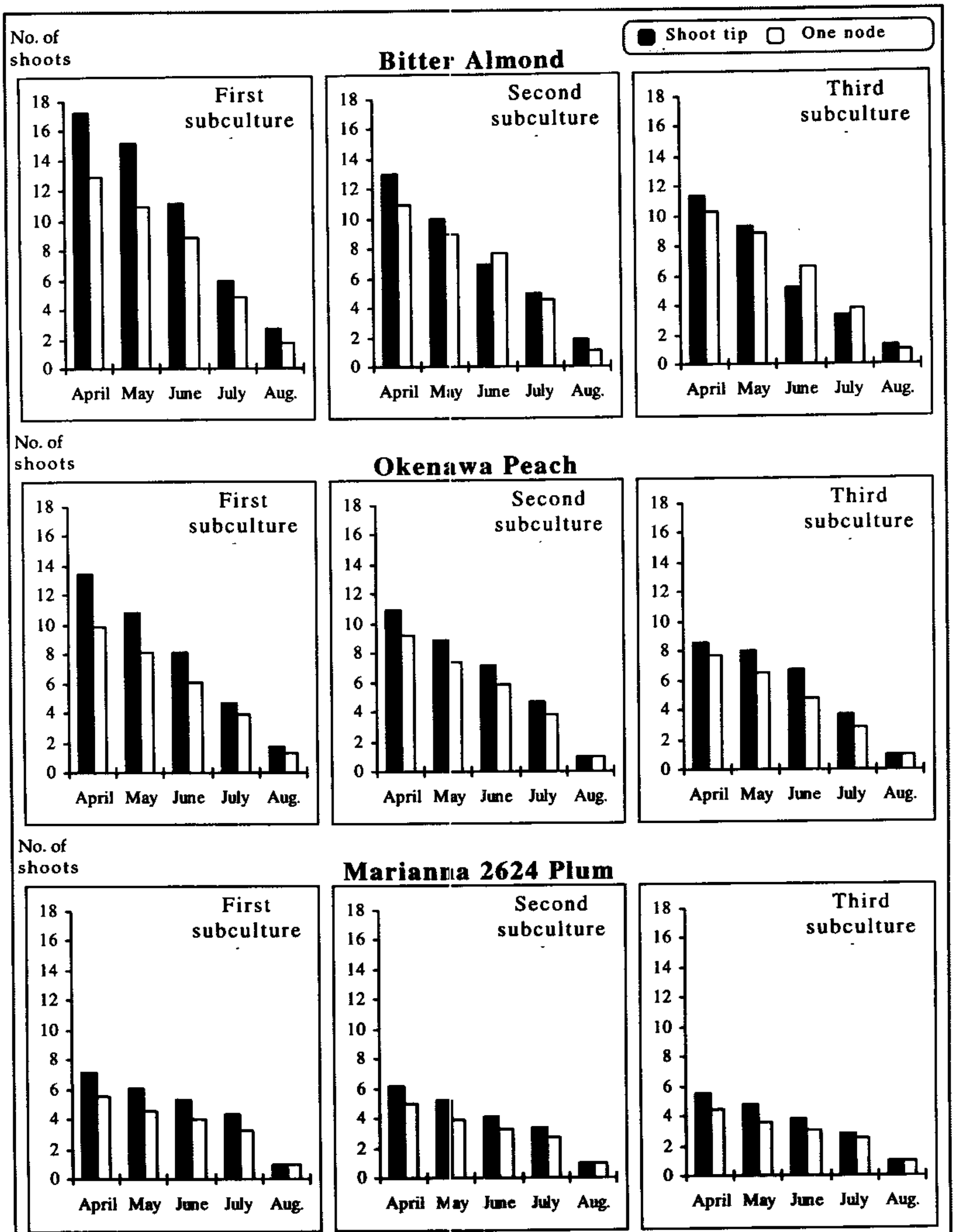

Fig. (22): Effect of explant preparation time on the performance of shoot-tip and one-node cuttings grown on modified MS medium with 1 mg BA, during the proliferation stage of three almond rootstocks.

Fig. (23): Shoot-tip and one-node cutting of bitter almond during **Proliferation Stage.**

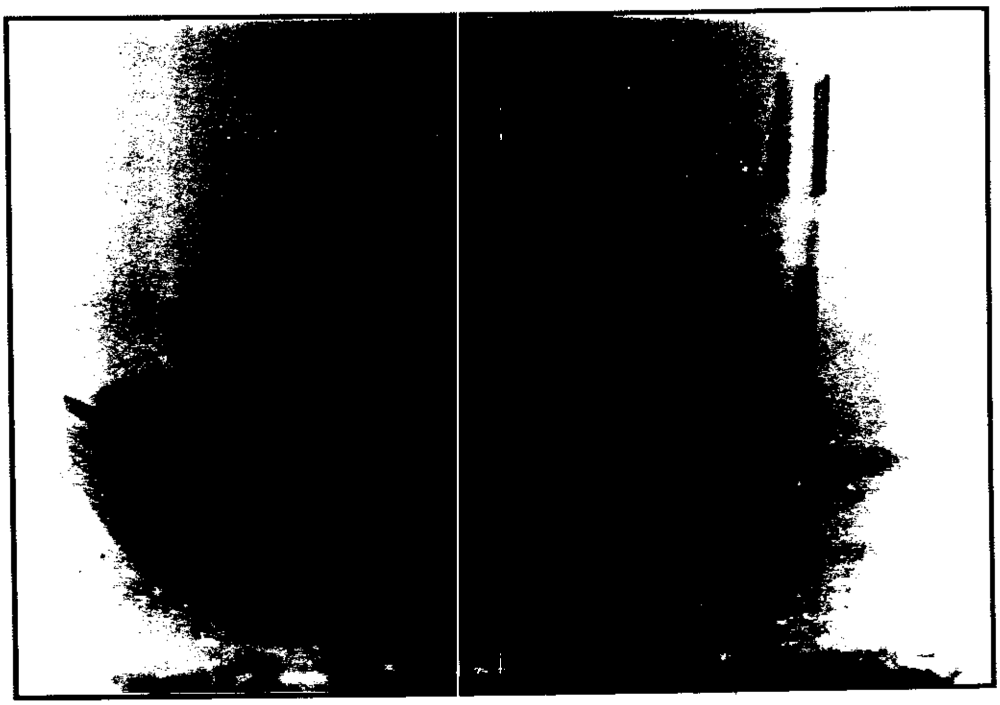

Fig. (24): Shoot-tip of bitter almond during **Proliferation Stage.**

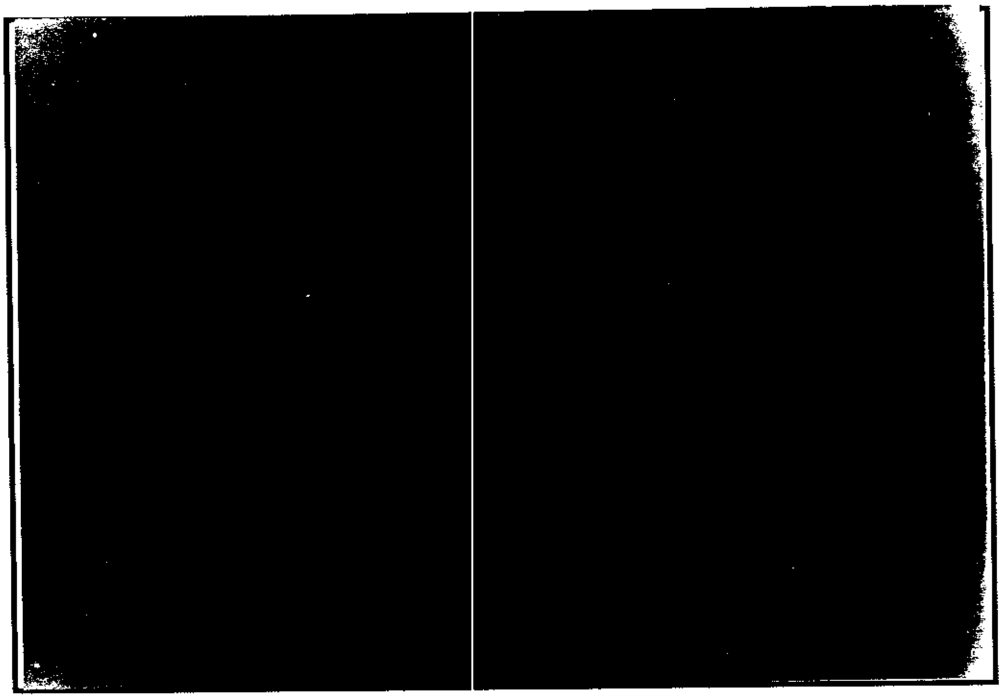

Fig. (25): Shoot-tip of Okenawa peach during **Proliferation Stage.**

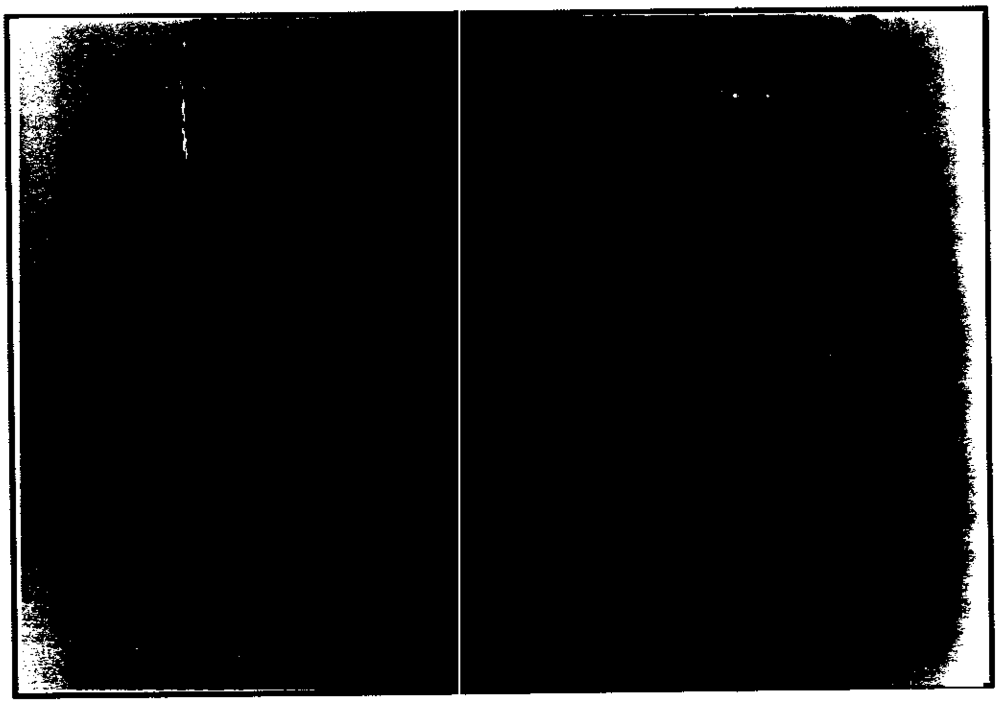

Fig. (26): One-node cutting of Okenawa peach during **Proliferation Stage.**

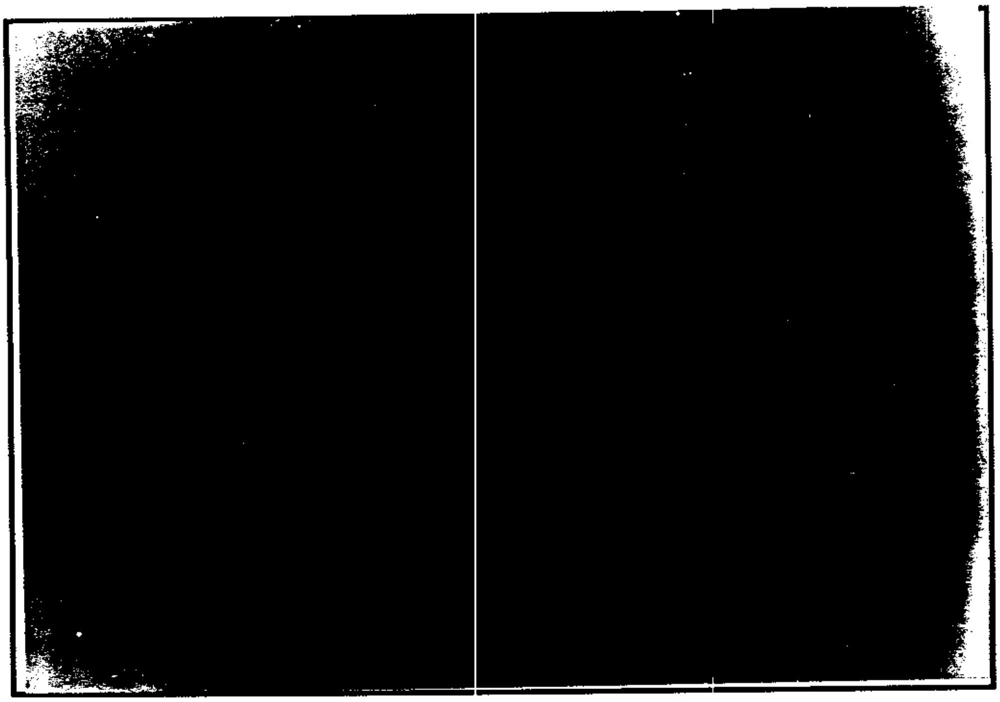

Fig. (27): Shoot-tip of Marianna 2624 plum during **Proliferation Stage.**

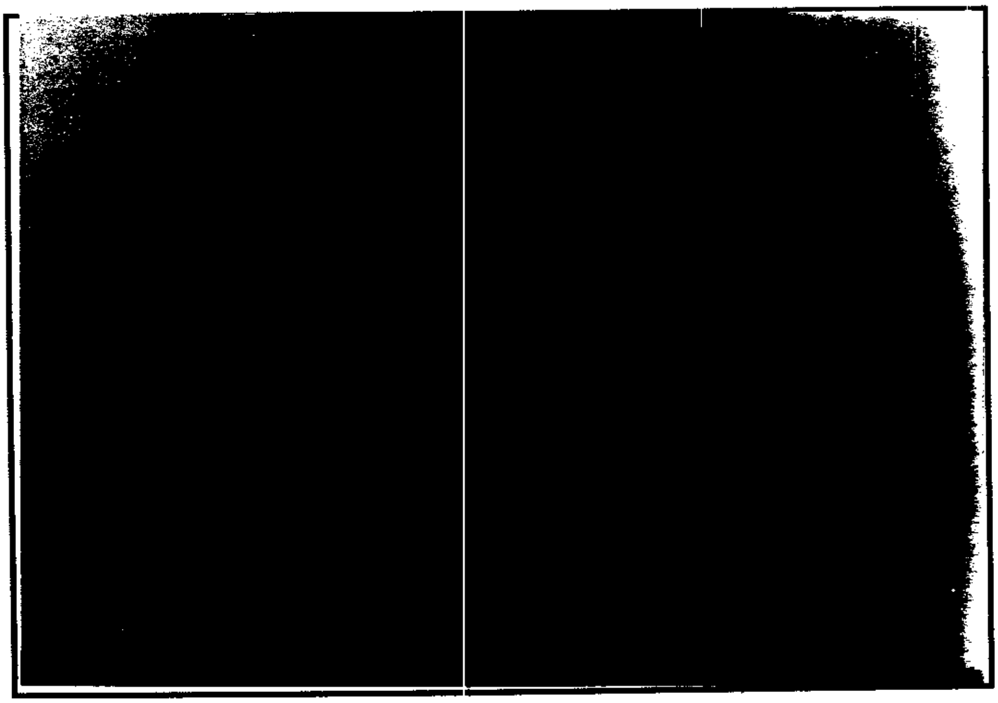

Fig. (28): One-node cutting of Marianna 2624 plum during **Proliferation Stage.**

In addition it was found that number of subcultures had no remarkable effect on proliferation rate. The first subculture gave the highest value as compared to those of subsequent cultures (second and third subculture).

In the proliferation stage, adding 1 mg/L BA increased the number of shoots per explant for all rootstocks used. These results are in harmony with the findings of **(Rosati *et al.*, 1980)**; **(Rugini and Verma, 1983)** working on almond; **(Allam and El-Rayes, 1991)** working on Nemaguard peach rootstock; **(Rosati *et al.*, 1980)**; **(Hammerschlage, 1992)** and **(Pietropaolo and Reisch, 1984)**; **(Hansen, 1984)** working on plum rootstocks; **(Snir and Erez, 1980)** and **(Cheem and Shama, 1982)** working on apple rootstocks; **(Sabastia and Comb, 1986)** working on Carob; **(Lineberger, 1983)**; **(Katano, 1987)** and **(Oh. *et al.*, 1991)** working on cherry.

Regarding, the effect of cytokinin BAP on proliferation, it may be related to the effect of foliar application of exogenous BAP to standard peach trees that has been shown to induce buds to form lateral branches and spurs. This could be a growth habit dependent reaction related to cytokinins in *Vitro* and endogenous cytokinins. The high percentage of lateral bud break is most likely a specific characteristic of the tree that most likely is influenced by the endogenous cytokinin **(Scorza and Cordts, 1979)**.

4-3-1-3- Rooting Stage:

In rooting stage, shoot-tip and one-node cuttings for bitter almond, Okenawa peach and Marianna 2624 plum were grown on modified MS medium with 5 mg/L IBA + 1 mg/L NAA.

root primordia failed to develop due to the large amount of callus formed around the root initials of the three rootstocks under study.

These results are in harmony with those obtained by **(Tabachnik and Kester, 1977)**. using shoot-tips of both almond and almond-peach hybrid grown on modified Knob's macro element, mineral solution, 2% sucrose and FeEDTA. Application of (0.01 mg/L) auxin shifted development from shoot growth and caused callus production. On the contrary, indole acetic acid (IAA) induced less callus formation and allowed more shoot growth and limited rooting success.

In addition, higher IBA concentrations (2.0 and 5.0 mg/L) with the addition of either 0.25% activated charcoal or 0.162 g./L phloroglucinol, the omission of agar from the MS medium (using instead filter paper supports for the explants) and reduction of salt concentration by half failed to improve rooting of Red-leaf peach(*Prunus persica*. Batsch), **(Ochatt and Caso, 1983)**. However, a recent study **(Caboni and Damino, 1994)** indicated that rooting was achieved on almond micro cuttings using Bourgin and Nitch medium. Besides, rooting was obtained on peach shoot-tip explants using half strength MS medium **(Allam and El-Rayes, 1991)**. Moreover, **(Rosati *et al.*, 1980)**; **(Hammerschlag, 1982)**; **(Pietropaolo and Reisch, 1984)** and **(Junior *et al.*, 1991)** pointed out that rooting was achieved on plum shoot-tip explants using full or half strength MS medium. On the other hand, many investigators obtained rooting from shoot-tip or one-node cuttings of different fruit crops; cherry, pistasio, pear and plum using MS medium **{(James, *et al.*, 1979)**; **(Ivanicka and Pretova, 1980)**; **(Stick *et al.*, 1981)**

(Lineberger, 1983); (Barghchi and **Alderson, 1983); (Hensen, 1984); (Reeves** *et al.*, **1985); (Oh** *et al.*, **1991); (Rodriguez** and **Muzas, 1992)}.**

Meanwhile, **James** and **Thurbon (1979)** showed that auxins are necessary for root initiation and the development of root primordia but their continued presence may limit subsequent root development by continued promotion of cell division that leads to callus formation. Such finding may explain the inhibitory effect of auxins occurred in the present study.

Furthermore, transferring shoots to an auxin free medium was beneficial as exposing the shoots to auxin for sufficient duration permitted root initiation, but further exposure inhibited root development. Long exposure of auxin has previously been reported as inhibiting the development of roots and to promote the development of callus. Callus growth can inhibit root production by physically blocking the development of root-initials either by the competition for nutrients or by the development of growth inhibitors. **(Barghchi** and **Alderson, 1983).**