In addition , root dry weight was increased in response to both soil treatments used. The difference between zinc sulphate treatment and the control was highly significant.

Regarding root : shoot ratio , it is interesting to notice that zinc sulphate soil treatment was superior as compared with other treatments. Nevertheless , significant differences were lacking either within treatments or between treatments and the control.

From the aforementioned results it is safe to conclude that applying zinc sulphate to the soil increased significantly root length , root dry weight , total seedling dry weight , and number of leaves per seedling of pecan. On the other hand , treating soil with silver nitrate reduced shoot length increase and number of feeder roots per seedling but increased total seedling dry weight and number of leaves per seedling , simultaneously.

These results disagree with those obtained by **Pellett et al (1980)**. They reported that silver nitrate , and zinc sulphate were effective in killing root tips of squash , Lima been , and kentucky coffee seedlings without damaging the rest of the plant in greenhouse trials.

However , in the present study , it seems that metal concentrations used were not high enough to kill the root tip of pecan seedlings.

4-5. Experiment- V: RESPONSE OF ONE - YEAR - OLD PECAN SEEDLINGS TO SOME ROOT TREATMENTS.

Table (6- a) shows the effect of some root treatments on one -year - old pecan seedlings expressed as shoot length increase , number of lateral shoots and leaves per seedling during 1987 and 1988 seasons.

As for shoot length increase , it is obvious that roots of pecan seedlings - shortened and wounded by two vertical cuts at both sides gave statistically longer shoots , in 1987 , as compared with roots shortened only. But , data of 1988 and the mean of two seasons revealed that the stimulating effect of wounding treatment was nil. On the other hand , in the first season , treating the shortened and wounded pecan roots with IBA , NAA and Benomyl greatly reduced shoot length than either those shortened or shortened and wounded treatments in 1987. Anyhow , 2000 and 1000 ppm IBA , as well as , 500 and 1000 ppm NAA treatments gave the shortest shoots , respectively followed by 600 ppm Benomyl. Moreover , in 1988 , treating shortened and wounded pecan roots either with 1000 ppm IBA , or 1000 ppm NAA as well as 600 ppm Benomyl caused insignificant reduction in shoot length ; whereas the opposite was true when pecan roots were treated with 2000 ppm IBA. Beside , average of two seasons show that treating the shortened and wounded pecan roots with 500 and 1000 ppm NAA as well as 1000 ppm IBA + 600

ppm Benomyl significantly inhibited shoot growth as compared with shortening and wounding seedling roots. Meanwhile , 2000 ppm IBA treatment caused slight reduction in shoot length. On the other hand , in 1987 , treating shortened and wounded pecan roots with 600 ppm Benomyl gave insignificantly longer shoots than those seedlings of shortened and wounded roots treated with either 1000 ppm IBA or 500 ppm NAA. In the second season , 1000 ppm IBA + (Treatment 7) gave the shortest shoots as compared with Treatment 7 only or (1000 ppm IBA + 500 ppm NAA + Treatment 7) treatment , whereas (500 ppm NAA + Treatment 7) treatment significantly stimulated shoot growth.

Briefly , it is easy to conclude that both IBA and NAA application either alone or combind with Benomyl resulted in reducing stem length , espeailly at the lower concentration i. e 500 and 1000 ppm for NAA and IBA , respectivly.

Similar results were mentioned by **Hartman and Kester (1972)** on the effect of root shortening and wounding. Meanwhile , the results of IBA and NAA treatments disagree with those reported by **Kelly and Moser (1983- a)** and **Kathiravetpillae et al (1983).**

Concerning number of lateral shoots per seedling , it is clear that neither root wounding nor growth regulators i.e. IBA , NAA and Benomyl as well as their combinations had any effect on number of lateral shoots per seedling. However , **Kelly and Moser (1983- a)** reported contrasting results on the effect of IBA on *Liriodron tulipifera*, L .

Concerning number of leaves per seedling , tabulated data of 1987 , 1988 seasons and their mean , show that wounding the

Table (6-a) : Effect of some root treatments on vegetative growth of 1- year - old pecan seedlings.

Treatment	Shoots length increase (cm)			No. of lateral shoots / seedling			No. of leaves / seedling		
	1987	1988	Mean	1987	1988	Mean	1987	1988	Mean
1- Root shortening (Rs)	2.37 cd	4.07 cd	3.22 cd	2.00 a	2.33 a	2.17 a	3.07 a	4.03 a	3.55 a
2- R.S. +Wounding (W)	3.13 e	3.83 bcd	3.48 d	2.37 a	2.53 a	2.45 a	5.03 bc	8.97 de	7.00 de
3- R.S. +W+ IBA,1000 ppm	1.57 ab	3.87 bcd	2.72 abc	2.27 a	2.50 a	2.39 a	5.33 bc	7.57 cd	6.45 bcde
4- R.S. +W+ IBA, 2000 ppm	1.17 a	5.00 e	3.08 bcd	2.00 a	1.83 a	1.92 a	4.90 abc	6.33 bc	5.62 bc
5- R.S. +W+ NAA, 500 ppm	1.43 ab	3.37 ab	2.40 a	2.37 a	2.43 a	2.40 a	5.23 bc	9.43 e	7.33 e
6- R.S. +W+ NAA, 1000 ppm	1.53 ab	3.57 bc	2.55 ab	1.80 a	2.37 a	2.09 a	4.00 ab	6.83 bc	5.42 b
7- R.S. +W+ Benomyl,600 ppm ..	2.03 bcd	3.73 bc	2.88 abc	1.96 a	2.17 a	2.07 a	5.10 bc	7.70 cd	6.27 bcde
8- (7)+ IBA, 1000 ppm	1.87 bc	2.80 a	2.33 a	2.26 a	2.20 a	2.23 a	5.47 bc	6.50 bc	5.98 bcd
9- (7)+ NAA, 500 ppm	1.63 ab	4.17 d	2.90 abc	2.10 a	2.33 a	2.22 a	6.50 c	7.27 cd	6.88 cde
10- (7)+IBA, 1000 ppm+NAA, 500 ppm	2.53 d	3.57 bc	3.05 bcd	2.33 a	2.00 a	2.17 a	5.43 bc	5.07 ab	5.25 b

Means followed by same letter(s), within each column , are not significantly different from each other at1% level.

shortened pecan roots caused a highly significant increase in the number of leaves per seedling than when roots were shortened only. Moreover , treating shortened and wounded pecan roots with 1000 or 2000 ppm IBA , 500 or 1000 ppm NAA and 600 ppm Benomyl did not statistically affect the number of leaves per seedling as compared with the root shortening + wounding treatment. Meanwhile , the trend of the previously mentioned growth regulator treatments took the other way around in 1988 and the mean of two seasons. This was more obvious when shortened and wounded pecan roots were treated with 2000 ppm IBA or 1000 ppm NAA. Such treatments greatly decreased the number of leaves per seedling , whereas , treating shortened pecan roots with 500 ppm NAA caused the reverse without significancy. Beside , treating shortened and wounded pecan roots with 1000 ppm IBA or 600 ppm Benomyl did not statistically affect number of leaves per seedling. On the other hand , as shortened and wounded pecan roots treated with 600 ppm Benomyl (Treatment 7) were compared with aftermentioned treatments i.e. 8 , 9 and 10 , in the table it is clear that the addition of 1000 ppm IBA , 500 ppm NAA or their combinations to Treatment 7 did not statistically affect the number of leaves per seedling except in 1988 , since the addition of the mixture of 1000 ppm IBA and 500 ppm NAA to treatment 7 caused a highly significant increase in number of leaves per seedling. In this respect , **Bolt (1982)** pointed out similar results on the effect of wounding. However , **Kathiravetpillai et al (1983)** reported opposite results on the effect of NAA + IBA.

Furthermore , **Table (6- b)** and **Fig. (5)** show the response of one - year - old pecan seedlings to some root treatments expressed as root length , number of lateral roots per seedling , total seedling

dry weight , shoot and root dry weight as well as root : shoot ratio during 1987 and 1988 seasons.

Considering root length , tabulated data revealed that in both seasons , shortening and wounding pecan roots significantly reduced root length than those shortened only. Meanwhile , in 1987 season , treating shortened and wounded pecan roots with IBA , NAA and Benomyl greatly stimulated root growth. This was highly significant when the seedlings received 1000 ppm NAA , 1000 , 2000 ppm IBA and 500 ppm NAA treatments.

Anyhow , wounding pecan roots most likely increased number of lateral roots per seedling , root dry weight and root : shoot ratio. Such increment could be attributed to the presence of wound hormone (Trumatine) which is formed in the crushed tissues **(Bonner and English , 1938).**

Otherwise , shortened and wounded pecan roots treated with 600 ppm Benomyl were statistically similar in their lengths to those shortened and wounded only. Moreover , in 1988 , treating shortened and wounded pecan roots with 1000 or 2000 ppm IBA and 500 or 1000 ppm NAA significantly increased root length. On the contrary , 600 ppm Benomyl treatment had insignificant effect in this respect. The average of two seasons declare that , the treatments that stimulated root elongation could be descendingly arranged as follows : 1000 ppm IBA , 1000 ppm NAA , 2000 ppm IBA , 500 ppm NAA and 600 ppm Benomyl as compared with shortening and wounding pecan roots.

As for shortned and wounded roots , treated with growth regulators as well as with their combinations , it is easy to conclude

that in 1987 , 1988 and the average of two seasons , treating shortened and wounded roots + 600 ppm Benomyl i.e. (Treatment 7) with 500 ppm NAA gave the longest roots as compared with treatment (7) only. Other treatments i. e. treatment (7) + 1000 ppm IBA and treatment (7) + 1000 ppm IBA + 500 ppm NAA had root length values statistically similar to each other as well as to those of treatment (7) and 500 ppm NAA. This was more obvious in both 1987 and the mean of two seasons. Similar results were mentioned by **Greene et al (1982) , Struve (1984) and Moser (1984) and Cappiello and Kling (1987)** on the effect of IBA , and NAA , and Benomyl alone or in their combinations. Meanwhile , **Hocking and Thomas (1981 a and b)** reported opposite results on the effect of Benomyl.

Regarding the number of lateral roots per seedling it is obvious that shortening and wounding pecan roots increased number of lateral roots per seedling as compared with root shortening only. This was highly significant in 1988 season as well as the mean of two seasons , while was insignificant in 1987.

On the other hand , treating shortened and wounded roots with IBA , NAA and Benomyl did not statistically affect number of lateral roots per seedling as compared with untreated ones , except those treated with 1000 ppm IBA which had the highest number of lateral roots. Nevertheless , the mean of two seasons , showed another picture , since , treating shortened and wounded pecan roots with 1000 ppm NAA or 600 ppm Benomyl caused a significant reduction in number of lateral roots as compared with untreated ones. Meanwhile, treating shortened and wounded pecan roots with 1000 ppm IBA significantly increased number of lateral roots per seedling. In contrast , other treatments had insignificant effect. Moreover , when shortening + wounding + 600 ppm Benomyl i.e. treatment 7 was

Table (6-b) : Effect of some root treatments on root growth and seedling dry weight parameters of 1 - year - old pecan seedlings.

Treatment	Root length (cm)			No. of lateral roots / seedling			Total seedling dry wt. (g)			Shoot dry wt. (g)			Root dry wt. (g)			Root / shoot ratio		
	1987	1988	Mean	1987	1988	Mean	1987	1988	Mean	1987	1988	Mean	1987	1988	Mean	1987	1988	Mean
1- Root shortening (Rs)	32.60 bc	32.90 bc	32.75 bc	1.17 a	1.17 a	1.17 a	2.63 a	2.86 ab	2.75 ab	0.83 a	0.93 a	0.88 a	1.80 a	1.96 a	1.88 a	2.17 a	2.07 d	2.15 cd
2- R.S. +Wounding (W)	19.23 a	21.80 a	20.52 a	1.50 ab	1.90 bc	1.70 cd	4.53 bc	3.83 cde	4.18 c	1.30 ab	1.43 abc	1.37 ab	3.23 bc	2.40 bcd	2.82 ab	2.48 a	1.68 bcd	2.08 bcd
3- R.S. +W+ IBA,1000 ppm	39.60 cde	46.10 d	42.85 e	2.07 cd	2.33 d	2.20 e	6.20 cd	4.73 ef	5.47 d	1.80 bc	1.77 c	1.78 bc	4.40 cd	2.97 de	3.68 c	2.44 a	1.67 bcd	2.06 bcd
4- R.S. +W+ IBA, 2000 ppm	36.57 cde	39.83 cd	38.20 cde	1.83 bcd	1.83 bcd	1.83 d	8.54 f	4.76 f	6.65 f	2.57 e	2.63 d	2.60 d	5.97 f	2.13 abc	4.05 cd	2.32 a	0.81 a	1.57 a
5- R.S. +W+ NAA, 500 ppm	33.93 bcd	37.00 bc	35.47 cd	1.10 a	1.77 abc	1.43 abc	3.23 ab	3.77 bcd	3.50 bc	1.03 a	1.70 bc	1.37 ab	2.20 ab	2.07 abc	2.13 a	2.13 a	1.22 abc	1.68 ab
6- R.S. +W+ NAA, 1000 ppm	43.40 e	35.83 bc	39.62 de	1.10 a	1.50 ab	1.30 ab	3.67 ab	3.40 abc	3.53 bc	1.20 a	1.40 abc	1.30 ab	2.47 ab	2.00 abc	2.47 ab	2.06 a	1.43 abc	1.74 abc
7- R.S. +W+ Benomyl,600 ppm	27.56 ab	28.23 ab	27.90 ab	1.37 ab	1.35 ab	1.36 ab	2.33 a	2.63 a	2.48 a	0.80 a	0.93 a	0.87 a	1.53 a	1.70 a	1.62 a	1.91 a	1.83 cd	1.87 abcd
8- (7) + IBA, 1000 ppm	33.33 bcd	36.27 bc	34.80 bcd	1.57 abc	1.83 bcd	1.70 cd	6.64 de	5.00 f	5.82 de	1.97 cd	1.63 abc	1.80 bc	4.67 de	3.37 e	4.02 cd	2.37 a	2.07 d	2.22 d
9- (7) + NAA, 500 ppm	41.10 bc	33.10 bc	37.10 cde	2.17 d	2.20 ed	2.18 e	8.03 ef	4.70 def	6.37 ef	2.40 de	1.73 c	2.07 cd	5.63 ef	2.97 de	4.30 d	2.35 a	1.71 bcd	2.03 abcd
10- (7) + IBA, 1000 ppm + NAA, 500 ppm	36.00 cde	33.77 bc	34.88 bcd	1.50 ab	1.57 ab	1.53 bc	6.66 de	5.20 f	5.93 def	2.13 cde	2.53 d	2.33 cd	4.53 de	2.67 cd	3.60 c	2.13 a	1.06 ab	1.59 a

Means followed by same letter(s), within each column , are not significantly different from each other at 1% level.

compared with thereafter treatments in **Table (6- b)** it is clear that in 1987 , 1988 and the mean of two seasons , treatment (7) + 1000 ppm IBA + 500 ppm NAA and treatment (7) + 1000 ppm IBA did not statistically affect number of lateral roots per seedling. Meanwhile , treatment (7) + 500 ppm NAA treatment significantly increased number of lateral roots. **Satyanarayana (1982) . Kelly (1985) . Linton et al (1985)** pointed out analogous results on the effect of wounding. Also , **Hocking and Thomas (1981- b)** pointed out similar results on the effect of Benomyl. In addition , **Gustafson and Miles (1978) . Fordhan (1978) . Moser (1984) . Struve (1984) . Shim (1985) . Blyth (1986) . Simpson (1987) . Boser et al (1987) and Perkins and Kling (1987)** mentioned similar results on the effect of NAA , IBA and Benomyl alone or in combinations.

Concerning total seedling dry weight , it is quite evident from **Table (6- b) and Fig. (5)** that in 1987 , 1988 and the mean of two seasons, wounding the shortened pecan roots increased seedling dry weight as compared with shortened roots only. In addition , treating shortened and wounded pecan roots with 1000 ppm IBA , 500 and 1000 ppm NAA did not statistically affect seedling dry weight. On the contrary , treating shortened and wounded roots with 2000 ppm IBA significantlyincreased seedling dry weight. Meanwhile , substituting 1000 ppm IBA by 600 ppm Benomyl statistically increased total seedling dry weight. However , 1000 and 2000 ppm IBA treatments took the same trend as the mean of the two seasons was concerned.

On the other hand , treatment 7 as compared with aftermentioned treatments , data indicated that treatment 7 + 1000 ppm IBA , treatment " 7 " + 500 ppm NAA resulted in highly

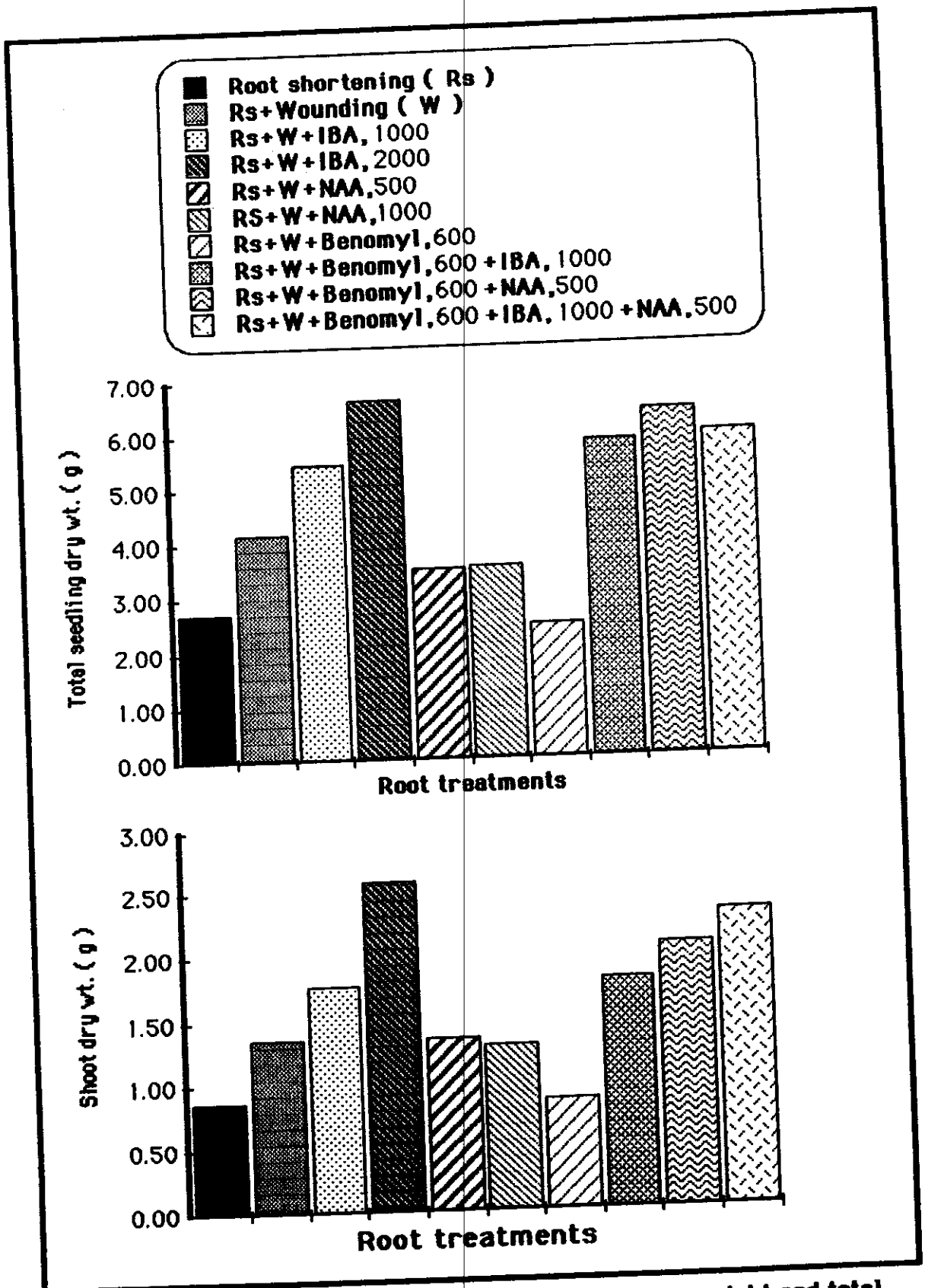

Fig. (5): Effect of some root treatments on shoot dry weight and total seedling dry weight of 1-year-old pecan seedlings.

significant increase in this respect. **Lee et al (1983)** reported similar findings on the effect of Benomyl + IBA.

Regarding shoot dry weight , illustrated data in **Table (6- b) and Fig. (5)** show that in 1987 , 1988 and the mean of two seasons , wounding shortened pecan roots caused an insignificant increase as compared with shortened pecan roots only. Moreover , treating shortened and wounded pecan roots with 1000 ppm IBA , 500 or 1000 ppm NAA and 600 ppm Benomyl did not significantly affect shoot dry weight as compared with untreated ones. In addition , the highest value of shoot dry weight was observed with shortened and wounded pecan roots and treated with 2000 ppm IBA. On the other hand , treatment (7) i.e. root shortening and wounding + 600 ppm Benomyl supplied with 1000 ppm IBA or 500 ppm NAA or a mixture of 1000 ppm IBA + 500 ppm NAA significantly increased shoot dry weight than when it was left without supplying with those previously mentioned growth regulators.

Concerning root dry weight , disclosed data in **Table (6- b)** and graphed in **Fig. (6)** declare that shortening and wounding pecan roots gave higher root dry weight values than those shortened only. The effect was highly significant in 1987 and 1988 seasons but insignificant in the mean of two seasons. On the other hand , as for the effect of IBA , NAA and Benomyl on shortened and wounded pecan roots , it is clear that 600 Benomyl caused a high reduction in root dry weight value. On the contrary , 2000 ppm IBA only significantly increased root dry weight in 1987 and the mean of two seasons. Anyhow , 500 or 1000 ppm NAA and 1000 ppm IBA treatments did not statistically affect this character , except 1000 ppm IBA which significantly increased root dry weight in the mean of two seasons. Moreover , comparing treatment (7) with aftermentioned treatments

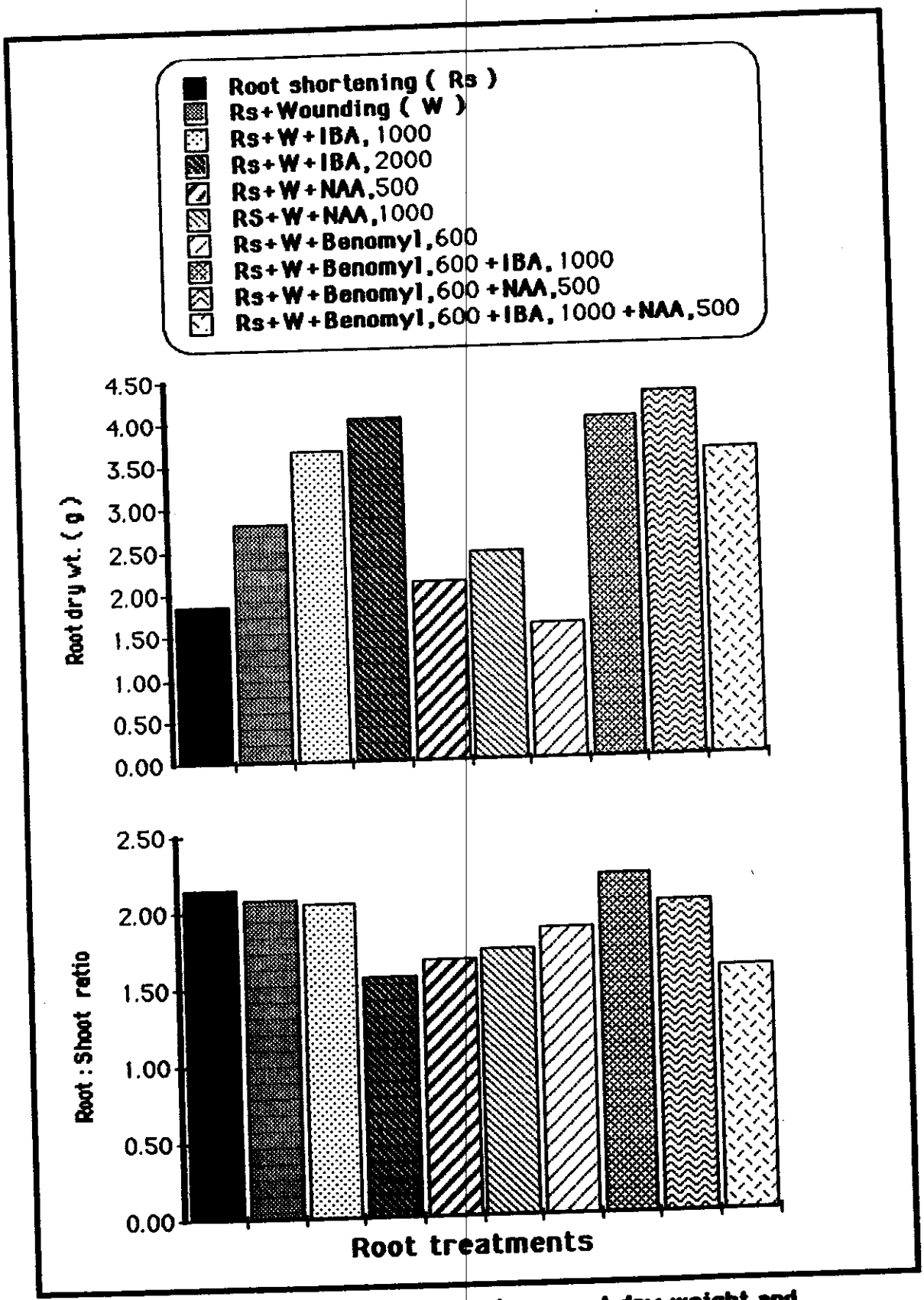

Fig. (6): Effect of different treatments on root dry weight and root : shoot ratio of 1-year-old pecan seedlings.