IV. RESULTS and DISCUSSION

In this investigation vegetative growth measurements and nutritional status "mineral composition" of six month old mango seedlings in response to various rate of P soil application in combination with different levels of zinc provided either as soil or foliar application were investigated through the 1st. and 2nd. experiments, respectively that conducted during both 1997 and 1998 seasons. Moreover, absorption, translocation and utilization of zinc foliar application under various rates of P soil application were also studied i.e., experiment, III during 1999 year.

Thus, it was so worthy that data of each experiment might be discussed separately as follows:

IV. I. Experiment, I: Growth and nutritional status of mango seedlings in response to soil application rates of P & Zn and their combinations:

In this regard the various combination between four levels of phosphorus soil applied i.e., 0.0, 25.0, 50.0 and 100.0 ppm from one hand and four rates of zinc soil application (0.0, 5.0, 10.0 and 20.0 ppm) from the other were the fertilization treatments investigated pertaining the response of both growth measurements and mineral composition of six month old mango seedlings during 1997 & 1998 seasons.

IV. I. I. Vegetative growth measurements:

Average number of leaves per seedling; plant height (cm); stem thickness (m.m.); dry weight of leaves, stem, root and total plant (g.), as well as top/root ratio were the growth parameters included pertaining the

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IV. I. I. Vegetative growth measurements:

Average number of leaves per seedling; plant height (cm); stem thickness (m.m.); dry weight of leaves, stem, root and total plant (g.), as well as top/root ratio were the growth parameters included pertaining the

specific effect of each investigated factor (soil application rates of P & Zn fertilizers) and their combinations (interaction effect).

IV. I.I. 1. Number of leaves per seedling:

A - Specific effect:

With regard to the specific effect of P soil application rates, data in Table (2) displayed that number of leaves was obviously responded to the investigated P rates. The maximum number of leaves per seedling was always concomitant to the highest P rate (100 ppm). The reverse was true with lowest P rate (0.0 ppm). Moreover, the trend of response showed a significant positive relationship between the rate of P soil drench application from one hand and the average number of leaves per seedling from the other. Such trend was true during both seasons of study.

As for the response to the specific effect of the zinc soil drench rate, it is quite clear that applying zinc at 5, 10 or 20 ppm increased significantly the number of leaves per plant than the control (0.0 ppm/no zinc application). Moreover, the response of number of leaves to the specific effect of zinc soil application rate followed nearly the same trend previously detected with P applied rate. Hence, a gradual significant increase in number of leaves was observed with increasing the zinc soil rate, whereas the greatest number of leaves was closely related to these seedlings received the highest zinc rate (20 ppm). However, the rate of differences in number of leaves due to the variation in Zn dose applied was more pronounced rather than that exhibited with P level. Such trend was true during both seasons of study.

B - Interaction effect (P X Zn):

Table (2) shows clearly that average number of leaves per plant responded significantly to the interaction effect of various combinations between different soil drench applied rates of both phosphorus and zinc. Since, the specific effect of applied rate from each fertilizer was reflected on the number of leaves per plant. Hence, the combinations between the highest zinc rate (20 ppm) from one hand and the two higher levels of phosphorus i.e., 50 and 100 ppm especially the latter one from the other exhibited statistically the greatest number of leaves per seedling, followed by those combinations (10 ppm Zn X 100 ppm P) and (20 ppm Zn X 25 ppm P), however, differences did not reach level of significance during 1st. season (1997) in comparison with the aforesaid superior combinations (20 ppm Zn X 100/50 ppm P). On the contrary, the combinations between 0.0 ppm Zn (no zinc applied) from one hand and any of 0.0, 25 or 50 ppm phosphorus from the other as well as the (5 ppm Zn X 0.0 ppm P) were statistically the inferior. However, the decrease in number of leaves/seedling resulted by (0.0 ppm Zn X 0.0 ppm P) was statistically the severst one in this concern. Such trend was true during both seasons of study. These results pointed out the more pronounced response to the beneficial effect of Zn fertilization rather than phosphorus.

These results are in partial agreement with the findings of **Syamal and Mishra, 1989** on mango trees, **Youssef *et al.*, (1985)** on seedlings of some citrus rootstock species and **Girgis, (1991)** on some olive cultivars, regarding the effect of P soil application. Moreover, **Mallik and Singh,**

(1959), Martin-Prevel *et al.*, (1975) and Rajput *et al.*, (1976) on mango all pointed out the beneficial effect of zinc application in this concern.

IV. I.I.2. Plant height:

A – Specific effect:

It is quite evident from data presented in Table (2) that the plant height of mango seedlings responded specifically to the rate of P soil applied. Hence, a significant positive relationship was detected between the dose of P soil added and plant height. The shortest plants were closely related to those received no phosphorus, while the tallest ones were the 100 ppm P soil provided.

Referring the specific effect of zinc soil application rate, data obtained during both 1997 & 1998 seasons revealed that the plant height of mango seedling followed typically the same trend previously detected with the number of leaves per plant. Since the zinc soil application at 20 ppm was significantly the superior, while the control (no Zn added) was the inferior. In addition two other rates of Zn soil application (5 & 10 ppm) were in between the aforesaid two extents, however the differences in plant height due to the four various Zn application levels were significant as each was compared to the three other ones during both seasons of study.

Conclusively, the plant height of mango seedling was significantly in closed positive relationship to the applied level of each nutrient element P/Zn, i.e., any of two investigated factors.

B – Interaction effect (P X Zn):

Data in Table (2) displayed that the specific effect of applied rates of both phosphorus and zinc was reflected on the height of mango seedlings.

Since the combinations between 20 ppm Zn soil application and P soil applied at either 100 or 50 ppm and to great extent the treatments of 100 ppm P X 10 ppm Zn resulted significantly in the tallest seedlings during both seasons of study. The reverse was true for the combinations between no Zn application (0.0 ppm) from one hand and P soil application either at 0.0 ppm (no P applied) or 25 ppm P soil added, where the shortest plants were significantly induced. Moreover, other investigated combinations were in between the above mentioned two extents.

These results are generally in partial agreement with findings of **Syamal and Mishra, (1989)** on mango, **Youssef *et al.*, (1985)** on some citrus rootstock seedlings, **Tattini *et al.*, (1986)** on olive plants and **Girgis, (1991)** on some olive cultivars seedlings, pertaining the effect of phosphorus application.

However, the beneficial effect of zinc application, observed from the present results goes partially with the findings of **Oppenheimer and Gazit, (1961)** on Alphonso mango trees, **Jawanda and Singh, (1971); Koo *et al.*, (1992) and Banik and Sen, (1997)** on mango.

IV. I.I.3. Stem thickness:

A – Specific effect:

Regarding the specific effect of phosphorus soil application rate on the mango seedlings, data in Table (2) declared that the response followed the same trend previously detected with both measurements of number of leaves and height of plant. Such trend was true during two seasons of study. Moreover, the specific effect of Zn soil application rate followed

also the same trend previously found with both plant height and number of leaves/plant. On the other hand the rate of change in stem thickness due to raising the level of Zn was more pronounced than that of increasing P rate, however, differences were significant as rates of each applied element were compared each to other during two seasons of study.

B – Interaction effect (P X Zn) :

The thickest stem was always in closed relationship with those mango seedlings received the highest rat of both nutrient elements i.e., 20 ppm Zn X 100 ppm P. On the contrary the thinnest stem was that of mango seedlings received any treatments representative of the application rate of any element (P/Zn) combined with either the 0.0 ppm or the lowest level of the other element. Other combinations were intermediate with an obvious tendency showed a parallel increase in stem thickness with raising applied level of both elements.

The present results are in harmony with those reported by **Suriyapananont and Subhardrabandhu, (1992)** on mango, **Sharma *et al.*, (1993)** and **Meneses Junior *et al.*, (1993)** on mango as the positive influence of phousphorus was concerned. On the other hand the effect of zinc application are in partial agreement with the findings of **Bose *et al.*, (1988) and El-Azzouni *et al.*, (1976)** on mango trees.

IV. I.I.4. Leaves dry weight:

A – Specific effect :

Regarding the specific effect of phosphorus soil applied rate on the leaves dry weight, data in Table (3) showed obviously a positive response.

Table (2): Number of leaves, plant height and stem thickness of mango seedlings as influenced by soil application rates of both phosphorus & zinc and their combinations during 1997 & 1998 seasons.

P (ppm) \ Zn(ppm)	Number of leaves/plant					Plant height (Cm)					Stem thickness (mm)				
	0	5	10	20	Mean	0	5	10	20	Mean	0	5	10	20	Mean
	1997 Season														
0	11.60g	13.60e	15.40bcd	15.20cd	**13.95D**	39.80I	41.80gh	42.80ef	43.60bcd	**42.00C**	48	53	58	60	**55D**
25	12.60f	13.80e	15.00d	15.80abc	**14.30C**	40.40I	41.80gh	43.00def	44.00abc	**42.30C**	52	56	61	64	**58C**
50	13.40e	14.00e	15.20cd	16.20a	**14.70B**	41.20h	42.40fg	43.40cde	44.40a	**42.85B**	56	60	65	69	**63B**
100	14.00e	15.40bcd	16.00ab	16.40a	**15.45A**	42.60f	43.60bcd	44.20ab	44.60a	**43.75A**	58	63	67	69	**64A**
Mean	**12.90D**	**14.20C**	**15.40B**	**15.90A**	-	**41.00D**	**42.40C**	**43.35B**	**44.15A**	-	**54D**	**58C**	**63B**	**65A**	-
	1998 Season														
0	12.00j	14.00h	15.40ef	16.00cde	**14.35D**	30.80k	35.00ij	36.60fg	37.20cdef	**34.90D**	51k	55j	.60h	63f	**57D**
25	13.20I	14.60gh	15.80de	16.60bc	**15.05C**	34.80j	36.20gh	37.00defg	37.80abcd	**36.45C**	58I	60h	62g	65d	**61C**
50	14.0h	15.0fg	16.20cd	17.00ab	**15.55B**	35.60hi	36.80efg	37.60bcde	38.20ab	**37.05B**	62g	64e	66c	67b	**65B**
100	14.80fg	16.00cde	16.60bc	17.40a	**16.20A**	36.20gh	37.40bcdef	38.00abc	38.60a	**37.55A**	66c	66c	67b	68a	**67A**
Mean	**13.50D**	**14.90C**	**16.00B**	**16.75A**	-	**34.35D**	**36.35C**	**37.30B**	**37.95A**	-	**59D**	**61C**	**64B**	**66A**	-

Differences were significant as each P level was compared to the other investigated rates.

Nevertheless the leaves dry weight per mango seedling showed also an increase with raising Zn soil application rate. However, such increase was significant as mango plants of each Zn rate were compared to those of the other investigated zinc levels. On the other hand the rate of changes in the leaves dry weight per mango seedling was less pronounced (relatively lower) than those resulted by variance in P soil applied level.

B – Interaction effect (P X Zn):

Regarding the response of leaves dry weight of mango seedlings to the differential combinations between the various applied rates of both phosphorus and zinc "interaction effect" Table (3) shows that the heaviest leaves dry weight was significantly gained by those mango seedlings supplied with the highest rates of both nutrient elements i.e., 100 and 20 ppm for P & Zn, respectively. The (100 ppm P X 10 ppm Zn) applied seedlings ranked statistically second as their leaves dry weight was concerned, followed in a descending order by those seedlings received the combinations of (100 ppm P X5 ppm Zn) and (50 ppm P X 20 ppm zn). Such trend was true during both seasons of study and differences were significant either the aforesaid four categories were compared each other from one hand or compared to those of the other investigated ones from the other side. Moreover, lightest leaves dry weight produced by a single seedling was closely linked with those mango transplants received neither phosphorus nor zinc. In addition, other combinations were in between the

above mentioned two extents with a tendency showed that increasing the rate of phosphorus gained more benefits than zinc.

These results are in partial agreements with those of **Kuradoka *et al.*, (1959), Kim and Ko, (1975)** on Satsuma orange, **Tattini *et al.*, (1986) and Girgis, (1991)** on olive regarding the effect of P application. On the other hand the effect of zinc application are in partial agreement with the findings of **Oppenheimer and Gasit, (1961); Singh and Katyol, (1961); Young *et al.*, (1966); Jawanda and Singh, (1971); Rajput *et al.*, (1976); Agarwala *et al.*, (1988); Diaz *et al.*, (1991) and Koo *et al.*, (1992)** on mango.

IV. I.I.5. Stem dry weight:

A – Specific effect:

Table (3) shows that stem dry weight of six month old mango transplants responded specifically to rates of each investigated factor (P/Zn). Increasing the application rate of each nutrient element resulted in a significant increase in stem dry weight. However, the rate of increase in stem dry weight was relatively higher with raising the dose of phosphorus than with zinc.

B – Interaction effect (P X Zn):

Data in Table (3) revealed that the interaction effect of (P soil applied X Zn soil applied rates) on stem dry weight was to great extent similar to that previously detected with leaves dry weight. Hence, the heaviest stem dry weight was found when mango seedlings were supplied with P and Zn

at 100 & 20 ppm, respectively (the highest invistigated rate of both elements). Contrary to that the control was the inferior.

These results go in line with the findings of **Sharma *et al.*, (1993); Meneses Junior *et al.*, (1993); Haggag and Azzazy, (1996)** on mango and **Girgis, (1991)** on olive regarding the effect of phosphorus application.

However, the beneficial effect of zinc application, the present results go partially with the findings of **Young *et al.*, (1966); Jawanda and Singh, (1971); El-Azzouni *et al.*, (1976); Agarwala *et al.*, (1988); Bose *et al.*, (1988); Chattopadhyay and Mahunta, (1990); Diaz *et al.*, (1991); Koo *et al.*, (1992) and Banik and Sen, (1997)** on mango.

IV. I.I.6. Root dry weight:

A – Specific effect:

Obtained data during both 1997 & 1998 seasons revealed that the root dry weight of six month old mango seedlings followed typically the same trends previously detected with both leaves and stem dry weight regarding the response to the specific effect of applied rate of either phosphorus or zinc. Variances were significant as each level of every nutrient element was compared to its other investigated levels. However, the rate of change in root dry weight was more pronounced with raising phosphorus level than with zinc.

B - Interaction effect (P X Zn):

With regard to the interaction effect of (P X Zn) soil application rates data in Table (3) declared that the combinations between the highest applied rate of each element i.e., 100 ppm P X 20ppm zinc treatment was

statistically the superior that produced the heaviest root dry weight during both seasons of study followed in a descending order by the combinations of (100 ppm phosphorus X 10 ppm Zn) which ranked statistically second and (50 ppm PX 20 ppm Zn) which came third. Contrary to that, the root dry weight of unfertilized seedling (0.0 ppm PX 0.0 ppm Zn) was statistically the inferior followed in an increasing order by those received the lowest applied rate of an element from one hand and combined with 0.0 ppm of the second nutrient element i.e., (0.0 ppm PX5.0 ppm Zn) and (25.0 ppm PX0.0 ppm Zn). In addition other combinations were in between the aforesaid two extents with an obvious tendency indicating that the root dry weight was increased by raising the applied rate of any of both investigated nutrient elements P/Zn.

The present findings are in confirmity with those found by **Girgis, (1991)** on some olive cultivars regarding the effect of phosphorus application. On the other hand the effect of zinc application are in partial agreement with the findings of **Chattopadhyay and Mahunta, (1990)** on mango seedlings.

IV. I.I.7. Total plant dry weight:

A – Specific effect :

Table (4) reveals that the total plant dry weight of six month old mango seedlings was responded specifically to the soil applied rates of both phosphorus and zinc. Such response followed typically the same trends previously detected with any of each individual plant organ. Since the greatest value of plant dry weight was always concomitant to the highest applied rate of each nutrient element. The reverse was true with the no soil application whereas the lightest weight was occurred.

Table (3): Leaves, stems and roots dry weight (gm./plant) of mango seedlings as influenced by soil application rates of both phosphorus & zinc and their combinations during 1997 & 1998 seasons.

P(ppm) \ Zn(ppm)	Leaves dry weight					Stem dry weight					Root dry weight				
	0	5	10	20	Mean	0	5	10	20	Mean	0	5	10	20	Mean
	1997 Season														
0	2.76p	2.99 o	3.20n	3.40m	**3.09D**	3.30m	3.61 l	3.86j	4.02h	**3.70D**	2.24p	2.54 o	2.86m	3.02k	**2.67D**
25	3.42 l	3.66k	3.78I	3.90h	**3.69C**	3.72k	3.94I	4.18g	4.32e	**4.04C**	2.72n	2.96 l	3.24I	3.36h	**3.07C**
50	3.74j	3.98g	4.12e	4.24d	**4.02B**	3.94I	4.18g	4.41d	4.58b	**4.28B**	3.18j	3.40g	3.66e	3.81c	**3.52B**
100	4.08f	4.32c	4.64b	4.86a	**4.48A**	4.24f	4.46c	4.59b	4.75a	**4.51A**	3.40f	3.72d	3.98b	4.18a	**3.85A**
Mean	**3.50D**	**3.74C**	**3.94B**	**4.10A**	-	**3.80D**	**4.05C**	**4.26B**	**4.42A**	-	**2.91D**	**3.16C**	**3.44B**	**3.59A**	-
	1998 Season														
0	3.05 o	3.21n	3.51m	3.69k	**3.37D**	3.92n	4.24m	4.42k	4.56I	**4.29D**	2.72p	3.03 o	3.29m	3.47 l	**3.13D**
25	3.62 l	3.82j	3.99h	4.14g	**3.89C**	4.32 l	4.50j	4.71h	4.82f	**4.59C**	3.26n	3.50k	3.80I	3.95f	**3.63C**
50	3.93I	4.15g	4.32e	4.42d	**4.21B**	4.55I	4.72h	4.90e	5.04c	**4.80B**	3.66j	3.86h	4.11e	4.27c	**3.98B**
100	4.20f	4.45c	4.59b	4.71a	**4.49A**	4.80g	5.01d	5.15b	5.25a	**5.05A**	3.91g	4.14d	4.31b	4.45a	**4.20A**
Mean	**3.70D**	**3.91C**	**4.10B**	**4.24A**	-	**4.40D**	**4.62C**	**4.80B**	**4.92A**	-	**3.39D**	**3.63C**	**3.88B**	**4.04A**	-

B - Interaction effect (P X Zn) :

Data in Table (4) revealed obviously that the specific effect of applied rate of each element was reflected directily on their interaction effect, whereas, the heaviest plants were gained by the combinations of (100 ppm PX 20ppm Zn), followed in descending order by (100 ppm PX 10 ppm Zn) and (50 ppm PX 20 ppm Zn). However, differences in total plant dry weight due to the aforesaid superior treatments (combinations) were significant as each was compared to the two other ones. On the contrary the (0.0 ppm P X 0.0 ppm Zn) was the inferior. However, other investigated combinations were in between with a variable tendency of increasing the total plant dry weight with raising the applied rate of either an element or both together.

These results are in harmony with those reported by **Sharma *et al.*, (1993); Meness Junior *et al.*, (1993); Haggag and Azzazy (1996)** on mango; **Mohamed, (1979) and Girgis, (1991)** on olive regarding the effect of phosphorus application. Moreover, **El-Azzouni *et al.*, (1976); Rajput *et al.*, (1976); Agarwala *et al.*, (1988); Bose *et al.*, (1988); Chattopadhyay and Mahunta, (1990); Diaz *et al.*, (1991); Koo *et al.*, (1992) and Banik and Sen, (1997)** on mango all pointed out the beneficial effect of zinc application in this concern.

IV. I.I.8. Top/root ratio:

A – Specific effect :

Concerning the specific effect of soil application rate of either phosphorus or zinc on top/root ratio, data in Table (4) pointed out that the ratio was specifically influenced. However, the trend of response of the

Table (4): **Total plant dry weight and top/root ratio of mango seedlings as influenced by soil application rate of both phosphorus & zinc and their combinations during 1997 & 1998 seasons.**

Zn(ppm) / P(ppm)	Total plant dry weight (g.)					Top/root ratio				
	0.0	**5**	**10**	**20**	**Mean**	**0.0**	**5**	**10**	**20**	**Mean**
	1997 Season									
0	8.30p	9.14 o	9.93m	10.44 l	**9.45D**	2.71a	2.60c	2.47e	2.46ef	**2.58A**
25	9.86n	10.56k	11.20 I	11.58g	**10.80C**	2.63b	2.56d	2.46ef	2.45f	**2.52B**
50	10.87j	11.57h	12.20e	12.63c	**11.82B**	2.41g	2.40h	2.33k	2.32 l	**2.36C**
100	11.82f	12.50d	13.22b	13.80a	**12.83A**	2.38 I	2.36j	2.32 l	2.30m	**2.34D**
Mean	**10.21D**	**10.94C**	**11.63B**	**12.11A**	-	**2.53A**	**2.48B**	**2.39C**	**2.38D**	-
	1998 Season									
0	9.69 o	10.48n	11.22 l	11.72k	**10.78D**	2.56a	2.46b	2.41d	2.38e	**2.45A**
25	11.20m	11.82j	12.50h	12.91f	**12.11C**	2.44c	2.38e	2.29h	2.27 I	**2.34B**
50	12.14 I	12.73g	13.33e	13.73c	**12.98B**	2.32f	2.30gh	2.24j	2.22k	**2.27C**
100	12.91f	13.60d	14.05b	14.41a	**13.74A**	2.30g	2.29h	2.26 I	2.24j	**2.27C**
Mean	**11.49D**	**12.16C**	**12.78B**	**13.19A**	-	**2.40A**	**2.36B**	**2.30C**	**2.28D**	-

Neverthless, the highest top/root ratio was detected by those mango seedlings received neither phosphorus nor zinc followed by those of the (25 ppm PX 0.0 Zn) and/or (0.0 P X 5 ppm Zn). Contrary to that the least top/root ratio was exhibited by the (100 ppm P X 20 ppm Zn soil added) followed by those of (100 ppm P X 10 ppm Zn soil application) and (50 ppm P X 20 ppm Zn soil added). However, other investigated combinations of P-Zn soil added were in between.

IV. I. II. Mineral Composition/Nutritional Status:

In this regard N,P,K and Zn contents in the three plant organs viz; leaf, stem and root of 6 month old mango seedlings as influenced by the specific and interaction effects of different P-Zn soil application rates combined together were concerned. Data obtained during both seasons of study were tabulated in Tables (5), (6), (7) and (8) for N,P,K and Zn, respectively.

IV. I.II.1. Nitrogen content:

A – Specific effect:

Referring the specific effect of phosphorus soil application level on nitrogen content of the three plant organs "leaf, stem and root" of 6 month old mango seedlings, Table (5), reveals that an obvious increase was clearly shown with raising the P applied rate. Such trend was true during both 1997 and 1998 seasons, irrespective of plant organ, however the trend was more firmer in the leaf than the two other organs especially roots as the rate of change in N% was taken into consideration. On the

other hand, leaf was the richest plant organ in its N content, followed by root, while stem was the poorest one in this respect.

As for the leaf, stem and root of mango seedlings in response to the specific effect of zinc soil application level, it in quite clear that a similar trend to that previously found with phosphorus was also detected. However, the rate of increase in N% due to raising the P soil applied rate was relatively lower than that exhibited with zinc, especially as the changes in leaf N% was concerned. Moreover, the N% in the three plant organs was steadily increased with raising the soil application rate of both nutrient elements (P/Zn) and differences were significant as any investigated rate of a given applied fertilizer element was compared to either its lower or higher levels.

B – Interaction effect (P X Zn) :

Data obtained during both 1997 and 1998 seasons as shown from Table (5) displayed that the variances in N% of the three plant organs (leaf, stem, root) represented the direct reflection of the specific effect of each investigated factor i.e., the rate of either P or Zn soil application. Hence, the highest nitrogen percentage in any plant organ (leaf, stem or root) was closely related to those of mango seedlings, supplied with the greatest levels of both phosphorus and zinc i.e., the 100 ppm P X 20 ppm Zn combination/treatment, followed by those received the (50 ppm P X 20 ppm Zn) and (100 ppm P X 10 ppm Zn) combinations, whereas differences between those three superior combinations were significant as each compared to the two other ones, irrespective of the plant organ, with few exceptions especially in stem during 1997 and 1998 seasons whereas

difference between both superior combinations (100 ppm P X 20 ppm Zn) and (50 ppm P X 20 ppm Zn) were so little to reach level of significance. On the other hand the control i.e., mango seedlings received neither P nor Zn induced significantly the poorest organs in their nitrogen content as N% of each organ was compared to the analogous values of other investigated combinations (treatments). Moreover, other combinations were in between the aforesaid two extents.

These results are in agreement with the findings of **Malhi *et al.*, (1988); Haggag and Azzazy, (1996)** on mango; **Mohamed, (1979); Girgis, (1991)** on olive regarding the effect of phosphorous application.

However, the beneficial effect of zinc application, as shown from the present results goes in line of the findings of **Thakur *et al.*, (1980); Agarwala *et al.*, (1988); Shu *et al.*, (1992); Ponchner *et al.*, (1993)** on mango. **Ibrahim and Ali, (1970)** on apple orange and **Khamis *et al.*, (1984)** on some citrus rootstocks seedlings.

Generally it could be safely concluded that leaf was the richest plant organ in nitrogen discendingly followed by root then stem which ranked last in this regard. Nevertheless, the nitrogen content in three plant organs of mango seedlings was specifically influenced by the soil application rates investigated for either phosphorus or zinc, however the changes, were more pronounced in leaves than the two other plant organs from one hand and zinc was relatively more effective than phosphorus in this regard. In addition, the richest organ (leaf, stem or root) in nitrogen content was always in concomitant to the mango seedlings received the highest soil application rates of both P or Zn i.e., (100 ppm P X 20 ppm

Table (5): **Nitrogen content (%) in various plant organs of mango seedlings in relation to soil applied rates of both phosphorus & zinc and their combinations during 1997 & 1998 seasons.**

P(ppm) \ Zn(ppm)	Leaves					Stem					Root				
	0	5	10	20	Mean	0	5	10	20	Mean	0	5	10	20	Mean
	1997 Season														
0	1.81k	1.98j	2.12h	2.22e	**2.03D**	1.09I	1.18g	1.23f	1.27e	**1.19D**	1.70I	1.84h	1.85h	1.97f	**1.84D**
25	1.97j	2.08I	2.20f	2.29c	**2.14C**	1.16h	1.24f	1.28e	1.31cd	**1.25C**	1.85h	1.95g	1.95g	2.06d	**1.95C**
50	2.08I	2.16g	2.25d	2.32b	**2.20B**	1.23f	1.28e	1.31d	1.34ab	**1.29B**	1.97f	2.03e	2.09c	2.14b	**2.06B**
100	2.16g	2.22e	2.29c	2.36a	**2.26A**	1.28e	1.32bcd	1.33bc	1.35a	**1.32A**	2.05d	2.10c	2.14b	2.18a	**2.12A**
Mean	**2.01D**	**2.11C**	**2.22B**	**2.30A**		**1.19D**	**1.26C**	**1.29B**	**1.32A**		**1.89D**	**1.98C**	**2.01B**	**2.09A**	
	1998 Season														
0	2.01 l	2.16j	2.31h	2.41e	**2.22D**	1.19j	1.27I	1.34gh	1.37ef	**1.29D**	1.51k	1.66I	1.77h	1.85f	**1.70D**
25	2.14k	2.26I	2.40ef	2.48c	**2.32C**	1.27I	1.35fj	1.40d	1.42cd	**1.36C**	1.64j	1.75h	1.85f	1.91d	**1.79C**
50	2.25I	2.33g	2.43d	2.49b	**2.38B**	1.33h	1.41d	1.43c	1.48a	**1.41B**	1.75h	1.81g	1.89e	1.94b	**1.85B**
100	2.32g	2.39f	2.47c	2.52a	**2.43A**	1.38e	1.46b	1.46b	1.49a	**1.45A**	1.82g	1.88e	1.93c	1.96a	**1.90A**
Mean	**2.18D**	**2.29C**	**2.40B**	**2.48A**	-	**1.29D**	**1.37C**	**1.41B**	**1.44A**	-	**1.68D**	**1.78C**	**1.86B**	**1.92A**	-

Zn), while the reverse was found with those received neither P nor Zn. As well as, other combinations of P-Zn soil applications were in between the aforesaid two extents with a steady tendency to be increased with raising rate of P and Zn either each solely or both together.

IV. I.II.2. Phosphorus content:

A – Specific effect:

Data presented in Table (6) displayed that the leaf, stem and root phosphorus contents of 6 month old mango seedlings were specifically responded to the investigated soil application rate of either phosphorus or zinc. However, the P % in the three plant organs i.e. leaf, stem and root of mango seedlings in response to the P soil application rats followed typically the same trend. Such trend showed clearly a significant positive relationship between the P soil added level and percentage of P content in the three plant organs. Hence, the greatest value of P% in any plant organ was always concomitant to those samples collected from mango seedlings received the highest P soil application rate (100 ppm) followed in a descending order by those supplied with 50 and 25 ppm P soil added, while the 0.0 ppm P (no P application) exhibited statistically the lowest P content. Differences were significant during both seasons of study, regardless of the plant organ, while few exceptions could be noticed especially in leaf and root P% during 1997 and 1998 seasons, respectively. Whereas, differences between the two higher P applied rates i.e, 100 and 50 ppm did not reach level of significance in this respect.

As for the specific effect of zinc soil applied rate on the P content, it is quite evident that the trend took the other way around. In other words the

Table (6): **Phosphorus content (%) in various plant organs of mango seedlings in relation to soil applied rates of both phosphorus & zinc and their combinations during 1997 & 1998 seasons.**

P(ppm) \ Zn(ppm)	Leaves					Stem					Root				
	0	5	10	20	Mean	0	5	10	20	Mean	0	5	10	20	Mean
	1997 Season														
0	0.145g	0.147g	0.146g	0.141g	**0.145C**	0.108g	0.109g	0.109g	0.106g	**0.108D**	0.132I	0.134hi	0.133hi	0.130I	**0.132D**
25	0.181cde	0.175cde	0.167ef	0.153fg	**0.169B**	0.142cde	0.134e	0.127ef	0.115fg	**0.130C**	0.163def	0.157cf	0.150fgh	0.138ghi	**0.152C**
50	0.206ab	0.201ab	0.189bcd	0.171de	**0.192A**	0.166ab	0.159bc	0.146cde	0.130ef	**0.150B**	0.189abc	0.183bc	0.171cde	0.155efg	**0.174B**
100	0.218a	0.204ab	0.191bc	0.179cde	**0.198A**	0.179a	0.167ab	0.154bcd	0.140de	**0.160A**	0.203a	0.191ab	0.177bcd	0.164def	**0.184A**
Mean	**0.187A**	**0.181AB**	**0.173B**	**0.161C**	-	**0.149B**	**0.142AB**	**0.134B**	**0.123C**	-	**0.172A**	**0.166A**	**0.158B**	**0.147C**	-
	1998 Season														
0	0.145h	0.143h	0.141h	0.138h	**0.142D**	0.105g	0.107g	0.108g	0.106g	**0.106D**	0.129g	0.133fg	0.131g	0.127g	**0.130C**
25	0.174ef	0.170ef	0.163fg	0.151gh	**0.165C**	0.141de	0.135ef	0.130ef	0.120fg	**0.132C**	0.163cd	0.155de	0.149def	0.137efg	**0.151B**
50	0.200abc	0.194bcd	0.183cde	0.169ef	**0.187B**	0.164abc	0.156bcd	0.144de	0.130ef	**0.148B**	0.187ab	0.183ab	0.180bc	0.155de	**0.176A**
100	0.214a	0.203ab	0.193bcd	0.81def	**0.198A**	0.179a	0.167ab	0.159bcd	0.147cde	**0.163A**	0.199a	0.189ab	0.176bc	0.163cd	**0.182A**
Mean	**0.183A**	**0.177AB**	**0.170B**	**0.160C**	-	**0.147A**	**0.141AB**	**0.135B**	**0.126C**	-	**0.170A**	**0.165AB**	**0.159B**	**0.146C**	-

combinations had significantly the poorest leaf, stem and root in their phosphorus content. Differences between the combinations of the aforesaid two categories (superior and inferior) from one hand and other investigated P-Zn treatments (combinations) from the other side were significant during both seasons of study, regardless of the plant organ as P content was concerned.

The present results are in harmony with that reported by **Salem, (1984); Malhi *et al.*, (1988); Haggag and Azzazy, (1996)** on mango; **Mohamed, (1979); Girgis, (1991)** on olive; **Bansal and Motivamani, (1971)** on guava and **Ramizi and Kimonidu, (1974)** on different citrus species as the positive influence of phosphorus was concerned. On the other hand the effect of zinc application are in agreement with the findings of **Fawusi and Ormord, (1975); Vinay Singh, (1982)** on sweet orange; **Asma, (1981)** on Valencia orange and **Khamis *et al.*, (1984)** on some citrus rootstock, but in disagreement with the findings of **Shu *et al.*, (1992) and Ponchner *et al.*, (1993)** on mango.

IV. I. II.3. Potassium content:

A – Specific effect:

Table (7) shows clearly that the leaf, stem and root K content of 6 month old mango seedlings was specifically influenced by the applied rate of each fertilizer element i.e., P or Zn. Hence, the K% was in closed positive relationship with the soil applied rate of either phosphorus or zinc, regardless of the plant organ as K content was concerned. Moreover, the increases exhibited in all plant organ K% due to raising level of each applied element were significant as an applied rate of a given fertilizer

element (P/Zn) was compared to either its higher or lower ones regarding the response of the K content in the same plant organ was taken into consideration. On the other hand, the rate of changes in K% due to the specific effect of P soil application rate was more pronounced than that exhibited by the zinc soil application level. Moreover, leaf was relatively richer in its potassium content than stem, while the root was the poorest organ in this respect.

Nevertheless, the highest rate of P or Zn soil application exhibited statistically the greatest values of K% in all three plant organs. However, the highest leaf, stem and root K% was closely coupled with the 20 ppm Zn soil applied rate followed statistically in a descending order by those of 10.0, 5.0 and 0.0 ppm as zinc soil applied rate was taken into consideration. Meanwhile, both higher rates of phosphorus soil application were equally effective, especially as changes in K content of both leaf and stem were concerned, followed in a descending order by the 25 and 0.0 ppm P soil application rates.

Contrary to that the 0.0 ppm rate of either P or Zn soil application was the inferior in this concern. Moreover, other investigated rates of each fertilizer element were in between the above mentioned two extents during both seasons of study.

B – Interaction effect (P X Zn) :

As for the interaction effect resulted by the various combinations between the four investigated rates of both phosphorus and zinc soil application data obtained during both seasons of study as shown from Table (7) displayed that combinations between the two higher rates of zinc

Table (7): Potassium content (%) in various plant organs of mango seedlings in relation to soil applied rate of both phosphorus & zinc and their combinations during 1997 & 1998 seasons.

P(ppm) \ Zn(ppm)	Leaves					Stem					Root				
	0	5	10	20	Mean	0	5	10	20	Mean	0	5	10	20	Mean
	1997 Season														
0	0.90	0.99	1.11	1.17	**1.05C**	0.81	0.90	1.00	1.05	**0.94C**	0.60 1	0.69k	0.78j	0.85I	**0.73D**
25	1.19	1.27	1.36	1.42	**1.31B**	1.09	1.18	1.24	1.28	**1.20B**	0.87h	0.95ef	1.04c	1.09b	**0.99C**
50	1.23	1.30	1.38	1.42	**1.34AB**	1.09	1.20	1.25	1.32	**1.22AB**	0.91g	0.96e	1.05c	1.10b	**1.01B**
100	1.27	1.32	1.39	1.46	**1.36A**	1.14	1.23	1.30	1.34	**1.26A**	0.94f	1.01d	1.11b	1.13a	**1.05A**
Mean	**1.15D**	**1.22C**	**1.31B**	**1.37A**	-	**1.04D**	**1.13C**	**1.20B**	**1.25A**	-	**0.83D**	**0.91C**	**0.99B**	**1.04A**	-
	1998 Season														
0	1.03I	1.13h	1.24g	1.29fg	**1.18C**	1.01	1.09	1.17	1.25	**1.13C**	0.69k	0.79j	0.88I	0.93h	**0.82D**
25	1.31efg	1.39de	1.50ab	1.57a	**1.45B**	1.25	1.36	1.44	1.49	**1.39B**	0.96g	1.04e	1.12c	1.17b	**1.07C**
50	1.36def	1.44bcd	1.52ab	1.59a	**1.48AB**	1.27	1.37	1.47	1.51	**1.41B**	0.98f	1.07d	1.13c	1.20a	**1.10B**
100	1.40cde	1.49abc	1.56a	1.59a	**1.51A**	1.37	1.42	1.46	1.56	**1.46A**	1.05e	1.12c	1.18b	1.21a	**1.14A**
Mean	**1.28D**	**1.37C**	**1.46B**	**1.51A**	-	**1.23D**	**1.31C**	**1.39B**	**1.46A**	-	**0.92D**	**1.01C**	**1.08B**	**1.13A**	-

i.e., 10 and 20 ppm from one hand and any applied rate of phosphorus (25, 50 and 100 ppm) from the other exhibited the highest K% especially those of the two P higher rates (50/100 ppm) which tended to be the superior, regardless of the plant organs. The reverse was true with those mango seedlings received neither P nor Zn (control) which had the poorest plant organs regarding their K content.

The obtained herein results are generally in line with those reported by **Malhi *et al.*, (1988)** on mango; **Ramizi and Kimonidu, (1974)** on different citrus species; **Mohamed, (1979)** on olive and **El-Fangary, (1990)** on both Washington orange and Valencia orange regarding the effect of P application. As for the Zn effect **Thakur *et al.*, (1980); Agarwala *et al.*, (1988); Shu *et al.*, (1992); Ponchner *et al.*, (1993) and Singh and Khan, (1996)** on mango.

Conclusively, the K% of mango plant organs of six month old mango seedlings was specifically responded to the soil applied rates of either P or Zn. However, the change was more pronounced with P rates than Zn. Moreover, the combinations between 20 ppm soil applied Zn and 50 or 100 ppm rates induced statistically the highest K% in all plant organs of mango seedlings.

IV. I.II.4. Zinc content:

A – Specific effect:

Data presented in Table (8) declared that the leaf, stem and root zinc content was specifically influenced by the zinc soil applied rate and showed an obvious positive relationship. Since, with raising the zinc

applied rate its content was significantly increased. Such trend was true during both seasons and differences were significant as each zinc applied level was compared to any of the other investigated ones.

Meanwhile, the trend of response to the specific effect of P soil applied rate took the other way around, whereas the 0.0 ppm treated seedlings showed significantly the highest value of zinc content regardless of plant organ. Moreover, the decrease of zinc content exhibited in various plant organs of mango seedlings by raising the P soil application was ceased at 50 ppm P rate. In other words the zinc content in various plant organs reached its minimum value with the 50 ppm phosphorus applied rate, while it increased again by 100 ppm P level.

However, no logic explanation could be given for such case but it may be due to the interrelationship between the various nutrient elements either in the growing medium or within the plant tissues its selves especially the effect on the accumulation rate of both dry matter particularly carbohydrates and the determined mineral elements. Therefore, further studies are needed in this concern.

B – Interaction effect (P X Zn) :

Referring the interaction effect of various combinations between the investigated four rates of both phosphorus and zinc soil applications, data in Table (8) revealed that the highest zinc content was always concomitant to these seedlings received the highest rate (20 ppm) of zinc soil application in combination with no P soil added. This trend was true during both seasons for all plant organs. Moreover, the combinations between (20 ppm Zn X 0.0 ppm P) and (20 ppm Zn X 25 ppm P) showed

appreciable the same value of zinc content especially during 1998 season for stem and root, respectively.

Contrary to that the lowest zinc value was statistically coupled with those mango seedlings received no zinc application (0.0 ppm) as combined with the two higher rates of P soil applied i.e., 50 and 100 ppm especially the former one. In addition other combinations were in between the aforesaid two categories with variable tendency mainly coupled with variance in applied rate of each element individually.

These results are in general agreement with those found by **Labanauskas *et al.*, (1960)** on Washington orange; **Ramizi and Kimonidu, (1974)** on different citrus species and **Kandil, (1994)** on Communis pear and Nema guard peach pertaining the effect of phosphorus application. On the other hand, **El-Gazzar *et al.*, (1979)** on oranges, olives and guavas seedlings; **Sharaf *et al.*, (1985)** on 5 citrus rootstock and **Joolka *et al.*, (1990)** on new castle apricot reported that Zn content was not affected by P application.

Regarding the zinc effect, the obtained herein results are in harmony with those reported by **Oppenheimer and Gazit, (1961); El-Fouly, (1987); Lal-Bahadur *et al.*, (1998)** on mango, **Manchanda *et al.*, (1972)** on sweet orange and **Nijjar and Barar, (1977)** on young kinnow mandarin.

Table (8): Zinc content (ppm) in various plant organs of mango seedlings in relation to soil applied rate of both phosphorus & zinc and their combinations during 1997 & 1998 seasons.

P(ppm) \ Zn(ppm)	Leaves					Stem					Root				
	0	5	10	20	Mean	0	5	10	20	Mean	0	5	10	20	Mean
	1997 Season														
0	29.0j	44.0e	52.0b	58.7a	**45.9A**	16.0g	18.0def	24.0b	27.3a	**21.3A**	32.0h	50.3c	60.0b	65.0a	**51.8A**
25	24.3 1	33.0h	36.0g	50.0c	**35.8B**	14.0h	14.3h	18.3de	23.0c	**17.4B**	26.0j	38.0f	41.3d	59.0b	**41.1B**
50	22.3m	27.0k	31.3I	35.0g	**28.9C**	12.3I	13.0I	17.0f	18.3de	**15.2D**	24.0k	31.0hi	36.3g	40.0e	**32.8D**
100	23.0 lm	35.3g	40.0f	47.3d	**36.4B**	12.0I	14.7h	17.3ef	19.0d	**15.8C**	27.0j	30.3i	38.3f	50.0c	**36.4C**
Mean	**24.7D**	**34.8C**	**39.8B**	**47.8A**	-	**13.6D**	**15.0C**	**19.2B**	**21.9A**	-	**27.3D**	**37.4C**	**44.0B**	**53.5A**	-
	1998 Season														
0	27.0j	40.3d	49.0c	55.0a	**42.8A**	18.0de	20.3b	26.0a	27.0a	**22.8A**	31.0I	47.3d	51.0c	59.0a	**47.1A**
25	24.0 1	35.0g	38.0f	53.3b	**37.6B**	15.0g	16.7f	19.0cd	20.0bc	**17.7BC**	26.0j	39.3g	44.0e	59.0a	**42.1B**
50	23.0h	29.0I	35.3g	39.3e	**31.7D**	13.0h	16.0fg	19.3bc	20.3b	**17.2c**	25.3j	34.0h	40.3fg	44.0e	**35.9D**
100	26.0k	30.3h	38.0f	48.3c	**35.7C**	15.3g	17.0ef	20.0bc	20.3b	**18.2B**	30.3I	34.3h	41.0f	56.0b	**40.4C**
Mean	**25.0D**	**33.7C**	**40.1B**	**49.0A**	-	**15.3D**	**17.5C**	**21.1B**	**21.9A**	-	**28.2D**	**38.8C**	**44.1B**	**54.5A**	-

IV. II. Experiment, II: Growth and nutritional status of mango seedlings in response to various combinations between zinc foliar and phosphorus soil applications:

In this respect foliar application with zinc solution at four concentrations (0.0, 0.125, 0.25 and 0.50%) in combination with four P soil application (0.0, 25, 50 and 100 ppm) were the investigated P-Zn fertilization treatments regarding their influence on both vegetative growth and mineral composition of six month old mango seedlings during 1997 and 1998 seasons.

IV.II.I. Vegetative growth:

The specific effect of either P soil added or zinc concentration in the foliar applied solutions, as well as the interaction effect of the various combinations between rates/concentrations of both fertilizer elements i.e., P & Zn were studied regarding their effects on the growth measurements of number of leaves per plant, plant height, stem thickness, dry weight of leaves, stem, root and total plant per mango seedling and top/root ratio.

IV. II. I. 1- Number of leaves per plant:

A – Specific effect :

Referring the specific effect of P soil added, Table (9), shows obviously that the number of leaves per six month old mango seedling was significantly responded to its investigated rates. The greatest number of leaves per seedling was significantly associated with the 100 ppm P soil applied mango seedlings. Moreover, mango seedlings received P soil drench application at 50 and 25 ppm descendingly-followed the aforesaid

superior category and ranked statistically 2nd and 3rd., respectively in this respect. However, those received no P soil application (0.0 ppm) were the inferior.

Regarding the specific effect of zinc concentration in foliar applied solutions, data obtained during both 1997 and 1998 seasons as shown from data presented in Table (9) displayed clearly that number of leaves per seedling was in closed positive relationship with Zn concentration. The increase in number of leaves exhibited by any of the three Zn concentrations i.e., 0.125, 0.25 and 0.50% in the foliar sprayed solutions over the control (0.0% Zn/water spray) was significant during both seasons of study. On the other hand, foliar sprays with 0.50% Zn solution surpassed statistically the two other concentrations i.e., 0.250 and 0.125% which ranked 2nd and 3rd., respectively from the statistical stand point of view.

Briefly, it could be concluded that the number of leaves per mango seedling was markedly increased by raising the rate of either P soil level or Zn concentration of the foliar spray solution. However, the increment rate exhibited by raising Zn concentration was more pronounced i.e., more than two times much more that induced by P soil applied rate during both 1997 and 1998 seasons.

B – Interaction effect (P soil rate X Zn% of spray solution):

It is quite evident from data presented in Table (9) that the number of leaves per the individual mango seedling was significantly influenced by the various P-Zn fertilization treatments (the interaction between P soil applied rate and Zn concentration of the solution sprays). Such interaction

influence reflected directly the specific effect of investigated levels of each fertilizer element (P/Zn), whereas the greatest number of leaves was in a firmer relationship with both combinations between the highest Zn concentration of the foliar sprayed solution (0.50%) from one hand and the two higher rates of P soil added (100 and 50 ppm) from the other. In other words the P-Zn fertilization treatments of both (0.50% Zn of sprayed solution X 100 ppm P soil added) and (0.50% Zn concentration X 50 ppm P soil added) were the superior as both induced the greatest value of leaves number per plant and were equally effective from the statistical point of view in this regard. Moreover, both combinations of (100 ppm P soil added X 0.25% Zn solution) and (25 ppm P soil application X 0.50% Zn solution) ranked statistically second.

Nevertheless, the reverse was true with these mango seedlings received neither P nor Zn were the inferior whereas they had statistically the fewest number of leaves, followed in an increasing order by those received (25/50 ppm P soil added X 0.0 Zn foliar application) and to great extent the (0.0 ppm P X 0.125% Zn sprayed solution) treated seedlings. In addition, other combinations came in between the above mentioned two extents.

The present results go partially in line with the previously findings reported by **Syamal and Mishra, (1989)** on mango trees, **Youssef *et al.*, (1985)** on seedlings of some citrus rootstock species and **Girgis, (1991)** on some olive cultivars as the effect of P soil application was taken into consideration. Moreover, the improvement in number of leaves exhibited by zinc foliar application as data obtained from this (2^{nd}.) experiment was

supported by the earlier finding of **Rajput *et al.*, (1976)** on Chausa mango foliar sprays with ZnSO4.

IV. II. I. 2- Plant height:

A – Specific effect :

Regarding the plant height of mango seedlings as influenced by the specific effect of investigated levels of each fertilizer element, data in Table (9) showed clearly the positive relationship between each studied factor from one hand and the concerned growth measurement from the other. Such trend was true during both seasons of study, however the rate of changes due to zinc concentration of foliar applied solution was markedly higher than the analgous rate resulted by P soil application rate. Differences in plant height were significant as mango seedlings received a given P soil application rate was compared to the analogus one/s of either higher or lower P rates. This trend was true during two seasons except in 1997 season when the 25 ppm P soil applied seedlings were compared to those received P at 100 ppm.

Nevertheless, differences in plant height of mango seedlings exhibited by variance in Zn concentration of solution used were not only significant as all investigated zinc concentrations were compared each other but also the changes were so greater than those resulted by P application levels.

B – Interaction effect (P soil rate X Zn% of sprayed solution):

Referring the plant height of mango seedlings as influenced by the interaction effect between both P and Zn fertilization treatments i.e., combinations of the various levels of both P & Zn fertilizers investigated,

data obtained during both 1997 & 1998 seasons are tabulted in Table (9). It is quite clear that the response was not so firmer as compared to that shown with the number of leaves per seedling, however both parameters followed approximately the same trend. Hence, the tallest seedlings were those received the highest concentration of Zn solution (0.50%) in combination with the P soil application either at 100 or 50 ppm and to great extent with 25 ppm P level, whereas variations between these combinations were significantly absent in most cases especially in 1997 season.

Contrary to that the shortest mango seedlings were usually those received no zinc foliar application as combined with 0.0, 25 and 50 ppm P soil added. In spite of the mango seedlings received neither P soil application nor Zn foliar application were the inferior, the depressing effect of such treatment was significant during the second (1998) season only. Moreover, other P soil application X Zn foliar sprays combinations came in between the aforesaid two extents.

The present result dealing with the beneficial effect of P soil application goes generally in line with those found by **Syamal and Mishra, (1989)** on mango; **Sharma *et al.*, (1993)** on mango; **Youssef *et al.*, (1985)** on seedlings of some citrus root-stock species, **Tattini *et al.*, (1986)** on olive plants and **Girgis, (1991)** on some olive cultivars seedlings.

As for the response of shoot length/seedling height to zinc foliar application, obtained results in this concern are supported by the findings of several investigators i.e., **Oppenheimer and Gazit, (1961)** on

Alphonso mango trees; **Young *et al.*, (1966); Jawanda and Singh, (1971); El-Azzouni *et al.*, (1976)** on Taimour mango trees; **Banik and Sen, (1997)** on Fazli mango cv.; **Bose *et al.*, (1988)** on Taimoure mango cv., **Koo *et al.*, (1992) and Banik *et al.*, (1997)** on Fazli mango cv.

IV. II. I. 3- Stem thickness:

A – Specific effect:

Concerning the stem thickness of mango seedlings in response to specific effect of P soil application rate, data in Table (9) revealed obviously that the previously mentioned trend of the two former growth measurements i.e., number of leaves per plant and plant height was also detected. Moreover, the stem thickness was positively responded to raising zinc percentage in sprayed solution. On the other hand, changes in stem thickness exhibited by raising the applied level of each investigated factor i.e., P or Zn were nearly coincident and showed the same rate, whereas, stem thickness was gradually increased by raising the applied dose of each fertilizer element. In addition, differences in stem thickness were significant as seedlings of the various investigated rates of each fertilizer element (P/Zn) were compared separately each other. Such trend was true during both seasons of study.

Generally, it could be safely concluded that stem thickness of mango seedlings was specifically responded to the investigated rates of application for both P soil and Zn foliar application. Both P & Zn were equally effective in this concern.

B – Interaction effect (P soil rate X Zn % of sprayed solution):

Referring the interaction effect of various P-Zn combinations (P soil X Zn sprays) on the stem thickness of mango seedlings, data in Table (9) declared obviously the parallelled positive response to raising the applied level of each fertilizer element (P/Zn). Hence, the thickest stem was gained by these mango seedlings supplied with the P-Zn fertilization treatment (combination) between the highest rate of both P soil added and Zn% in foliar sprayed solution i.e., (100 ppm P soil added X 0.50% Zn of sprayed solution.

Moreover, the foliar sprayed seedlings with Zn at 0.50 % or 0.25% concentrations combined with P soil application at either 50 or 100 ppm, respectively ranked statistically second. However, the combinations of (0.50% Zn X 25 ppm P) and (0.25% Zn X 50 ppm P) showed statistically the same effectiveness from one hand and ranked third in this respect, especially during 1997 season.

On the contrary the thinnest stem was induced by those seedlings received neither P nor Zn which was statistically the inferior. However, P-Zn fertilization treatments of both (0.0 ppm P X 0.125% Zn sprays) and (25 ppm P X 0.0 Zn) combinations were the same and came in an increasing order next to the inferior treatment. Any how, the other investigated P-Zn combinations were in between.

The benefits of P soil application on stem thickness of mango seedlings is in accordance with the earlier findings of **Suriyapananent and Subhardrbandhu, (1992)** on mango, **Sharma *et al.*, (1993) and Meneses Junior *et al.*, (1993)** on mango.

Table (9): Number of leaves, plant height and stem thickness of mango seedlings as influenced by rates of both (phosphorus soil & zinc foliar applied) and their combinations during 1997 & 1998 seasons.

Zn(%) / P(ppm)	Number of leaves					Plant height (Cm)					Stem thickness (mm)				
	0.0	0.125	0.25	0.50	Mean	0.0	0.125	0.25	0.50	Mean	0.0	0.125	0.25	0.50	Mean
	1997 Season														
0	11.20k	13.20 I	14.80fg	15.60de	**13.70D**	39.00	41.60	43.20	44.00	**41.95C**	52j	58hi	64f	67d	**60D**
25	12.20j	13.80h	15.20ef	16.20bc	**14.35C**	39.40	41.80	43.60	44.40	**42.30B**	57I	59h	66e	69c	**63C**
50	13.00 i	14.40g	15.60de	16.60ab	**14.90B**	39.80	42.00	43.80	44.60	**42.55B**	61g	.64f	68c	72b	**66B**
100	13.80h	15.00f	16.00cd	16.80a	**15.40A**	41.20	42.80	44.20	44.80	**43.25A**	65ef	66e	71b	75a	**69A**
Mean	**12.55D**	**14.10C**	**15.40B**	**16.30A**	-	**39.85D**	**42.05C**	**43.70B**	**44.45A**	-	**59D**	**62C**	**67B**	**71A**	-
	1998 Season														
0	12.20j	14.60h	16.20ef	17.00bcd	**15.00D**	33.60h	36.60f	38.00e	39.00d	**36.80D**	51j	56I	64f	68d	**60D**
25	13.80I	15.40g	16.80cde	17.60b	**15.90C**	35.60g	37.60e	38.80d	39.80bc	**37.95C**	59h	62g	66e	71c	**64C**
50	14.60h	16.00fg	17.40bc	18.40a	**16.60B**	36.60f	38.80d	39.40cd	40.40ab	**38.80B**	65ef	69d	73b	74a	**70B**
100	15.40g	16.40def	17.60b	18.40a	**16.95A**	37.40e	39.00d	40.20ab	40.80a	**39.35A**	71c	71c	73b	74a	**72A**
Mean	**14.00D**	**15.60C**	**17.00B**	**17.85A**	-	**35.80D**	**38.00C**	**39.10B**	**40.00A**	-	**61D**	**64C**	**69B**	**72A**	-

As for the results obtained regarding the positive relationship between zinc in foliar applied solution and stem thickness, it goes in line of those findings reported by **Banik and Sen, (1997),** on Fazli mango cv.; **Bose *et al.*, (1988)** on mango trees cv. Fazli and **Lal-Bahdur *et al.*, (1998)** on Dashehari mango cv.

IV. II. I. 4- Leaves dry weight:

A – Specific effect:

Data in Table (10) displayed that leaves dry weight per plant measurement was specifically responded to applied rates of both investigated factors i.e., P & Zn. Differences were significant as various investigated rates of the same fertilizer element were compared each other during both 1997 and 1998 seasons. However, phosphorus was more effective than zinc in this concern, whereas the rate of increase due to raising level of P soil application was more pronounced rather than the analogous one occurred by Zn concentration of foliar sprayed solution.

Nevertheless, such positive relationship between the leaves dry weight/seedling from one hand and applied levels of each investigated fertilizer element (P/Zn) from the other exerted statistically that the heaviest weight was always in a concomitant to the highest level of either P (100 ppm) or Zn (0.50%). Moreover, a significant reduction in leaves dry weight per seedling was gradually took place with lowering the applied rate of each fertilizer element whereas the control (0.0 level) was the inferior.

B – Interaction effect (P soil rate X Zn % of sprayed solution):

As for the interaction effect of various P-Zn combinations, Table (10) shows that the heaviest leaves dry weight per an individual mango seedling was statistically gained by the (100 ppm P soil added X 0.50% Zn sprayed solution) treated mango seedlings. Both combinations of (100 ppm P soil added X 0.25% Zn sprayed solution) and (50 ppm P soil applic. X 0.50% Zn solution) descendingly ranked 2nd and 3rd., respectively after the superior one from the statistical stand point.

Contrary to that, the lightest leaves dry weight per mango seedling was statistically associated to those received neither phosphorus nor zinc, followed in an increasing order by those received (0.0 P X 0.125% Zn) and (25 ppm P soil added X 0.0 Zn) or (0.0 P X 0.25% Zn sprayed solution). In addition other investigated P soil X Zn spray application combinations were in between the aforesaid two extents.

These results are in partial agreement with those reported by **Kuradoka *et al.*, (1959); Kim** and **Ko, (1975)** on Satsuma orange; **Tattini *et al.*, (1986)** and **Girgis, (1991)** on olive seedlings as the beneficial effect of P application on the leaves dry weight was taken into consideration.

Meanwhile, the positive relationship between leaves dry weight of mango seedlings from one side and the zinc foliar application from the other as detected from the present experiment was supported by the earlier findings of **Oppenheimer** and **Gasit (1961)** on Alphonso mango trees; **Singh** and **Katyol, (1961)** on Langra mango, cv.; **Koo *et al.*, (1992); Young *et al.*, (1966); Jawanda** and **Singh, (1971)** on some mango cvs. In

addition, **Rajput *et al.*, (1976)** on Chausa mango cv. and **Agrawala *et al.*, (1988)** on Dashehari mango cv. supported the same trend found regarding the beneficial effect of Zn spray on leaves dry weight.

IV. II. I. 5- Stem dry weight:

A – Specific effect:

Data in Table (10) displayed clearly that the stem dry weight of 6 month old mango seedlings was specifically responded to each investigated factor i.e., P or Zn, whereas both stem dry weight value from one hand and the applied level of any investigated fertilizer element from the other were in closed positive relationship. Such positive relationship between the stem dry weight and the applied rates of either P or Zn typically followed the analogous trend previously detected with leaves dry weight as the specific effect of each fertilizer element was separately concerned. However, the response followed the same trend for both leaves and stem, but the rate of increase in stem dry weight resulted by raising the applied rate of both P and Zn was relatively lower than that exhibited in leaves. Moreover, the relative higher effectiveness of P soil application on leaves dry weight rather than the zinc foliar sprays was still observed with the stem dry weight.

B – Interaction effect (P soil added X Zn% of solution spray):

Regarding the interaction effect of P-Zn applied levels, Table (10) displayed that the stem dry weight of mango seedling reflected obviously the specific effect of each fertilizer element. Hence, the heaviest stem was in closed relationship to those mango seedlings supplied with the nutritional combination of (100 ppm P soil added + foliar sprays with Zn

solution at 0.50% concentration). Meanwhile, the (100 ppm P soil added + 0.25% Zn sprayed solution) and (50 ppm P + 0.50% Zn sprayed solution) ranked 2nd and 3rd., respectively from the statistical stand point. Such trend was true and differences between these three effective P-Zn combinations were significant either they were compared each other or compared with the other investigated P-Zn combinations during both 1997 and 1998 seasons.

On the other hand the lowest value of stem dry weight per seedling was in a firmer relationship with those mango seedlings received neither P nor Zn followed in an increasing order by those received (0.0 ppm P X 0.125% Zn foliar sprays) and (25 ppm P soil added X 0.0 Zn). Moreover, other investigated (P soil added X Zn% foliar spray) were in between during both seasons of study.

The present results are in general agreement with the findings of **Sharma *et al.*, (1993); Meneses Junior *et al.*, (1993); Haggag and Azzazy, (1996)** on mango and **Girgis, (1991)** on olive regarding the positive response to phosphorus application.

Meanwhile, the findings **of El-Azzouni *et al.*, (1976); Bose *et al.*, (1988)** and **Lal-Bahadura *et al.*, (1998)** on the response to the Zn foliar application in some mango cultivars confirmed our results in this respect.

IV.II.I.6 – Root dry weight:

A – Specific effect:

From data presented in Table (10) it is quite evident that root dry weight of 6 month old mango seedlings was responded specifically to the applied rate of each fertilizer element (P/Zn) investigated during both

1997 and 1998 seasons. Both investigated factors i.e., soil applied rate of phosphorus and zinc concentration of its foliar sprayed solutions followed the same trend of response previously detected with dry weight of two aboveground organs i.e., leaves and stem. In other words root dry weight of mango seedlings was positively coupled with the applied rate of either phsophorus (estimated in ppm soil application) or zinc (evaluated as Zn% of its sprayed solution). Whereas the 100 ppm P soil added and 0.50% Zn concentration were the superior for phosphorus and zinc rates, respectively. On the other hand the response to phosphorus was more pronounced rather zinc.

B – Interaction effect (P soil added X Zn% sprays):

Regarding the interaction effect of various combinations between different P soil added rates and Zn concentrations of foliar sprayed solutions, data presented in Table (10) declared that the heaviest root dry weight per seedling was closely coupled with the combination of (highest P soil applied rate 100 ppm X Zn concentration at 0.50% in the foliar spray solution), whereas it ranked statistically 1st (superior) during both seasons of study. Moreover, two combinations of (100 ppm P soil application X 0.25% Zn sprays) and (50 ppm P soil added X 0.50% Zn of sprayed solution) descendingly ranked second and third, respectively from the statistical stand point. Such trend was true during both 1997 and 1998 seasons, whereas the relative higher effectiveness of phosphorus soil application rate than the concentration of Zn foliar spray solution was reflected directly on the interaction effect of the investigated P-Zn fertilization treatments.

Table (10): **Leaves, stems and roots dry weight (gm./plant) of mango seedlings as influenced by rates of both (phosphorus soil & zinc foliar applied) and their combinations during 1997 & 1998 seasons.**

Zn(%) / P(ppm)	Leaves dry weight					Stem dry weight					Root dry weight				
	0.0	0.125	0.25	0.50	Mean	0.0	0.125	0.25	0.50	Mean	0.0	0.125	0.25	0.50	Mean
	1997 Season														
0	3.01p	3.50 o	3.81m	3.96k	**3.57D**	3.64 o	3.98n	4.16 l	4.28k	**4.02D**	2.18p	2.44 o	2.76m	2.90 l	**2.57D**
25	3.66n	3.90 l	4.08 I	4.28g	**3.98C**	4.08m	4.34 I	4.48h	4.60f	**4.38C**	2.66n	2.92k	3.18I	3.32h	**3.02C**
50	4.02j	4.26h	4.46e	4.60c	**4.34B**	4.30j	4.52g	4.68d	4.79c	**4.58B**	3.00j	3.36g	3.70e	3.90c	**3.49B**
100	4.32f	4.58d	4.82b	4.92a	**4.66A**	4.48h	4.64e	4.86b	5.01a	**4.75A**	3.46f	3.78d	4.06b	4.26a	**3.89A**
Mean	**3.75D**	**4.06C**	**4.29B**	**4.44A**	-	**4.13D**	**4.37C**	**4.55B**	**4.67A**	-	**2.83D**	**3.13C**	**3.43B**	**3.60A**	-
	1998 Season														
0	2.97p	3.11 o	3.29n	3.38m	**3.19D**	3.71m	4.08 l	4.27j	4.42I	**4.12D**	2.81n	3.05m	3.35k	3.51j	**3.18D**
25	3.56 l	3.85k	4.03 I	4.24f	**3.91C**	4.19k	4.42 I	s4.66f	4.80e	**4.52C**	3.31 l	3.59I	3.85g	4.02f	**3.69C**
50	3.87j	4.13h	4.38e	4.48c	**4.20B**	4.42 I	4.64g	4.82d	4.98c	**4.72B**	3.72h	4.02f	4.35d	4.54c	**4.16B**
100	4.19g	4.45d	4.68b	4.80a	**4.53A**	4.62h	4.82d	5.04b	5.20a	**4.92A**	4.06e	4.34d	4.60b	4.79a	**4.45A**
Mean	**3.65D**	**3.89C**	**4.08B**	**4.23A**	-	**4.24D**	**4.49C**	**4.70B**	**4.85A**	-	**3.48D**	**3.75C**	**4.04B**	**4.22A**	-

On the contrary, the control seedlings (received neither P nor Zn) was statistically the inferior i.e., induced significantly the lighest root dry weight per seedling. Meanwhile, both combinations of (0.0 ppm P X Zn 0.125% foliar spray solution) and (25 ppm P soil added X 0.0 Zn spray solution) followed statistically the control in an increasing order. Differences between these three latest P-Zn combinations were significant either they compared each other or to any of the other investigated combinations.

In addition, other investigated P-Zn combinations came in between the aforesaid two extents of the stimulative (superior) and depresive (inferior) combinations during both seasons of study, however the combinations of the higher P rate tended relatively to be more effective.

These results are in general agreement with that found by **Girgis, (1991)** on seedlings of some olive cultivars, pertaining the positive response to phosphorus application. Meanwhile, our finding regarding the beneficial effect of zinc foliar sprays goes in line of that found by **Chattopadhyay and Mahanta, (1990)** on mango seedlings.

II.I.7. Total plant dry weight:

A – Specific effect:

Table (11), reveals obviously that the total plant dry weight of six month old mango seedlings responded positively to the applied rate/concentration of P soil added or zinc foliar sprays, respectively. Hence, each investigated factor i.e., fertilizer element (P/Zn) revealed its own specific effect which typically coincident with both previously

detected ones with either above ground system (leaves and shoot/stem) or the underground system (roots).

Nevertheless the heaviest plant dry weight was always associated with those mango seedlings soil applied with phosphorus at 100 ppm, followed in a descending order by 50, 25 and 0.0 ppm phosphorus applied seedlings. On the other hand foliar sprays with zinc sulphate solution with 0.50% Zn was the superior and exceeded statistically those of 0.25, 0.125 and 0.0% Zn which ranked 2nd, 3rd. and 4th, respectively from the statistical stand point.

B – Interaction effect (P soil added X Zn % spray solution):

Regarding the response of total plant dry weight of 6 month old mango seedlings to the interaction effect of various P soil added and zinc foliar spray combinations, Table (11) indicates obviously that the specific effect of each fertilizer element was directly reflected. Hence, the heaviest plant dry weight was closely coupled with the (100 ppm P soil added X 0.50% Zn spray solution) treated seedlings followed statistically in a descending order by those of (100 ppm P X 0.25% Zn solution) and 50 ppm P X 0.50% Zn foliar spray) as both ranked 2nd and 3rd.. Differences were significant as the most effective three P-Zn combinations (superior) were compared each other from one hand or compared to the other investigated ones from the other.

On the contrary, the mango seedlings received neither P soil added nor Zn were the inferior followed in an increasing order by those supplied with (0.0 ppm P soil added + 0.125% Zn spray solution) and the (25 ppm P soil added + 0.0 Zn). Moreover, other combinations were in between

regarding their influence on total plant dry weight. Such trend was true during both 1997 and 1998 seasons and differences were significant.

These results are in harmony with those found by **Sharma *et al.*, (1993); Meneses Junior *et al.*, (1993); Haggag and Azzazy, (1996)** on mango, as well as **Mohamed, (1979)** and **Girgis, (1991)** on olive, pertaining the response to phosphorus application.

Meanwhile, the beneficial effect of zinc foliar application observed from this study is supported by the findings of **Rajput *et al.*, (1976)** on Chausa mango; **Bose *et al.*, (1988); Agarwala *et al.*, (1988); Chattopadhyay** and **Mahanta, (1990)** and **Banik** and **Sen, (1997)** on Fazli mango cv.

IV.II.I.8- Top/root ratio:

A – Specific effect:

Regarding the specific effect of both P soil and Zn foliar application, data obtained during both 1997 and 1998 seasons are presented in Table(11).

It is quite clear that the top/root ratio responded negatively to the P soil applied rate, whereas the highest added level (100 ppm) resulted significantly in the lowest ratio. The reverse was true with the zero P level which showed the highest top/root. Moreover, other P soil applied rates i.e.., 25 and 50 ppm descendingly followed the no P application from the statistical stand point during both seasons of study.

Nevertheless, the specific effect of zinc concentration in the foliar spray solution followed the same trend of the P soil application rate.

Hence, the highest zinc concentration of sprayed solution was the lowest top/root ratio. The reduction exhibited in the top/root ratio of mango seedlings due to raising the P soil added rate was more pronounced in comparison to that due to the zinc concentration of foliar spray solution used.

In other words the aforesaid seven growth measurements i.e., 1-number of leaves per plant; 2-plant height; 3- stem thickness; 4-leaves dry weight; 5-stem dry weight; 6-root dry weight and 7-total plant dry weight were positively responded to the P soil applied rate and zinc concentration of sprayed solution. However, the trend took the other way around with the top/root ratio.

These results could be logically explaiend on that fact which pointed out the unparallelled rates of response of both top (above ground system/shoots & leaves) and root (underground system) to the P applied rate and Zn concentration. Since, the rate of increase in root dry weight due to raising applied level of either P or Zn was obviously higher than the analogus one exhibited with two plant organs of the top (leaves and shoots).

B – Interaction effect (P soil added rate X Zn % of sprayed solution):

Referring the top/root ratio in respone to the interaction effect of various P soil application and zinc foliar spray levels, data in Table (11) revealed that the combinations between the P omission (0.0) and either the omitted Zn or the 0.125% Zn i.e., (0.0 P + 0.0 Zn) and/or (0.0 P + 0.125% Zn) induced statistically the highest top/root ratio. Contrary to that the

Table (11): **Total plant dry weight and top/root ratio of mango seedlings as influenced by rates of both (phosphorus soil & zinc foliar applied) and their combinations during 1997 & 1998 seasons.**

Zn(%) / P(ppm)	Total plant dry weight (gm.)					Top/root ratio				
	0.0	**0.125**	**0.25**	**0.50**	**Mean**	**0.0**	**0.125**	**0.25**	**0.50**	**Mean**
	1997 Season									
0	8.83p	9.92 o	10.73m	11.14 l	**10.16D**	3.05b	3.07a	2.89d	2.84e	**2.96A**
25	10.41n	11.17k	11.74 I	12.20g	**11.38C**	2.91c	2.83f	2.69h	2.67 I	**2.77B**
50	11.33j	12.15h	12.85e	13.29c	**12.41B**	2.77g	2.61j	2.47 l	2.41n	**2.57C**
100	12.26f	13.01d	13.74b	14.20a	**13.30A**	2.54k	2.44m	2.39 o	2.33p	**2.42D**
Mean	**10.71D**	**11.56C**	**12.27B**	**12.71A**	-	**2.82A**	**2.74B**	**2.61C**	**2.56D**	-
	1998 Season									
0	9.49p	10.24 o	11.91n	11.31 l	**10.49D**	2.37a	2.36b	2.26d	2.22e	**2.30A**
25	11.06m	11.87k	12.54 i	13.07 l	**12.13C**	2.34b	2.30c	2.26d	2.25d	**2.29B**
50	12.01j	12.80h	13.51e	14.00c	**13.08B**	2.23e	2.18f	2.10h	2.08i	**2.15C**
100	12.87g	13.61d	14.33b	14.79a	**13.90A**	2.17f	2.14g	2.11h	2.09i	**2.13D**
Mean	**11.36D**	**12.13C**	**12.82B**	**13.29A**	-	**2.28A**	**2.24B**	**2.18C**	**2.16D**	-

highest P soil applied rate (100 ppm) in combination with either the highest zinc concentration (0.50%) or to great extent with 0.25% Zn reduced statistically the top/root ratio to the least value. In addition, other investigated P-Zn treatments (combinations) were in between. Such trend was true during both 1997 and 1998 seasons.

IV. II. II. Mineral Composition/nutritional status:

To evaluate the nutritional status of mango seedlings as influenced by specific and interaction effects of various P-Zn fertilization treatments in this experiment i.e., combinations between four soil added rates of phosphorus (0.0, 25, 50 and 100 ppm) and four concentrations of sprayed zinc solution (0.0, 0.125, 0.25 and 0.50% Zn), the responses of N, P, K and Zn contents of the three plant organs namely; leaf, stem and root were the concerned measurements of nutritional status in this respect.

IV.II.II. 1- Nitrogen content:

A – Specific effect:

Concerning the specific effect of P soil drench applied on N%, data presented in Table (12) displayed obviously that the response followed typically the same trend previously detected from the former experiment. It was quite evident that N% was coupled in a positive relationship with the P soil drench applied rate, regardless of the plant organ used for nitrogen determination. Such trend was true during both 1997 and 1998 seasons and the increase in N% resulted by raising the P soil added rate was significant as a given rate was compared to either lower or higher ones. Moreover, leaf was not only the richest organ in its nitrogen content

but also it showed relatively higher rate of response. On the other hand, stem was the poorest in N%, while root was in between.

Referring the specific effect of zinc concentration of the foliar spray solution, Table (12) shows clearly that leaf; stem; and root nitrogen contents in mango seedlings followed the same trend previously discussed with P soil applied rates. Such trends of N content in response to the specific effect of both P soil applied rate and Zn% of foliar spray solution were not only similar in their positive relationship to the investigated rate/concentration of P/Zn but also they coincident as the rate of changes in N% of each analysed organ (leaf, stem, root) was separately concerned. Differences in N% exhibited by the specific effect of both P and Zn levels were significant during both 1997 and 1998 seasons as response of an organ to applied rate of a given fertilizer element was separately taken into consideration.

B – Interaction effect (P soil added X Zn % of spray solution):

It is quite clear as shown in Table (12) that the specific effect of both P soil applied rate and Zn concentration of foliar sprayed solution were reflected on the interaction effect of their combinations on the N% of three plant organs during both 1997 & 1998 seasons. In this regard the richest plant organs in nitrogen were always concomitant to those mango seedlings soil applied with the highest P rate (100 ppm) and sprayed with Zn solution at its highest concentration (0.50% Zn). Then, the mango seedlings received any of both (50 ppm soil added + 0.50% Zn sprayed solution) and (100 ppm P soil applied +0.25% Zn sprayed solution) combinations ranked statistically second regarding their effect on N% of three plant organs.

Table (12): Nitrogen content (%) in various plant organs of mango seedlings in relation to rates of both (phosphorus soil & zinc foliar applied) and their combinations during 1997 & 1998 seasons.

Zn(%) / P(ppm)	Leaves					Stem					Root				
	0.0	0.125	0.25	0.50	Mean	0.0	0.125	0.25	0.50	Mean	0.0	0.125	0.25	0.50	Mean
	1997 Season														
0	1.87j	2.00 I	2.11gh	2.18f	**2.04D**	1.12 I	1.18h	1.24g	1.29e	**1.21D**	1.65m	1.82k	1.92 I	1.99f	**1.85D**
25	1.99 I	2.12g	2.21e	2.27d	**2.15C**	1.19h	1.26f	1.29e	1.34c	**1.27C**	1.78 I	1.94h	2.02e	2.08d	**1.95C**
50	2.10h	2.21e	2.28cd	2.35b	**2.24B**	1.24g	1.31d	1.34c	1.38b	**1.32B**	1.88j	2.03e	2.10c	2.15b	**2.04B**
100	2.19f	2.29c	2.35b	2.39a	**2.31A**	1.28e	1.35c	1.37b	1.41a	**1.35A**	1.96g	2.10c	2.16b	2.19a	**2.10A**
Mean	**2.04D**	**2.16C**	**2.24B**	**2.30A**	-	**1.21D**	**1.27C**	**1.31B**	**1.36A**	-	**2.82D**	**1.97C**	**2.05B**	**2.10A**	-
	1998 Season														
0	1.97 I	2.09k	2.21h	2.28f	**2.14D**	1.25j	1.33 I	1.42g	1.48e	**1.37D**	1.54k	1.69 I	1.77g	1.82e	**1.71D**
25	2.11j	2.19 I	2.32e	2.39d	**2.25C**	1.33 I	1.43g	1.48e	1.55c	**1.45C**	1.65j	1.79f	1.86d	1.91c	**1.80C**
50	2.23g	2.27f	2.40d	2.48b	**2.34B**	1.40h	1.49e	1.53d	1.60a	**1.51B**	1.73h	1.87d	1.92c	1.97b	**1.87B**
100	2.32e	2.33e	2.46c	2.52a	**2.41A**	1.45f	1.53d	1.57b	1.53d	**1.52A**	1.80f	1.93c	1.97b	2.01a	**1.93A**
Mean	**2.16D**	**2.22C**	**2.35B**	**2.42A**	-	**1.36D**	**1.44C**	**1.50B**	**1.54A**	-	**1.68D**	**1.82C**	**1.88B**	**1.93A**	-

Contrary to that, the lowest N% in three plant organs of mango seedlings was closely coupled with those received neither P soil added nor Zn foliar sprays. Moreover, other investigated P-Zn fertilization treatments (combinations) were in between.

Such trend was true during both seasons, with few exceptions in stem samples especially in 1998 season as their N content in response to the three superior P-Zn combinations were concerned.

The obtained results regarding the beneficial effect of P soil application goes in the line of findings of **Malhi *et al.*, (1988)** on mango cv. Dashehari and **Haggag and Azzazy, (1996)** on mango seedlings.

Meanwhile, the positive response of N content to the zinc sulphate foliar sprays was supported by the findings of **Agarwala *et al.*, (1988)** on Dashehari mango cv.; **Thakur *et al.*, (1980)** on Langra mango cv.; **Ponchner *et al.*, (1993)** and **Shu *et al.*, (1992)** on Irwin and Tommy Atkins mango cvs.

IV.II.II. 2- Phosphorus content:

A – Specific effect:

It is quite clear from data tabulated in Table (13) that the phosphorus content of various plant organs of mango seedlings i.e., leaf, stem and root responded specifically to the investigated levels of both P soil added and concentration of sprayed Zn solution. Anyhow, the response of phosphorus content to its soil applied rate indicated obviously that a firmer positive trend had been taken place in all the three plant organs. Since, leaf, stem and root P% was significantly increased with raising the phosphorus soil added rate from 0.0 to 100 ppm. Such trend was true

during both 1997 and 1998 seasons as any P soil applied rate was compared to the three other investigated ones, whereas the highest P soil applied rate (100 ppm) was the superior, while the no P application (0.0) was the inferior from the statistical stand point. Moreover, all mango plant organs showed relatively the same rate of changes in their P contents as the response to the specific effect of P soil application was taken into concederation during both 1997 and 1998 seasons.

Referring the specific effect of zinc concentration in foliar sprayed solution on phosphorus content in three plant organs of mango seedlings, data in Table (13) revaled that the trend took the other way around during both 1997 and 1998 seasons, irrespective of the plant organ. Hence, the leaf, stem and root phosphorus content was negatively responded to the Zn concentration of the foliar sprayed solution. Anyhow, the 0.50% Zn sprayed seedlings had the poorest organs (leaf, stem and root) in their phosphorus content, while the richest organs in P content were those of the water sprayed (0.0.Zn) mango seedlings. However, such trend was true during both 1997 and 1998 seasons, but the differences in P content of every organ were so slight to reach level of significance, especially as the 0.0, 0.125 and 0.25% Zn sprayed seedlings were compared each other regarding the phosphorus conten of their three plant organs during both seasons of study. On the other hand, differences were significant as P content in various plant organs (leaf, stem or root) of the 0.50% Zn sprayed seedlings were compared to the analogous values of the same organ of the 0.0, 0.125 or 0.25% Zn sprayed transplants.

B – Interaction effect (P soil added X Zn% of sprayed solution):

Regarding the interaction effect of the different investigated rates of P soil added combined with Zn concentration of foliar spray solutions, on leaf, stem and root P content of 6 month old mango seedlings, data obtained during both 1997 & 1998 seasons are presented in Table (13). It could be noticed that the response was not so firm, whereas the differences were not acute but relatively slight in most cases. However, three categories could be observed; the first one included those seedlings received any of such combinations between the two higher P soil applied rates (100 and 50 ppm) from one hand and the zinc foliar spray solutions of 0.0, 0.125% Zn and to some extent 0.25% Zn from the other, which resulted in the relative richest organs in their P%. Second category was represented by those combinations of no P soil added (0.0 ppm) and different concentrations of Zn sprayed solutions (0.0, 0.125 and 0.50% Zn) which induced the minimum P% in various plant organs of mango seedlings. However, other combinations of the P soil added and Zn foliar spray were representive of the third category which ranked an intermediate site in this concern. Such trend was true during both 1997 and 1998 seasons regardless of the plant organ used for determining the response of P content to the various P-Zn fertilization treatments.

The nonpronounced limits between variations in P content of various plant organ induced by the interaction effect of different P-Zn combinations could be logically explained by the conflict between two trends of P response to specific effect of both P and Zn, since each took an oposite direction to the other.

Table (13): Phosphorus content (%) in various plant organs of mango seedlings in relation to rates of both (phosphorus soil & zinc foliar applied) and their combinations during 1997 & 1998 seasons.

P(ppm) \ Zn(%)	Leaves					Stem					Root				
	0.0	0.125	0.25	0.50	Mean	0.0	0.125	0.25	0.50	Mean	0.0	0.125	0.25	0.50	Mean
	1997 Season														
0	0.141g	0.145g	0.147g	0.143g	**0.144D**	0.102e	0.108e	0.104e	0.101e	**0.104D**	0.127e	0.131e	0.133e	0.130e	**0.131D**
25	0.185def	0.183ef	0.185def	0.171f	**0.181C**	0.147cd	0.146cd	0.148cd	0.136d	**0.144C**	0.172cd	0.171cd	0.174bcd	0.163d	**0.170c**
50	0.203abcd	0.200abcde	0.198abcde	0.195bcde	**0.199B**	0.163abc	0.160abc	0.156bc	0.154bcd	**0.158B**	0.191ab	0.189abc	0.186abc	0.183abc	**0.187B**
100	0.215a	0.211ab	0.204abc	0.200abcde	**0.208A**	0.176a	0.173ab	0.168ab	0.164abc	**0.170A**	0.201a	0.199a	0.194a	0.189abc	**0.196A**
Mean	**0.186A**	**0.185A**	**0.184A**	**0.177B**	-	**0.147A**	**0.147A**	**0.144A**	**0.139B**	-	**0.173A**	**0.172A**	**0.172A**	**0.166B**	-
	1998 Season														
0	0.143f	0.149f	0.151f	0.146f	**0.147D**	0.107e	0.112e	0.110e	0.108e	**0.109D**	0.128g	0.133g	0.135g	0.130g	**0.131D**
25	0.184de	0.185cde	0.183de	0.172e	**0.181C**	0.149cd	0.149cd	0.151cd	0.141d	**0.147C**	0.169ef	0.170def	0.174cdef	0.161f	**0.168C**
50	0.204abc	0.202abcd	0.198abcd	0.196bcd	**0.200B**	0.167abc	0.166abc	0.162abc	0.159bcd	**0.163B**	0.190abc	0.188abcd	0.187abcde	0.182bcde	**0.187B**
100	0.216a	0.214ab	0.209ab	0.205ab	**0.211A**	0.180a	0.179a	0.176ab	0.183ab	**0.177A**	0.202a	0.199ab	0.194ab	0.187abcde	**0.196A**
Mean	**0.187A**	**0.188A**	**0.185A**	**0.180B**	-	**0.151A**	**0.152A**	**0.150A**	**0.145B**	-	**0.172A**	**0.172A**	**0.173A**	**0.165B**	-

The present results regarding the positive relationship between P application rate and P cotnent in mango plant organs goes partially in line of those found by **Salem, (1984), Malhi *et al.*, (1988)** and **Haggag and Azzazy, (1996)** on mango.

Meanwhile, the negative relationship between the P content in various mango plant organs and all Zn sprays treatments was in agreement with the findings of **Asma, (1981)** on Valencia orange. However, the present result was in disagreement with those reported by **Agarwala *et al.*, (1988); Shu *et al.*, (1992)** and **Panchner *et al.*, (1993)** on mango cultivars all reported that the P content was increased by the zinc foliar spray treatments.

Anyhow, the conflict between the present result and those of other investigators may be due to other determining factors especially those dealing with the surounding condition i.e., planting media, nutritional supplies of other nutrient elements and the developmental stage of plant material used itsself. Therefore further studies are needed to throw some lights on the real reason/s of such conflict.

IV.II.II.3 – Potassium content:

A – Specific effect:

It is quite evident from data tabulated in Table (14) that leaf, stem and root K% of 6 month old mango seedlings responded specifically to each investigated fertilizer element i.e., P soil applied rate and Zn concentration of foliar sprayed solution. Such trend was true during both seasons of study, whereas K% in all plant organs positively responded to the investigated levels of both fertilizer elements i.e., P or Zn.

In spite of K% in all plant organs was increased with raising applied level of both P & Zn, but the trends of response detected were varied from one fertilizer element P/Zn to another as the following aspects were concerned:

1 – Net increase in K% over the control (0.0):

The net increase in potassium percent exhibited in all mango plant organs by any of the P soil applied rates (25, 50 or 100 ppm) over the control (no P soil added/ 0.0 ppm) was greater than the analogous values resulted by the investigated Zn concentrations of sprayed solution (0.125, 0.25 or 0.50%) rather than the water sprays (0.0 Zn).

2 – Differences between the investigated levels of each applied fertilizer element:

The changes in K% due to the successive concentrations of zinc foliar spray solutions were regular in all organs, whereas the K% was gradually increased with raising Zn concentration. Anyhow, the rate of increase in K% was smooth/gentle as a given Zn concentration of sprayed solution was compared to either the former (lower) or the later (higher) one.

Nevertheless, the changes in K% induced by the different soil applied rates of phosphorus were not equally, whereas the K% was sharply increased by raising the P soil added from 0.0 to 25 ppm, then it slightly increased by raising P soil rate to 50 and 100 ppm P. Accordingly, the differences between the 25 and 100 ppm P soil applied mango seedlings were so little and could be safely neglected from the statistical stand point.

Such trends were firmer during both 1997 and 1998 seasons, irrespective of plant organ.

Generally it could be concluded that however the K% of all mango organs responded positively to the specific effect of applied rates/levels of each fertilizer element, but the response to Zn application was more regular than that of phosphorus from one hand and the differences between all the investigated zinc concentrations of foliar sprayed solutions were significant either they compared each other or with control (0.0 Zn). On the other hand the three applied rates of P i.e., 25, 50 and 100 ppm resulted considerably in a significant increase over the control (0.0 P), however differences between the 25 and 50 ppm rates was too light to be taken into consideration and therefore it could be safely neglected during both seasons of study.

B – Interaction effect (P soil added X Zn% of sprayed solutions):

Regarding the interaction effect of various P soil applied X Zn % of zinc solution used on the K% of various organs of mango seedlings, data in Table (14) indicated obviously that all three plant organs (leaf, stem and root) followed approximately the same trend. Such trend was representative of the direct response to the specific effect of P and Zn, whereas the relative effectiveness of phosphorus soil application rather than the zinc foliar application was clearly observed from data tabulted in Table (14). In other words, the highest K% in all plant organs was closely related to those three combinations between the highest Zn concentration (0.50%) from one hand and the two higher levels of P soil added i.e., (50 and 100 ppm) from the other. However, the combination of (100 ppm P soil added + foliar sprays with 0.50% Zn solution) tended to be more effective than the two other ones of the aforesaid three superior combinations, but the differences did not reach level of significance

especially as the leaf and stem potassium contents were concerned during both 1997 and 1998 seasons.

Contrary to that the combinations between no P soil applied (0.0 ppm) rate and any of the Zn concentration spray resulted generally in the lowest K% in all plant organs (leaf, stem and root). However, the (0.0 ppm P + 0.0% Zn) was statistically the inferior in this concern during both 1997 and 1998 seasons, regardless of the plant organs used for measuring potassium content. Moreover, three other combinations between the 0.0 ppm P soil applied and 0.125, 0.25 or 0.50% Zn in foliar spray solutions followed second to the inferior combination in general. In addition other investigated P-Zn fertilization treatments (combinations) came in between the abovementioned two extents with a relative tendency that raising level of P soil added or Zn concentration of sprayed solution especially phosphorus resulted in an obvious increase in K% in all plant organs.

These results are in partial agreement with the findings of **Malhi *et al.*, (1988)** on mango, as the relationship between potassium content in mango plant tissues and phosphorus soil application was concerned. On the other hand, the relative positive relationship between zinc foliar application and potassium status in various mango plant organs as discussed from the obtained results was supported by earlier findings on several mango cvs., i.e, **Thakur *et al.*, (1980)** on Langra cv., **Agarwala *et al.*, (1988)** on Dashehari cv.; **Shu *et al.*, (1992)** and **Ponchner *et al.*, (1993)** on Irwin and Tommy Atkins mango cvs.

Table (14): Potassium content (%) in various plant organs of mango seedlings in relation to rates of both (phosphorus soil & zinc foliar applied) and their combinations during 1997 & 1998 seasons.

Zn(%) / P(ppm)	Leaves					Stem					Root				
	0.0	0.125	0.25	0.50	Mean	0.0	0.125	0.25	0.50	Mean	0.0	0.125	0.25	0.50	Mean
	1997 Season														
0	1.03j	1.15I	1.24h	1.29h	**1.18C**	0.98k	1.09j	1.19I	1.24h	**1.13C**	0.82k	0.93j	1.00I	1.09h	**0.96D**
25	1.32gh	1.42ef	1.49cde	1.58ab	**1.45B**	1.27gh	1.37e	1.46cd	1.50bc	**1.40B**	1.08h	1.18f	1.26d	1.34b	**1.22C**
50	1.37fg	1.45de	1.52bcd	1.59ab	**1.48B**	1.31fg	1.37e	1.47bcd	1.52b	**1.42B**	1.12g	1.22e	1.29c	1.34b	**1.24B**
100	1.42ef	1.49cde	1.56abc	1.62a	**1.52A**	1.36ef	1.43d	1.51bc	1.57a	**1.47A**	1.19f	1.26d	1.30c	1.37a	**1.28A**
Mean	**1.29D**	**1.38C**	**1.45B**	**1.52A**	-	**1.23D**	**1.32C**	**1.41B**	**1.46A**	-	**1.05D**	**1.15C**	**1.22B**	**1.29A**	-
	1998 Season														
0	0.93j	1.06 I	1.16h	1.22gh	**1.09C**	0.91h	1.02g	1.08g	1.17f	**1.05C**	0.63 l	0.73k	0.86j	0.89 I	**0.78D**
25	1.25fg	1.34e	1.44bcd	1.51ab	**1.39B**	1.18f	1.28e	1.37bcd	1.45ab	**1.32B**	0.92h	0.99f	1.09e	1.14c	**1.03C**
50	1.29efg	1.36de	1.46bc	1.51ab	**1.41B**	1.23ef	1.31de	1.40bc	1.45ab	**1.35B**	0.95g	1.08e	1.,11d	1.17b	**1.08B**
100	1.32ef	1.42cd	1.52ab	1.55a	**1.45A**	1.28e	1.36cd	1.42abc	1.49a	**1.39A**	1.00f	1.07e	1.16b	1.20a	**1.11A**
Mean	**1.20D**	**1.30C**	**1.40B**	**1.45A**	-	**1.15D**	**1.25C**	**1.32B**	**1.39A**	-	**0.88D**	**0.97C**	**1.06B**	**1.10A**	-

IV.II.II.4. Zinc Content:

A – Specific effect:

It is quite clear from data presented in Table (15) that leaf, stem and root zinc content of mango seedlings was specifically influenced by the P soil added rate and/or the zinc concentration of the foliar sprayed solution. However, the trend of response took two opposite ways, whereas it showed a positive relationship with zinc concentration, but negatively reacted with the phosphorus soil applied rate. Such trend was true during both 1997 and 1998 seasons, irrespective of the plant organ used of determination. However, the differences i.e., increases exhibited in zinc content by raising concentration of sprayed zinc solution was more firmer and significant as zinc content in various plant organs (leaf, stem & root) of the 0.125, 0.25 and 0.50% zinc sprayed mango seedlings were compared to either control (no zinc srpays) or each other.

On the other hand, the three P soil added rates i.e., 25, 50 and 100 ppm resulted in a significant reduction in zinc content of various plant organs (leaf, stem & root) below the control (no P soil applied) during both 1997 and 1998 seasons. However, the depressive effect of these three investigated P soil applied rates (25, 50 and 100 ppm) did not follow a specific trend as they were statistically compared each other regarding their influence on zinc content of various plant organs, especially the two higher P rates (50/100 ppm) in most cases.

Nevertheless, the rate of changes in zinc content in response to zinc concentration of sprayed solution was more pronounced as compared to that resulted by P soil applied rate. Such trend was true during both

seasons of study, regardless of plant organs. Hence, the increase in zinc content gained by spraying mango seedlings with 0.5% Zn solution reached about 1.5:2.0 times much more than the Zn content of the water sprayed seedlings (control). The higher rate of increase (2 times) was observed with both leaves and roots, while the lower rate was found in stem.

B – Interaction effect (P soil added X Zn% of sprayed solution):

Regarding the interaction effect of the combinations between the investigated P soil applied rate and zinc concentration of sprayed solution Table (15) reveals that the richest leaves, stem and roots in their zinc content were these of mango seedlings sprayed with 0.50% Zn solution and no P soil application i.e., (0.0 ppm P X 0.50 Zn sprayed solution), followed by those of the (25 ppm P soil added X 0.50% Zn sprayed solution). Such trend was true during both 1997 and 1998 seasons, however difference between the above mentioned two superior P-Zn combinations did not reach level of significance during 1998 season with both leaf and stem pertaining their zinc content.

Contrary to that the poorest organs in their zinc content was always in closed relationship to those mango seedlings received one of the three combinations between no zinc foliar sprays from one hand and the two higher rates of phosphorus soil applied (50/100 ppm). In addition other P-Zn fertilization treatments (combinations) were intermediate.

These results are in general agreement with those findings of **Labanauskas *et al.*, (1960)** on Washington Navel orange trees; **Ramizi and Kimonidu, (1974)** on some citrus species; **El-Gazzar *et al.*, (1979)**

Table (15): Zinc content (ppm) in various plant organs of mango seedlings in relation to rates of both (phosphorus soil & zinc foliar applied) and their combinations during 1997 & 1998 seasons.

Zn(%) / P(ppm)	Leaves					Stem					Root				
	0.0	0.125	0.25	0.50	Mean	0.0	0.125	0.25	0.50	Mean	0.0	0.125	0.25	0.50	Mean
	1997 Season														
0	28.3j	55.0e	64.0d	76.0a	**55.8A**	17.0 I	28.3e	37.0b	40.7a	**30.8A**	25.3g	50.0e	60.3c	67.0a	**50.7A**
25	24.0k	46.0g	54.0e	70.0b	**48.5B**	15.0j	21.3g	30.0d	37.3b	**25.9B**	21.3k	41.7g	47.0f	65.3b	**43.8B**
50	22.3 l	39.0 I	50.3f	66.0 c	**44.4C**	14.3jk	18.0hi	26.0f	30.3d	**22.2D**	18.0m	36.3I	40.0h	50.3e	**36.2D**
100	22.3 l	40.3h	50.0f	65.3c	**44.5C**	13.3k	19.0h	25.0f	34.3c	**22.9C**	19.3 l	35.7 I	46.0f	53.3d	**38.6C**
Mean	**24.3D**	**45.1C**	**54.6B**	**69.3A**	-	**14.9D**	**21.7C**	**29.5B**	**35.7A**	-	**21.0D**	**40.9C**	**48.3B**	**59.0A**	-
	1998 Season														
0	24.3k	49.3f	59.0c	70.7a	**50.8A**	20.0j	27.3f	34.0c	40.0a	**30.3A**	24.0j	46.3f	55.7c	61.0a	**46.8A**
25	22.0 l	45.0g	53.0e	70.0a	**47.5B**	17.3k	24.0h	32.7d	41.0a	**28.8B**	22.3k	41.0g	47.3f	58.0b	**42.2B**
50	20.3m	39.0j	43.0h	55.0d	**39.3D**	16.3k	22.0I	28.0f	35.3b	**25.4C**	18.3m	38.0h	41.3g	52.0e	**37.4C**
100	22.3 l	41.7i	50.3f	67.0b	**45.3C**	14.0 l	20.3j	25.3g	31.0e	**22.7D**	20.0 l	35.0 I	42.3g	54.3d	**37.9C**
Mean	**22.3D**	**43.8C**	**51.3B**	**65.7A**	-	**16.9D**	**23.4C**	**30.0B**	**36.8A**	-	**21.2D**	**40.1C**	**46.7B**	**56.3A**	-

on oranges, guava and olive seedlings; **Vinay Singh, (1982)** on sweet orange and **Kandil, (1994)** on Communis pear and Nemaguard seedlings, whereas all demonstrated the negative relationship between the P soil application and zinc content in plant tissues.

As for the positive correlation between level of zinc fertilizer application and its content in various plant organs of mango seedlings as occurred from the present results, such trend was supported by the recent findings of **Lal-Bhadour *et al.*, (1998)** on Dashehari mango cv. trees.

IV. III. Foliar absorption, translocation and utilization of Zn-65 by the leaves of mango seedlings:

IV. III. 1. Retained Zn-65 in treated leaves:

From the data given in Table (16) it can be seen that Zn-65 retained in the treated leaves was significantly increased by increasing Zn rate in the used solutions. In this concern, retained Zn-65 in the foliar applied leaves with the higher concentrations i.e., 0.25 and 0.50% was increased by 64 and 142% respectively as compared to that received the lowest Zn rate (0.125%). Moreover, retained Zn-65 in the treated leaves was gradually increased as the P rate of soil application increased from 0.0 up to 100 ppm. The exhibited increase in the retained Zn-65 in leaves of P soil applied of mango seedlings over the control (no P application) reached about 3.0, 11.5 and 13.0% for P-25, P-50 and P-100, respectively.

Generally, Zn-65 retained in the treated leaves represented almost the major portion of the absorbed Zn-65 by mango leaves which ranged from 83.78 to 86.52% of its total absorption value.

These results agreed with those obtained by **Adlan (1966), Mohamed and Ragab (1984) and Mohamed and Sharaf (1994)**.

IV.III.2. Translocation of Zn-65 in mango seedlings:

Data dealing with translocation of the absorbed Zn-65, either in upward or downward direction, within mango seedlings as affected by concentration of Zn solution foliar applied and/or P rates of soil application are presented in Tables (17) & (18), respectively.

Table (16): Retained Zn-65 in the treated leaves of mango transplants as influenced by the level of both Zn foliar and P soil applications during 1999 year.

Labelled Zn foliar applied solution (%) / P soil application (ppm)	Retained Zn-65 cpm/treated leef			
	0.125	**0.25**	**0.50**	**Mean**
0	14883	25165	37627	**25892 B**
25	15870	25798	38373	**26680 AB**
50	17303	27975	41372	**28883 A**
100	17663	28635	41548	**29282 A**
Mean	**16430 C**	**26893 B**	**39730 A**	

Table (16): Retained Zn-65 in the treated leaves of mango transplants as influenced by the level of both Zn foliar and P soil applications during 1999 year.

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50	17303	27975	41372	**28883 A**
100	17663	28635	41548	**29282 A**
Mean	**16430 C**	**26893 B**	**39730 A**	

As for the upward translocation of Zn-65 it was significantly increased by raising the Zn concentration in the foliar applied solution from 0.125 to 0.25 or 0.50%. This trend was occurred for both leaves Table (17-A) and stem Table (17-B) but the total activity of Zn-65 in leaves was more pronounced which ranged from 2.0 to 2.3 times as much as that in stems. Meanwhile, the rate of increase in translocated Zn-65 due to increasing rate of applied Zn took the other way around whereas the change exhibited in stems became more obvious than the analogous one observed in leaves.

Increasing the rate of P soil application caused a gradual increase in Zn-65 translocated either to leaves or stems but with different magnitude.

With regard to the downward translocation of Zn-65 in response to Zn-65 foliar and P soil application, data obtained are tabulated in Table (18-A,B,C) for translocation toward the leaves, stems and roots, respectively. Generally, it could be noticed that the previous trends of upward translocation regarding the influence of the application rates of Zn or P were also observed. Translocated Zn-65 to leaves, stems and roots was increased significantly due to the increaments of Zn rate up to 0.25 or 0.50%. Average of increase ranged from 47-51% and from 93-99% for Zn at 0.25 and 0.50%, respectively as compared with those of Zn at 0.125%. Agradual increase in the three fractions of translocated Zn-65 in leaves, stems and roots was occurred as a result of increasing P rates. Highest activity of Zn-65 was found in stems followed by leaves and roots.

Regarding the translocation of Zn-65 toward the various plant organs, data in Tables (17-A&B) and (18-A,B&C) revealed that the ratio was approximately 1.00:1.23:1.87 for roots, leaves and stems, respectively.

Table (17): Upward translocation of Zn-65 in mango plant, leaves (A) and stem (B) as affected by level of both Zn foliar and P soil applications during 1999 year.

A – (Leaves)

Labelled Zn foliar applied solution (%) / P soil application (ppm)	Upward translocation as cpm/plant			
	0.125	**0.25**	**0.50**	**Mean**
0	1128	1622	2265	**1672**
25	1222	1692	2347	**1754**
50	1232	1772	2438	**1814**
100	1307	1822	2555	**1895**
Mean	**1222 C**	**1727 B**	**2401 A**	

B – (Stems)

0	485	798	1082	**788**
25	500	823	1128	**817**
50	538	863	1192	**864**
100	572	913	1298	**928**
Mean	**524 C**	**849 B**	**1175 A**	

Table (18): Downward translocation of Zn-65 in mango plants, leaves (A), stems (B) and roots (C) in response to level of both Zn foliar and P soil applications during 1999 year.

A - (Leaves)

Labelled Zn foliar applied solution (%) / P soil application (ppm)	Downward translocation cpm/plant			
	0.125	**0.25**	**0.50**	**Mean**
0	372	562	738	**577**
25	403	603	793	**600**
50	438	643	857	**646**
100	470	672	868	**670**
Mean	**421 C**	**620 B**	**814 A**	

B - (Stems)

0	562	887	1162	**870**
25	615	947	1213	**925**
50	667	980	1285	**977**
100	695	1020	1303	**1006**
Mean	**635 C**	**959 B**	**1241 A**	

C - (Roots)

0	297	450	615	**454 B**
25	332	488	655	**492 AB**
50	352	525	692	**523 AB**
100	375	548	735	**553 A**
Mean	**339 C**	**503 B**	**674 A**	

Translocation of Zn-65 from treated leaves to both directions was highly related to its absorption where upward translocation ranged from 7.7 to 9.1% and downward one ranged from 5.78 to 7.12% of the total Zn-65 absorbed.

Moreover, the upward transport of Zn-65 was markedly higher than the downward transport as compared each other. This trend was found with the different rates of P and/or Zn. In this concern, upward translocation of absorbed Zn-65 by mango leaves was increased by 21-33% over that of down ward one.

These results are in agreement with those obtained by **Mohamed (1979) and Mohamed and Sharaf (1994)** using radioactive isotopes of P and Zn, i.e, P-32 and Zn-65.

This could be explained on the ground that the young leaves and the growing points "more active metabolically" are in a great demand of nutrients, whereas the old leaves, almost, supply the young leaves with the nutrients that already absorbed. Therefore, the translocation of Zn-65 was higher in the upward direction than in the downward one.

IV. III. 3. Total absorption of Zn-65 by mango leaves:

Data in Table (19) show that the total absorbed Zn-65 (retained + translocated) by mango leaves was responded obviously to rates of both Zn-65 foliar applied solution and P soil application. Foliar absorption of Zn-65 was markedly and significantly increased by raising the concentration of Zn-65 solution from 0.125% to 0.25 or 0.50% but this increase was not proportional to the increase in Zn rates. In this respect

increasing the concentration of labelled Zn foliar applied solution from 0.125% to 0.25 and 0.50% resulted in an increment reached 61 and 135% of the total Zn-65 respectively as compared to these mango seedlings received Zn-65 solution at 0.125%. This can be attributed to the fact that mango leaves have a limited capacity for absorbing nutrients from foliar applied Zn solutions.

With soil application of P, a slight and gradual increase in total absorption of Zn-65 by mango leaves was observed as a result of increasing the rates of P from 0.0 up to 100 ppm. This trend was occurred with the three rates of Zn, i.e., 0.125, 0.25 and 0.50%, but with different magnitude. The increase in total absorption of Zn-65 due to soil application of 100 ppm P was declined with increasing Zn rate of foliar application where it was 19, 14 and 11% for 0.125, 0.25 and 0.50% Zn, respectively, with an average of 13.5%.

It could be concluded that increasing soil application rate of P enhancing foliar absorption of Zn by mango leaves. This effect may be mainly due to the improvement of nutrients balance, in particular P-Zn ratio, within plant tissue.

On the other hand, it can be also noticed from Table (19) that the rate of increase in total absorption of Zn-65 by increasing Zn foliar applied rate was slightly declined as the P rate increased from 0.0 up to 100ppm. For example, total absorption ratio of Zn-65 at 0.0 P was 1.00:1.66:2.45 for Zn at 0.125; 0.25 and 0.50%, respectively, whereas this ratio was 1.00:1.59; 2.29 with P at 100 ppm.

Table (19): Total absorption of Zn-65 by mango leaves as influenced by the level of both Zn foliar and P soil applications during 1999 year.

Labelled Zn foliar applied solution (%) / P soil application (ppm)	Total absorption cpm/whole plant			
	0.125	**0.25**	**0.50**	**Mean**
0	17727	29483	43488	**30233 C**
25	18942	30352	44510	**31268 BC**
50	20530	32758	47835	**33708 AB**
100	21082	33610	48308	**34333 A**
Mean	**19570 C**	**31551 B**	**46035 A**	

In addition, it can be also revealed that the rate of increase in total absorption of Zn-65 as a result of increasing Zn rates was slightly declined as the P rate increased from 0.0 up to 100 ppm. For instance, total absorption of Zn-65 by mango leaves was increased by 66 and 145% as Zn rate increased from 0.125 to 0.25 and 0.50%, respectively, without addition of P-"zero ppm", while the corresponding increase was 59 and 129% at 100ppm of P.

From the previous trends, it could be revealed that there was slight interaction effect of P on Zn absorption. However, the beneficial effect of P applications for enhancing plant growth and increasing nutrients uptake was more pronounced than the interaction effect of P on Zn absorption. In other words, the beneficial effect of P on plant growth and nutrients uptake could be compensate the interaction effect of P on Zn absorption by mango leaves.

Similar results were also obtained by **Hoffman and Samish (1966), Orphanose (1975), Mohamed (1979) and Mohamed *et al.*, (1995)**.

IV. III.4. Distribution pattern of translocated Zn-65 within mango plants :

From data in Table (17), the total activity of upward translocated Zn-65, after foliar application, was in leaves about 2.1 times as much as that in stems. For downward translocation (Table, 18) the highest activity of translocated Zn-65 was found in stems followed by leaves and then roots where the corresponding ratio was 2.8:2.3:1.0.

When relative activity of Zn-65 in different organs of mango plant, i.e. Zn-65 in cpm/g. dry weight, was taken into consideration (Table, 20), the previous trends were markedly changed. In this regard, Zn-65 in cpm/g. dry weight of stems was slightly more than that of leaves either above or below treated leaves where this increase ranged from 9-20%. Whereas the lowest activity of Zn-65 in cpm/g. dry weight was obtained in roots samples.

Generally, the relative distribution of translocated Zn-65 in cpm/g. dry weight was found as follows: stems above treated leaves > leaves above treated leaves > stems below treated leaves> leaves below treated leaves> roots. The corresponding ratios were 7.3:6.7:2.8:2.3:1.0, respectively.

Moreover, the relative distribution of Zn-65 showed that Zn-65 in cpm/g. dry weight of leaves above treated leaves was 2.87 times as much as that of leaves below treated leaves. Also, Zn-65 in stems above treated leaves was 2.60 times as much as that of stems bellow treated leaves.

These results are in agreement with those obtained by **Adlan (1966), Devlin (1975), Mohamed (1979) and Mohamed and Sharaf (1994)**.

IV.III.5. Percentage use of Zn-65 by mango plants:

From the given data in Table (21), it can be noticed that percentage use of Zn-65 foliar applied was varied according to the application rate of Zn and/or P. Average of Zn use efficiency ranged from 8.70-16.87% of the added Zn in the foliar applied solution. In spite of the total absorption of Zn-65 was markedly increased as the rate of Zn in the foliar applied solutions increased, the percentage of its utilization was greatly reduced.

Table (20): Distribution of translocated Zn-65 in various mango plants organs, leaves (A), stems (B) and roots (C) in response to level of both Zn foliar and P soil applications during 1999 year.

A - (Leaves)

Labelled Zn foliar applied solution (%) / P soil application (ppm)	Up ward translocation cpm/g. dry weight				Down ward translocation cpm/g. dry weight			
	0.125	0.25	0.50	Mean	0.125	0.25	0.50	Mean
0	1143	1412	1953	**1503**	360	518	664	**514**
25	1110	1459	1967	**1512**	375	514	690	**526**
50	1082	1487	2056	**1542**	382	539	729	**550**
100	1127	1531	2119	**1592**	391	552	701	**548**
Mean	**1116**	**1472**	**2024**		**377**	**531**	**696**	

B - (Stems)

0	1039	1593	2160	**1597**	400	655	819	**625**
25	1066	1636	2247	**1650**	425	690	868	**661**
50	1107	1686	2306	**1700**	464	664	870	**666**
100	1144	1783	2496	**1808**	449	662	819	**643**
Mean	**1089**	**1675**	**2302**		**435**	**668**	**844**	

C - (Roots)

0					145	212	282	**213**
25					156	226	297	**226**
50					161	239	323	**241**
100					166	240	322	**243**
Mean					**157**	**229**	**306**	

Table (21): Percentage use of Zn-65 by mango transplants as influenced by the level of both Zn foliar and P soil applications during 1999 year.

Labelled Zn foliar applied solution (%) / P soil application (ppm)	Percentage use of Zn-65			
	0.125	**0.25**	**0.50**	**Mean**
0	14.18	11.79	8.70	**11.56C**
25	15.15	12.14	8.90	**12.06 BC**
50	16.42	13.10	9.57	**13.03 AB**
100	16.87	13.44	9.66	**13.32 A**
Mean	**15.66 A**	**12.62 B**	**9.21 C**	

In this respect, average of Zn use efficiency for Zn rates of 0.125, 0.25 and 0.50% was 15.66, 12.62 and 9.21%, respectively. In other words, Zn use efficiency was reduced by 19 and 41% by increasing Zn rate from 0.125 up to 0.25 and 0.50%.

On the contrary, there was a slight and a gradual increase in the percentage use of added Zn as a result of increasing soil application rate of P from 0.0 upto 100ppm, where its average increased from 11.56 to 13.32%.

The previous trends are in harmony with those noticed by **Mohamed (1979), Mohamed and Ragab (1984), Mohamed and Sharaf (1994) and Mohamed *et al.*, (1995).**

Generally, the percentage use of Zn-65 by mango leaves ranged from 8.70 to 16.87 under the condition of this experiment. Therefore, foliar application of Zn-SO_4 could be recommended as a good source of Zn for mango nutrition in particular with high rates of phosphorus soil fertilization.

The conflict in the negative and positive response of zinc content to the specific effect of phosphorus soil drench applied rate occurred from data of (1^{st} and 2^{nd} experiments) and (3^{rd}. experiment), respectively may be attributed to the variance in duration had been expended from applying the P-Zn treatment before zinc determination was carried out. In other words a logic explanation based on such fact that the accumulation rate of a given substanc/s or component/s in a given plant organ/s could be changed with aging and advancement of growth season itself. Consequently, the

stimulative effect of P application on increasing dry matter, especially carbohydrates may be enhanced aging i.e, with extending duration from P application for longer time. However, further investigation is required for proving such explanation and throw some lights on the real reason/s may be responsible in such case.