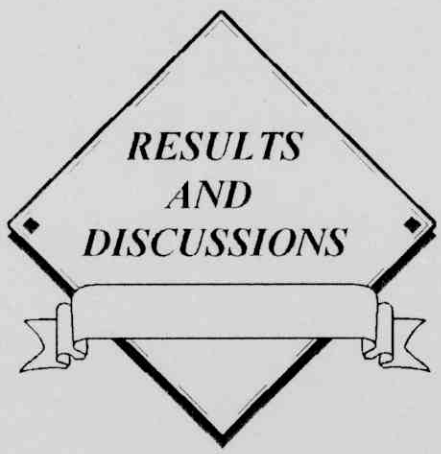
RESULTS
AND
DISCUSSIONS

4- RESULTS and DISCUSSION

Part I : Experiment I: Effect of organic manure source, method of organic manure application and biofertilizers on tree growth, leaf mineral content, tree fruiting and fruit quality of Balady mandarin.

4.1. Tree growth

The effect of organic manure sources namely cattle, poultry and sheep, method of organic manure application *i.e.* surface and trench and biofertilization namely Rhizobacterien and Nitrobien as well as their combination on tree growth of Balady mandarin trees during 2000 and 2001 seasons expressed as growth cycles (duration and intensity), increase in shoot length during different growth cycles, increase in number of leaves in each growth cycle and some leaf parameters *i.e.* surface area, leaf shape index, leaf chlorophyll (*a*) & (*b*) and leaf dry weight is presented in **Tables (5-27)**.

4.1.1. Growth cycles duration

Data reported in **Tables (5 & 6)** show the effect of organic manure source, method of organic manure application and biofertilization as well as their interactions on the growth cycles of Balady mandarin trees during 2000 and 2001 seasons.

Generally, under conditions of Kalubia Governorate, growth of Balady mandarin trees commenced on March, 15th and March, 6th in 2000 and 2001 seasons, respectively.

Furthermore, tree growth occurred in four distinctive and consecutive cycles *i.e.* one in spring, two during summer and

Table (5): Effect of organic manure source, method of application and biofertilization on growth cycles of Balady mandarin trees (2000 season).

Organic manure source	Application method	Biofertilizer {N-fixing bacteria}	Spring growth cycle			Summer growth cycle						Autumn growth cycle			Annual growth (days)
						1st cycle			2nd cycle						
			Beg.	End	Duration (days)	Beg.	End	Duration (days)	Beg.	End	Duration (days)	Beg.	End	Duration (days)	
Cattle manure	Surface	Nitrobien	15/3	2/5	49 b	25/6	21/7	27 b	1/8	16/8	16 b	15/9	8/10	24 c	116 c
		Rhizobacterien	15/3	2/5	49 b	25/6	21/7	27 b	1/8	16/8	16 b	17/9	8/10	22 e	114 c
	Trench	Nitrobien	15/3	2/5	49 b	25/6	28/7	34 a	1/8	16/8	16 b	17/9	8/10	22 e	121 b
		Rhizobacterien	15/3	2/5	49 b	25/6	28/7	34 a	1/8	16/8	16 b	12/9	8/10	27 a	126 a
Poultry manure	Surface	Nitrobien	15/3	6/5	53 a	25/6	21/7	27 b	1/8	16/8	16 b	17/9	8/10	24 c	120 b
		Rhizobacterien	15/3	6/5	53 a	25/6	21/7	27 b	1/8	16/8	16 b	17/9	11/10	24 c	120 b
	Trench	Nitrobien	15/3	2/5	49 b	18/6	21/7	34 a	1/8	19/8	20 a	17/9	8/10	24 c	127 a
		Rhizobacterien	15/3	2/5	49 b	18/6	21/7	34 a	1/8	19/8	20 a	15/9	8/10	23 d	126 a
Sheep manure	Surface	Nitrobien	15/3	2/5	49 b	25/6	21/7	27 b	1/8	16/8	16 b	17/9	8/10	24 c	116 c
		Rhizobacterien	15/3	2/5	49 b	18/6	21/6	34 a	1/8	16/8	16 b	15/9	11/10	25 b	124 a
	Trench	Nitrobien	15/3	2/5	49 b	18/6	21/7	34 a	1/8	19/8	20 a	15/9	8/10	24 c	127 a
		Rhizobacterien	15/3	2/5	49 b	18/6	21/7	34 a	1/8	19/8	20 a	15/9	8/10	24 c	127 a

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

Table (6): Effect of organic manure source, method of application and biofertilization on growth cycles of Balady mandarin trees (2001 season).

Organic manure source	Application method	Biofertilizer {N-fixing bacteria}	Spring growth cycle			Summer growth cycle						Autumn growth cycle			Annual growth (days)
						1st cycle			2nd cycle						
			Beg.	End	Duration (days)	Beg.	End	Duration (days)	Beg.	End	Duration (days)	Beg.	End	Duration (days)	
Cattle manure	Surface	Nitrobien	6/3	23/4	47 c	20/6	14/7	25 b	31/7	18/8	19 b	7/9	2/10	26 b	117 f
		Rhizobacterien	6/3	23/4	47 c	20/6	21/7	32 a	31/7	18/8	19 b	7/9	2/10	26 b	124 e
	Trench	Nitrobien	6/3	23/4	47 c	13/6	14/7	32 a	31/7	18/8	19 b	1/9	2/10	32 a	130 d
		Rhizobacterien	6/3	23/4	47 c	13/6	14/7	32 a	31/7	18/8	19 b	1/9	2/10	32 a	130 d
Poultry manure	Surface	Nitrobien	6/3	30/4	54 b	13/6	14/7	32 a	31/7	18/8	19 b	7/9	2/10	26 b	133 c
		Rhizobacterien	6/3	30/4	54 b	20/6	14/7	32 a	31/7	18/8	19 b	7/9	2/10	26 b	133 c
	Trench	Nitrobien	6/3	5/5	54 b	13/6	14/7	32 a	31/7	22/8	23 a	1/9	2/10	32 a	141 a
		Rhizobacterien	6/3	30/4	54 b	13/6	14/7	32 a	31/7	22/8	23 a	1/9	2/10	32 a	141 a
Sheep manure	Surface	Nitrobien	6/3	23/4	47 c	20/6	14/7	32 a	31/7	18/8	19 b	7/9	2/10	26 b	124 e
		Rhizobacterien	6/3	23/4	59 a	13/6	14/7	32 a	31/7	18/8	19 b	7/9	2/10	26 b	136 b
	Trench	Nitrobien	6/3	30/4	54 b	13/6	14/7	32 a	31/7	22/8	23 a	1/9	2/10	21 a	141 a
		Rhizobacterien	6/3	30/4	54 b	13/6	14/7	32 a	31/7	22/8	23 a	1/9	2/10	32 a	141 a

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

one in autumn. The spring growth cycle of poultry manured trees fertilized superficially and inoculated with Rhizobacterien and Nitrobien started on March, 15th and continued till May, 6th in the first seasons about (53 days duration), followed descendingly by poultry manured trees applied in surface and trenches and inoculated with Rhizobacterien and Nitrobien started on March, 6th and continued till April, 30th and May, 5th in the second season, about 54 days duration. On the other hand, cattle and sheep manured trees, fertilized superficially and in trenches and inoculated with Rhizobacterien commenced spring growth cycle on March, 15th and continued till May,2nd in 2000 (about 49 days duration). Cattle manured trees , fertilized superficially or in trenches and inoculated with Rhizobacterien and Nitrobien commenced spring growth cycle on March, 6th , and continued till April 23rd in 2001 season (about 47 days duration). Besides, sheep manured trees, fertilized superficially or in trenches and inoculated with Rhizobacterien and Nitrobien commenced spring growth cycle on March, 15th and continued till May, 2nd in the second season, followed descendingly by sheep manure x superficial application x Rhizobacterien and sheep manure x trench application x (Rhizobacterien or Nitrobien) which commenced spring growth cycle on March, 6th and continued till April, 23rd , April, 30th about 59 and 54 days duration respectively.

On the other hand, the new growth of the first summer growth cycle of poultry manure applied in trenches provided with Rhizobacterien and Nitrobien, followed descendingly by sheep manure x trenches inoculated with Rhizobacterien or

Nitrobien and sheep manure x surface application supplemented with Rhizobacterien peeped out on June, 18th and ceased on July, 21st in the first seasons (about 34 days duration). On the contrary, cattle manured trees applied in superficially or in trenches inoculated with Rhizobacterien or Nitrobien peeped out on June, 25th and ceased on July, 21st or July, 28th in the second season (about 27or 28 days duration), respectively.

Moreover, the growth of the first summer in the second season cycle began on June, 13th for those trees fertilized with poultry manure applied in trenches and /or sheep manure applied in trenches and enriched with Rhizobacterien and ceased on July, 14th, about 32 and 32 days duration, respectively.

Moreover, the growth of the second summer cycle began on August, 1st and July, 31st for those trees fertilized with poultry manure applied in trenches and provided with Rhizobacterien and ceased on August, 19th and August, 22nd with duration of about 20 and 23 days for the first and second seasons, respectively. On the contrary, cattle manured trees, fertilized with superficially and inoculated with Nitrobien recorded the shortest duration for the second summer growth cycle (16 and 19 days) in 2000 and 2001 seasons, respectively.

The growth of autumn cycle of poultry manured trees, fertilized in trenches and inoculated with Rhizobacterien began on September, 15th and September, 1st and ceased on October, 8th and October, 2nd with duration of about 24 and 32 days for the first and second seasons, respectively. On the contrary, the shortest autumn growth cycle duration was shown on cattle manured trees, fertilized superficially and inoculated with Nitrobien (about 24 and 26 days) in the first and second seasons, respectively. Other tested interactions showed comparatively

inbetween values regarding autumn growth cycle duration (24 – 26 days).

In summary, poultry manure applied in trenches and supported with Rhizobacterien prolonged the annual growth cycle (127 and 141 days), followed descendingly by poultry manured trees, fertilized in trenches and inoculated with Nitrobien (126 and 141 days) in the first and second seasons, respectively. On the contrary, cattle manured trees, fertilized superficially and inoculated with Nitrobien recorded the shortest annual growth (116 and 117 days) in the first and second seasons, respectively. The other studied combinations scored similar values of annual growth cycle (127 – 141 days).

The obtained results of growth cycles of Balady mandarin trees in the present study go in line with the findings of **Helail and Awad (1993) and Moustafa (2002).** They mentioned that under conditions of Kalubia Governorate, growth of Washington navel orange trees commenced on January, 31st and 29th and ceased on October, 25th and 21st in 1990 and 1991 seasons, respectively. They added that tree growth occurred in four distinctive cycles *i.e*, one in spring, two during summer and one in autumn.

4.1.2. Growth intensity (No. of shoots/branch)

The effect of organic manure source, method of organic manure application and biofertilization as well as their interaction on growth intensity (No. of shoots/branch) of growth cycles of Balady mandarin trees during 2000 and 2001 seasons is reported in **Tables (7-11)**.

It is quite clear from **Table (7)** that fertilizing Balady mandarin with poultry manure significantly increased growth intensity of spring growth cycle (30.1 shoots/branch), first summer growth cycle (15.9 shoots/branch), second summer growth cycle (12.9 shoots/branch) and autumn growth cycle (7.2 shoots/branch) with grand average (16.5 shoots/branch) against (24.5, 11.9, 8.6 and 5.2 shoots per branch for spring, first and second summer and autumn growth cycles of cattle manured trees, respectively, with grand average (12.5 shoots/branch). On the other hand, sheep manured trees scored 28.0, 13.9, 10.9 and 5.8 shoots/branch for spring, first and second summer growth cycles and autumn growth cycle, respectively with grand average (14.6 shoots/branch). However, differences between the three studied organic manure sources regarding No. of shoots/branch of different growth cycles were more obvious to reach the significance level at 5% level.

Furthermore, the application of organic manure in trenches surpassed the surface application regarding the number of produced shoots per branch of first and second summer and autumn growth cycles during 2000 and 2001 seasons **(Table, 7)**.

In addition, it is obvious from **Table (7)** that biofertilizing Balady mandarin trees with Rhizobacterien significantly enhanced growth intensity of different growth cycles (second summer and autumn) as compared with the analogous ones inoculated with Nitrobien.

On the other hand, **Table (8)** demonstrates that fertilizing Balady mandarin trees with poultry manure firstly in trenches and secondly superficially induced the highest stimulative effect on growth intensity of spring, first and second summer and

Table (7): Specific effect of organic manure source, application method and biofertilization on number of shoots per branch of Balady mandarin trees(2000 and 2001 seasons).

Factor	No. of Shoots per branch												
	Spring growth cycle			Summer growth cycle						Autumn growth cycle			Grand Average
				1st cycle			2nd cycle						
	(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	
a. Effect of organic manure source													
Cattle manure	24.0 c	26.8 c	24.5 b	11.3 b	12.4 b	11.9 b	8.1 c	9.0 c	8.6 c	4.9 c	5.1 c	5.2 b	12.5 c
Poultry manure	28.6 a	31.6 a	30.1 a	15.3 a	16.4 a	15.9 a	12.5 a	13.3 a	12.9 a	7.0 a	7.3 a	7.2 a	16.5 a
Sheep manure	26.5 b	29.5 b	28.0 a	13.3 ab	14.4 ab	13.9 ab	10.5 b	11.4 b	10.9 b	5.5 b	5.8 b	5.8 b	14.6 b
b. Effect of application method													
Surface	25.8 a	28.8 a	26.7 a	12.9 a	14.0 a	13.4 a	9.8 b	10.7 b	10.2 b	5.3 a	5.6 b	5.4 b	13.9 b
Trench	27.0 a	29.9 a	28.4 a	13.8 a	14.9 a	14.3 a	10.9 a	11.8 a	11.4 a	6.3 a	6.5 a	6.5 a	15.2 a
c. Effect of biofertilization													
Nitrobien	25.7 a	28.6 a	27.2 a	12.9 a	14.0 a	13.5 a	9.8 a	10.7 b	10.3 b	5.6 b	5.8 b	5.7 b	14.2 b
Rhizobacterien	27.0 a	30.0 a	27.9 a	13.7 a	14.8 a	14.2 a	10.9 a	11.8 a	11.3 a	6.0 a	6.3 a	6.3 a	14.9 a

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

Table (8): Effect of interaction between organic manure source and application method on number of shoots per branch of Balady mandarin trees(2000 and 2001 seasons).

Organic manure	Application method	No. of Shoots per branch												Grand Average
		Spring growth Cycle			Summer growth cycle						Autumn growth cycle			
					1st cycle			2nd cycle						
		(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	
Cattle →	Surface	23.2 b	26.2 c	22.9 b	10.8 d	11.9 d	11.4 d	7.6 f	8.5 f	8.1 f	4.5 f	4.7 f	4.5 f	11.7 e
	Trench	24.7 ab	27.4 bc	26.0 ab	11.8 cd	12.9 cd	12.4 cd	8.6 e	9.5 e	9.1 e	5.3 d	5.6 d	5.8 d	13.2 d
Poultry→	Surface	28.1 a	31.1 ab	29.6 a	14.9 ab	16.0 ab	15.5 ab	11.85 b	12.7 b	12.3 b	6.8 b	7.0 b	6.9 b	16.1 ab
	Trench	29.2 a	32.2 a	30.7 a	15.7 a	16.8 a	16.3 a	13.2 a	14.0 a	13.6 a	7.3 a	7.6 a	7.4 a	17.0 a
Sheep →	Surface	26.0 ab	29.0 abc	27.5 ab	12.9 bcd	14.0 bcd	13.4 bcd	10.0 d	10.9 d	10.4 d	4.8 e	5.0 e	4.9 e	14.1 cd
	Trench	27.1 ab	31.1 abc	28.6 a	13.0 abc	14.9 abc	14.3 abc	11.0 c	11.9 c	11.5 c	6.3 c	6.5 c	6.4 c	15.2 bc

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

autumn growth cycles. On the contrary, cattle manured trees particularly those fertilized superficially exerted the lowest positive effect in this concern. Besides, sheep manured trees with the superiority to those trenchly fertilized occupied an intermediate position between the previously two mentioned categories. However, differences between all the tested combinations were significant in the side of poultry manure and trench application.

Moreover, **Table (9)** indicates that in both seasons, the application method in trenches provided by Rhizobacterien proved to be the most effective combinations in enhancing growth intensity of the second summer and autumn growth cycles. On the contrary, biofertilizing with Nitrobien when interacted with surface method of organic manure application gave comparatively the lowest values of growth intensity of the second summer and autumn growth cycles. However, significant differences were obvious between the different studied combinations.

Additionally, the interaction between organic manure source and biofertilization shows that in both seasons the highest values of growth intensity (number of shoots per branch) of spring, first and second summer and autumn growth cycles were shown in descending order with the studied combinations as follows: (poultry manure x Rhizobacterien), (poultry manure x Nitrobien), (sheep manure x Rhizobacterien), (sheep manure x Nitrobien), (cattle manure x Rhizobacterien) and (cattle manure x Nitrobien) **(Table, 10)**.

Table (9): Effect of interaction between application method and biofertilization on number of shoots per branch of Balady mandarin trees(2000 and 2001 seasons).

Method of application	Biofertilizer	No. of Shoots / branch												Grand Average
		Spring growth Cycle			Summer growth cycle						Autumn growth cycle			
					1st cycle			2nd cycle						
		(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	
Surface →	Nitrobien	25.0 a	28.0 a	26.5 a	12.5 a	13.6 a	13.0 a	9.3 c	10.2 c	9.8 c	5.1 c	5.3 d	5.2 c	13.6 c
	Rhizobacterien	26.6 a	29.6 a	26.9 a	13.2 a	14.3 a	13.8 a	10.3 b	11.2 b	10.7 b	5.5 c	5.8 c	5.6 b c	14.3 bc
Trench →	Nitrobien	26.5 a	29.2 a	27.8 a	13.4 a	14.5 a	13.9 a	10.4 b	11.3 b	10.8 b	6.1 b	6.3 b	6.2 b	14.7 b
	Rhizobacterien	27.5 a	30.5 a	29.0 a	14.2 a	15.3 a	14.7 a	11.5 a	12.3 a	11.9 a	6.5 a	6.8 a	6.9 a	15.6 a

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

Table (10): Effect of interaction between organic manure source and biofertilization on number of shoots per branch of Balady mandarin trees(2000 and 2001 seasons).

Organic manure	Biofertilizer	No. of Shoots per branch												Grand Average
		Spring growth Cycle			Summer growth cycle						Autumn growth cycle			
					1st cycle			2nd cycle						
		(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	
Cattle →	Nitrobien	23.2 d	25.9 d	24.5 b	10.9 d	12.0 d	11.4 d	7.6 e	8.5 e	8.0 e	4.4 c	4.6 c	4.5 c	12.1 c
	Rhizobacterien	24.7 cd	27.7 cd	24.4 b	11.8 cd	12.9 cd	12.3 cd	8.7 d	9.6 d	9.1 d	5.3 b	5.6 b	5.8 b	12.8 c
Poultry →	Nitrobien	27.9 ab	30.9 ab	29.4 a	15.0 ab	16.1 ab	15.5 ab	11.9 b	12.8 b	12.3 b	6.9 a	7.1 a	7.1 a	16.1 a
	Rhizobacterien	29.4 a	32.4 a	30.98 a	15.7 a	16.8 a	16.2 a	13.1 a	13.9 a	13.5 a	7.2 a	7.5 a	7.3 a	17.0 a
Sheep →	Nitrobien	26.1 bcd	29.1 bc	27.6 ab	13.0 bcd	14.1 bcd	13.5 bcd	10.1 c	11.0 c	10.5 c	5.5 b	5.7 b	5.6 b	14.3 b
	Rhizobacterien	27.0 abc	30.0 abc	28.5 a	13.9 abc	14.8 abc	14.2 abc	10.9 bc	11.8 bc	11.4 bc	5.6 b	5.9 b	5.7 b	14.9 b

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

Furthermore, the interaction between organic manure source, method of organic manure application and biofertilization demonstrates that poultry manured trees, fertilized in trenches firstly or superficially and inoculated with Rhizobacterien recorded the highest values of growth intensity (number of shoots per branch of different growth cycles). Besides, trees fertilized with poultry manure applied in trenches or superficially and inoculated with Nitrobien and those manured with sheep manure applied in trenches and fertilized with Rhizobacterien exerted positive effect in this respect. On the contrary, cattle manured trees applied superficially and fertilized with Nitrobien or Rhizobacterien exerted the lowest positive effect in this concern. Other studied combinations occupied an intermediate position between the previously mentioned categories regarding their effect on growth intensity (number of shoots per branch) of the different growth cycles, **(Table, 11).**

4.1.3. Shoot length increase

Tables (12-16) show the effect of organic manure source (cattle, poultry and sheep), method of organic manure application (surface and trench) and biofertilization (Rhizobacterien and Nitrobien) as well as their combinations on shoot length increase of spring, summer and autumn growth cycles of Balady mandarin trees during 2000 and 2001 seasons.

It is quite clear that poultry manured trees produced the longest shoots during spring, summer and autumn growth cycles as compared with those resulted from cattle or sheep manured trees. In other words, the shortest shoots of the different studied

Table (11): Effect of interaction between organic manure source, application method and biofertilization on number of shoots per branch of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer {N-fixing bacteria}	No. of shoot per Branch: Spring growth Cycle 2000	Spring growth Cycle 2001	Spring growth Cycle Average	Summer growth cycle 1st cycle 2000	Summer growth cycle 1st cycle 2001	Summer growth cycle 1st cycle Average	Summer growth cycle 2nd cycle 2000	Summer growth cycle 2nd cycle 2001	Summer growth cycle 2nd cycle Average	Autumn growth cycle 2000	Autumn growth cycle 2001	Autumn growth cycle Average	Grand Average
Cattle manure	Surface	Nitrobien	22.2 d	25.2 d	23.7 cd	10.4 d	11.5 d	10.9 d	7.1 g	8.0 g	7.5 g	4.0 f	2.4 f	4.1 c	11.57 f
		Rhizobacterien	24.3 cd	27.3 cd	22.1 d	11.3 cd	12.4 cd	11.8 cd	8.2 fg	9.1 fg	8.6 fg	4.9 e	5.2 e	5.0 c	11.9 f
	Trench	Nitrobien	24.3 cd	26.6 cd	25.4 bcd	11.4 cd	12.5 cd	11.9 cd	8.1 fg	9.0 fg	5.5 fg	4.9 e	5.1 e	5.0 c	12.7 ef
		Rhizobacterien	25.2 bcd	28.2 bcd	26.7 abcd	12.3 bcd	13.4 bcd	12.8 bcd	9.2 ef	10.1 ef	9.6 ef	5.8 d	6.1 d	6.6 ab	13.7 de
Poultry manure	Surface	Nitrobien	27.3 abc	30.3 abc	28.8 abc	14.4 abc	15.5 abc	14.9 abc	11.3 bcd	12.2 bcd	11.7 bcd	6.7 abc	6.9 bc	6.8 ab	15.5 bc
		Rhizobacterien	29.0 ab	32.0 ab	30.5 ab	15.5 ab	16.6 ab	16.0 ab	12.4 ab	13.3 ab	12.8 ab	6.9 abc	7.2 abc	7.0 ab	16.6 ab
	Trench	Nitrobien	28.5 abc	31.5 ab	30.0 ab	15.6 ab	16.7 ab	16.1 ab	12.5 ab	13.4 ab	12.9 ab	7.2 ab	7.4 ab	7.3 ab	16.6 ab
		Rhizobacterien	29.9 a	32.9 a	31.4 a	15.9 a	17.0 a	16.4 a	13.9 a	14.6 a	14.2 a	7.5 a	7.8 a	7.6 a	17.4 a
Sheep manure	Surface	Nitrobien	25.6 abcd	28.6 bcd	27.1 abcd	12.8 abcd	13.9 abcd	13.3 abcd	9.6 def	10.5 def	10.1 def	4.8 e	5.0 e	4.9 c	13.8 de
		Rhizobacterien	26.5 abcd	29.5 abc	28.0 abc	13.0 abcd	14.1 abcd	13.5 abcd	10.4 cde	11.3 cde	10.8 cde	4.8 e	5.1 e	4.9 c	14.4 cd
	Trench	Nitrobien	26.7 abcd	29.7 abc	28.2 abc	13.2 abcd	14.3 abcd	13.7 abcd	10.6 cde	11.5 cde	11.0 cde	6.2 cd	6.1 cd	6.3 b	14.8 cd
		Rhizobacterien	27.5 abc	30.5 abc	29.0 abc	14.4 abc	15.5 abc	14.9 abc	11.5 bc	12.4 bc	11.9 bc	6.4 bcd	6.7 bcd	6.5 ab	15.6 bc

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

growth cycles were shown on cattle manured trees. Besides, shoots of sheep manured trees scored intermediate length values during spring, summer and autumn growth cycles. Generally, differences between the three studied organic manure sources in shoot length increase of the different growth cycles were remarkable to be significant **(Table, 12).**

It is obvious from **Table (12)** that the application of organic manure in trenches exerted higher positive effect on shoot length increase of spring growth cycles than surface application method. The differences in shoot length increase of the different growth cycles between the two organic manure application methods and sources were obvious to reach significance level.

Furthermore, fertilizing with Rhizobacterien enhanced shoot length increase than did Nitrobien fertilization during spring, summer and autumn growth cycles. However, the superiority of Rhizobacterien in this concern was remarkable to be significant.

Table (13) reveals that the interaction between organic manure source and organic manure application method exerted that poultry manure applied firstly in trenches and secondly superficially proved to be the most effect combinations in enhancing shoot length of different growth cycles of Balady mandarin trees. On the contrary, cattle manure whether applied in trenches or superficially gave similarly the lowest values of shoot length increase during the different growth cycles. Besides, sheep manure when applied in trenches produced longer shoots than surface application.

Table (12): Specific effect of organic manure source, application method and biofertilization on shoot length increase of Balady mandarin trees(2000 and 2001 seasons).

Factor	Shoot length increase (cm)												Grand Average
	Spring growth cycle			Summer growth cycle						Autumn growth cycle			
				1st cycle			2nd cycle						
	(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	
a. Effect of organic manure source													
Cattle manure	6.0 c	6.9 c	6.4 c	4.6 c	5.5 c	5.0 c	5.2 c	5.7 c	5.7 c	5.5 c	2.1 c	2.3 c	2.2 c
Poultry manure	8.7 a	9.6 a	9.2 a	6.2 a	7.1 a	6.7 a	6.7 a	7.2 a	7.2 a	7.0 a	3.4 a	3.7 a	3.5 a
Sheep manure	7.2 b	8.2 b	7.7 b	5.6 b	6.5 b	6.2 b	6.0 b	6.5 b	6.5 b	6.6 b	3.8 b	3.0 b	2.8 b
b. Effect of application method													
Surface	7.1 b	8.0 b	7.6 b	5.4 a	6.3 a	5.9 a	5.9 a	6.4 a	6.4 a	6.4 a	2.7 a	2.9 a	2.8 a
Trench	7.5 a	8.4 a	8.0 a	5.5 a	6.4 a	6.0 a	6.0 a	6.5 a	6.5 a	6.3 a	2.8 a	3.0 a	2.8 a
c. Effect of biofertilization													
Nitrobien	7.1 b	8.0 b	7.5 b	5.3 b	6.2 b	5.8 b	5.8 b	6.3 b	6.3 b	6.3 a	2.6 b	2.8 b	2.7 b
Rhizobacterien	7.5 a	8.5 a	8.0 a	5.6 a	6.5 a	6.1 a	6.2 a	6.7 a	6.7 a	6.4 a	2.9 a	3.1 a	3.0 a

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

Table (13): Effect of interaction between organic manure source and application method on shoot length increase of Balady mandarin trees(2000 and 2001 seasons).

Organic manure	Application method	Shoots length increase (cm)												Grand Average
		Spring growth cycle			Summer growth cycle						Autumn growth cycle			
					1st cycle			2nd cycle						
		(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	
Cattle	Surface	5.8e	6.6e	6.2e	4.5d	5.4d	5.0d	5.2c	5.7c	5.7b	5.6c	2.1c	2.3c	2.2c
	Trench	6.1d	7.2d	6.7d	4.6d	5.5d	5.1d	5.2c	5.7c	5.7b	5.5c	2.1c	2.3c	2.2c
Poultry	Surface	8.5b	9.4b	9.0b	6.2ab	7.1ab	6.6ab	6.6a	7.1a	7.1a	5.9a	3.4a	3.6a	3.5a
	Trench	8.9a	9.8a	9.4a	6.3a	7.2a	6.7a	6.8a	7.3a	7.3a	7.1a	3.5a	3.7a	3.5a
Sheep	Surface	7.1c	8.0c	7.5c	5.7bc	6.6bc	6.1c	6.0b	6.5b	6.5ab	6.8ab	3.8b	3.0b	2.8b
	Trench	7.4c	8.3c	7.9c	5.6c	6.5c	6.2bc	6.0b	6.5b	6.5ab	6.4b	3.8b	3.0b	2.9b

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

Additionally, the interaction between organic manure source and biofertilization induced similar trend to that of interaction between organic manure source and method of application, where poultry manured trees supported with Rhizobacterien fertilizer gave significantly the longest shoots of all studied growth cycles, followed descendingly by the analogous ones manured with poultry and enriched with Nitrobien fertilizer. On the contrary, cattle manure whether provided with Rhizobacterien or Nitrobien gave similarly and comparatively the shortest shoots during the different growth cycles. Besides, sheep manure provided with Rhizobacterien or Nitrobien induced similarly an intermediate positive effect on shoot length of different growth cycles, **(Table, 14)**.

As for the interaction between method of organic manure application and biofertilization, **Table (15)** declares that out of all tested combinations, the interaction between trench method of organic manure application and Rhizobacterien gave the highest values of shoot length increase of spring, summer and autumn growth cycles. Other tested interactions showed fluctuated trend in shoot length increase of the different growth cycles of Balady mandarin trees.

Finally, the interaction between the three studied factors *i.e.* organic manure source, method of organic manure application and biofertilization, **Table (16)** demonstrates that poultry manure applied in trench and supported with Rhizobacterien significantly increased shoot length of different growth cycles, followed descendingly by those manured with

Table (14): Effect of interaction between organic manure source and biofertilization on shoot length increase of Balady mandarin trees(2000 and 2001 seasons).

Organic manure	Biofertilizer	Shoot length increase (cm)												Grand Average
		Spring growth cycle			Summer growth cycle						Autumn growth cycle			
					1st cycle			2nd cycle						
		(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	
Cattle	Nitrobien	5.6 e	6.5 e	6.0 e	4.4 e	5.3 e	4.8 d	5.0 e	5.5 e	5.5 d	5.4 d	2.0 d	2.1 f	2.0 c
	Rhizobacterien	6.4 d	7.3 d	6.3 d	4.8 d	5.7 d	5.2 c	5.5 d	6.0 d	6.0 cd	5.7 d	2.2 d	2.4 e	2.3 c
Poultry	Nitrobien	8.5 b	9.4 b	8.9 b	6.1 ab	7.0 ab	6.5 ab	6.5 ab	7.0 ab	7.0 ab	6.8 b	3.3 b	3.5 b	3.4 a
	Rhizobacterien	9.0 a	9.9 a	9.4 a	6.4 a	7.3 a	6.8 a	6.9 a	7.4 a	7.4 a	7.2 a	3.6 a	3.9 a	3.7 a
Sheep	Nitrobien	7.2 c	8.1 c	7.6 c	5.5 c	6.4 c	6.1 b	5.9 c	6.4 c	6.4 bc	6.8 ab	2.6 c	2.8 d	2.7 b
	Rhizobacterien	7.3 c	8.3 c	7.8 c	5.8 bc	6.7 bc	6.2 b	6.1 bc	6.6 bc	6.6 b	6.4 c	3.0 b	3.2 c	3.0 b

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

Table (15): Effect of interaction between application method and biofertilization on shoot length increase of Balady mandarin trees(2000 and 2001 seasons).

Method of application	Biofertilizer	Shoot length increase (cm)												Grand Average
		Spring growth cycle			Summer growth cycle						Autumn growth cycle			
					1st cycle			2nd cycle						
		(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	
Surface	Nitrobien	6.8 b	7.7 c	7.2 b	5.4 b	6.3 b	5.8 b	5.8 b	6.3 b	6.3 a	6.5 a	2.6 bc	2.8 b	2.7 b
	Rhizobacterien	7.5 a	8.3 ab	7.9 a	5.5 ab	6.4 ab	6.0 ab	6.1 ab	6.6 ab	6.6 a	6.3 ab	2.8 ab	3.1 a	2.9 ab
Trench	Nitrobien	7.3 a	8.2 b	7.8 a	5.3 b	6.2 b	5.8 b	5.8 b	6.3 b	6.3 a	6.1 b	2.5 c	2.7 b	2.6 b
	Rhizobacterien	7.6 a	8.7 a	8.2 a	5.7 a	6.6 a	6.2 a	6.2 a	6.7 a	6.7 a	6.5 a	3.0 a	3.2 a	3.1 a

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

Table (16): Effect of interaction between organic manure source, application method and biofertilization on shoot length increase of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer {N-fixing bacteria}	Shoot length increase (cm)												
			Spring growth cycle			Summer growth cycle						Autumn growth cycle			Grand Average
						1st cycle			2nd cycle						
			(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	
Cattle manure	Surface	Nitrobien	5.1 f	6.0 g	5.5 e	4.4 e	5.3 e	4.8 d	5.0 f	5.5 f	5.5 d	5.8 d	2.0 gh	2.2 hi	2.1 ef
		Rhizobacterien	6.5 de	7.2 f	6.8 d	4.7 e	5.6 e	5.1 d	5.5 ef	6.0 ef	6.0 cd	5.7 d	2.2 fgh	2.4 ghi	2.3 def
	Trench	Nitrobien	6.1 e	7.0 f	6.5 d	4.4 e	5.3 e	4.8 d	5.0 f	5.5 f	5.5 d	5.2 d	1.9 h	2.1 I	2.0 f
		Rhizobacterien	6.2 e	7.5 ef	6.8 d	4.9 e	5.8 e	5.3 d	5.5 ef	6.0 ef	6.0 cd	5.7 d	2.3 fgh	2.5 gh	2.4 def
Poultry manure	Surface	Nitrobien	8.3 b	9.2 bc	8.7 b	6.1 abc	7.0 abc	6.5 abc	6.5 abcd	7.0 abcd	7.0 ab	5.7 bc	3.3 bc	2.5 bc	3.4 ab
		Rhizobacterien	8.8 ab	9.7 ab	9.2 ab	6.3 ab	7.2 ab	6.7 ab	6.8 ab	7.3 ab	7.3 ab	7.0 ab	3.5 ab	3.8 ab	3.7 ab
	Trench	Nitrobien	8.7 ab	9.6 ab	9.1 ab	6.1 abc	7.0 abc	6.5 abc	6.6 abc	7.1 abc	7.1 ab	6.8 abc	3.3 bc	3.5 bc	3.4 ab
		Rhizobacterien	9.2 a	10.1 a	9.6 a	6.5 a	7.4 a	6.9 a	7.1 a	7.6 a	7.6 a	7.3 a	3.8 a	4.0 a	3.7 a
Sheep manure	Surface	Nitrobien	7.1 cd	8.0 de	7.5 c	5.7 cd	6.6 cd	6.1 c	6.0 cde	6.5 cde	6.5 bc	7.2 ab	2.7 def	2.9 ef	2.8 cd
		Rhizobacterien	7.1 c	8.1 de	7.6 c	5.7 cd	6.6 cd	6.1 c	6.1 cde	6.6 cde	6.6 bc	6.3 c	2.9 def	3.1 de	2.8 cd
	Trench	Nitrobien	7.0 c	8.2 de	7.7 c	5.4 d	6.3 d	6.1 c	5.9 de	6.4 de	6.4 bcd	6.4 c	2.5 efg	2.7 fg	2.6 de
		Rhizobacterien	7.5 c	8.5 cd	8.0 c	5.9 bcd	6.8 bcd	6.3 bc	6.2 bcd	6.7 bcd	6.7 abc	6.4 c	3.1 bcd	3.3 cd	3.2 bc

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

poultry applied in trenches and provided with Nitrobien fertilizer. Besides, poultry manure, applied superficially and fertilized with Rhizobacterien surpassed the corresponding ones provided with Nitrobien in enhancing shoot length of different growth cycles. The combinations of sheep manure surpassed the corresponding ones of cattle manure in the same pattern of poultry manure interactions, regarding shoot length increase of spring, summer and autumn growth cycles of Balady mandarin trees.

4.1.4. No. of leaves/shoot

The effect of organic manure source, method of organic manure application and biofertilizers as well as their combinations on number of leaves per shoot of spring, summer and autumn growth cycles of Balady mandarin trees during 2000 and 2001 seasons is reported in **Tables (17-21).**

It is obvious from **Table (17)** that shoots of poultry manured trees had significantly higher number of leaves of spring (3.9 & 4.2), summer (4.4 & 4.7) and autumn (2.6 & 2.8), whereas, those of sheep manured trees recorded (3.6 & 3.9) for spring, (3.9 & 4.2) for summer and (2.2 & 2.4) for autumn growth cycles in 2000 and 2001 seasons, respectively. On the contrary, shoots of cattle manured trees recorded the lowest number of leaves for spring (3.4 & 3.7), summer (3.3 & 3.6) and autumn (2.0 & 2.2) in the first and second seasons, respectively.

Furthermore, the application of organic manure either superficially or in trenches induced similar effect on number of developed leaves per shoot of spring growth cycle. Meanwhile,

Table (17): Specific effect of organic manure source, application method and biofertilization on number of leaves per shoot of Balady mandarin trees(2000 and 2001 seasons).

Factor	No. of leaves / shoot					
	Spring growth Cycle		Means of summer growth cycles		Autumn growth cycle	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source						
Cattle manure	3.4 c	3.7 c	3.3 c	3.6 c	2.0 c	2.2 c
Poultry manure	3.9 a	4.2 a	4.4 a	4.7 a	2.6 a	2.8 a
Sheep manure	3.6 b	3.9 b	3.9 b	4.2 b	2.2 b	2.4 b
b. Effect of application method						
Surface	3.6 a	3.9 a	3.7 b	4.0 b	2.2 b	2.4 b
Trench	3.7 a	4.0 a	3.9 a	4.2 a	2.3 a	2.5 a
c. Effect of biofertilization						
Nitrobien	3.6 a	3.9 a	3.7 a	4.1 a	2.2 a	2.4 a
Rhizobacterien	3.6 a	4.0 a	3.9 a	4.2 a	2.3 a	2.5 a

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

trench application of organic manure surpassed surface application in enhancing number of produced leaves per shoot of summer and autumn growth cycles.

Moreover, the biofertilizers induced similar effect on number of leaves per shoots of spring, summer and autumn growth cycles. **(Table, 17)**.

Regarding the interaction between organic manure source and method of application, **Table (18)** shows that organic manure source exerted dominant influence on the net of interaction between organic manure source and method of application. Thereupon, the two methods of application of poultry manure showed comparatively similar and higher values of number of leaves per shoot of spring, summer and autumn, followed descendingly and typically by those of sheep and finally by the corresponding ones of cattle manure.

In addition, **Table (19)** reveals that the interaction between organic manure source and biofertilization took the same trend to that of organic manure source x method of application, hence the combinations of two biofertilizers with poultry manure scored similarly and higher values of number of leaves per shoot of spring, summer and autumn growth cycles, followed descendingly in the same trend by the combinations of sheep manure and lastly by the interactions of cattle manure.

Table (20) demonstrates that the interaction between method of organic manure application and biofertilization failed to induce a distinctive effect on number of developed leaves per shoot of most studied growth cycles of Balady mandarin trees in 2000 and 2001 seasons.

Table (18): Effect of interaction between organic manure source and application method on number of leaves per shoot of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	No. of leaves / shoot					
		Spring growth Cycle		Means of summer growth cycles		Autumn growth cycle	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Surface	3.3 b	3.6 c	3.2 d	3.4 d	2.0 d	2.2 d
	Trench	3.4 b	3.7 bc	3.4 d	3.7 d	2.0 d	2.2 d
Poultry	Surface	3.8 a	4.1 a	4.3 ab	4.6 ab	2.4 b	2.6 b
	Trench	3.9 a	4.2 a	4.5 a	4.8 a	2.7 a	2.9 a
Sheep	Surface	3.6 ab	3.9 abc	3.8 c	4.1 c	2.1 cd	2.3 cd
	Trench	3.7 ab	4.0 ab	4.0 bc	4.3 bc	2.3 bc	2.5 bc

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

Table (19): Effect of interaction between organic manure source and biofertilization on number of leaves per shoot of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Biofertilizer	No. of leaves / shoot					
		Spring growth cycle		Means of summer growth cycles		Autumn growth cycle	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Nitrobien	3.3 b	3.6 b	3.2 c	3.5 c	1.9 c	2.1 c
	Rhizobacterien	3.4 b	3.7 b	3.3 c	3.6 c	2.1 bc	2.3 bc
Poultry	Nitrobien	3.8 a	4.1 a	4.3 ab	4.6 ab	2.5 ab	2.7 ab
	Rhizobacterien	3.9 a	4.2 a	4.5 a	4.8 a	2.7 a	2.9 a
Sheep	Nitrobien	3.6 ab	3.9 ab	3.8 bc	4.1 bc	2.2 abc	2.4 abc
	Rhizobacterien	3.6 ab	4.0 a	4.0 ab	4.3 ab	2.3 abc	2.5 abc

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

Table (20): Effect of interaction between application method and biofertilization on number of leaves per shoot of Balady mandarin trees(2000 and 2001 seasons).

Application method	Biofertilizer	No. of leaves / shoot					
		Spring growth cycle		Means of summer growth cycles		Autumn growth cycle	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Surface	Nitrobien	3.5 a	3.8 a	3.6 a	3.9 a	2.0 a	2.2 a
	Rhizobacterien	3.6 a	3.9 a	3.8 a	4.1 a	2.3 a	2.5 a
Trench	Nitrobien	3.6 a	3.9 a	3.9 a	4.2 a	2.3 a	2.5 a
	Rhizobacterien	3.7 a	4.0 a	4.0 a	4.3 a	2.4 a	2.6 a

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

As for the interaction between the three studied factors namely organic manure source, method of organic manure application and biofertilization, **Table (21)** demonstrates that organic manure source had the upper hand on interaction net, where all combinations of poultry manure produced nearly similar and higher positive effect on number of developed leaves per shoot of spring, summer and autumn growth cycles followed descendingly in typical manner by those of sheep manure and finally by the corresponding ones of cattle manure.

4.1.5. Leaf parameters

Tables (22 – 26) show the response of some leaf parameters of Balady mandarin trees, *i.e.* leaf surface, leaf shape index, leaf chlorophyll (*a* & *b*) and leaf dry weight to organic manure source, method of organic manure application and biofertilization as well as their interactions during 2000 and 2001 seasons.

4.1.5.1. Leaf surface area

It is clear from **Table (22)** that poultry manured trees produced more expanded leaves as compared with those given by cattle or sheep manured ones. However, the differences between cattle and sheep manure in this respect were so small to reach the significance level.

Moreover, trench manured-orange trees produced more expanded leaves than superficially manured ones.

Table (21): Effect of interaction between organic manure source, application method and biofertilization on number of leaves per shoot of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer N-fixing bacteria	No. of leaves/shoot: Spring growth cycles (2000)	Spring growth cycles (2001)	Mean of summer growth cycles (2000)	Mean of summer growth cycles (2001)	Autumn growth cycles (2000)	Autumn growth cycles (2001)
Cattle manure	Surface	Nitrobien	3.3 d	3.6 d	3.1 e	3.4 e	1.8 c	2.0 c
		Rhizobacterien	3.4 cd	3.7 cd	3.2 de	3.5 de	2.2 abc	2.4 abc
	Trench	Nitrobien	3.4 bcd	3.7 bcd	3.4 cde	3.7 cde	2.0 bc	2.2 bc
		Rhizobacterien	3.5 bcd	3.8 bcd	3.5 bcde	3.8 bcde	2.1 abc	2.3 abc
Poultry manure	Surface	Nitrobien	3.8 abc	4.1 abc	4.2 abc	4.5 abc	2.3 abc	2.5 abc
		Rhizobacterien	3.9 ab	4.2 ab	4.4 ab	4.7 ab	2.6 ab	2.8 ab
	Trench	Nitrobien	3.9 ab	4.2 ab	4.4 ab	4.7 ab	2.7 ab	2.9 ab
		Rhizobacterien	4.0 a	4.3 a	4.6 a	4.9 a	2.8 a	3.0 a
Sheep manure	Surface	Nitrobien	3.6 abcd	3.9 abcd	3.7 abcde	4.0 abcde	2.1 abc	2.3 abc
		Rhizobacterien	3.6 abcd	4.0 abcd	3.9 abcde	4.2 abcde	2.2 abc	2.4 abc
	Trench	Nitrobien	3.7 abcd	4.0 abcd	3.9 abcde	4.2 abcde	2.3 abc	2.5 abc
		Rhizobacterien	3.7 abcd	4.0 abcd	4.1 abcd	4.4 abcd	2.4 abc	2.6 abc

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

Table (22): Specific effect of organic manure source, application method and biofertilization on some leaf parameters of Balady mandarin trees(2000 and 2001 seasons).

Factor	Leaf surface area (cm^2)		Leaf shape index (L/W)		Leaf chlorophyll (mg/L) (a)		Leaf chlorophyll (mg/L) (b)		Leaf dry weight (g)	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source										
Cattle manure	4.40 c	4.42 b	2.81 a	2.83 a	57.70 b	59.70 b	32.97 c	30.92 c	0.109 a	0.113 a
Poultry manure	4.56 a	4.58 a	2.84 a	2.82 a	63.25 a	65.25 a	39.40 a	37.15 a	0.120 a	0.123 a
Sheep manure	4.45 b	4.48 b	2.82 a	2.81 a	60.08ab	61.99ab	36.45 b	34.62 b	0.114 a	0.118 a
b. Effect of application m :thod										
Surface	4.44 b	4.47 b	2.83 a	2.82 a	58.47 a	61.41 a	35.49 a	33.30 b	0.112 a	0.116 a
Trench	4.50 a	4.52 a	2.83 a	2.83 a	61.22 a	63.22 a	37.05 a	35.16 a	0.117 a	0.121 a
c. Effect of biofertilization										
Nitrobien	4.45 b	4.48 b	2.83 a	2.82 a	59.68 a	61.63 a	35.92 a	33.92 a	0.112 a	0.115 a
Rhizobacterien	4.49 a	4.51 a	2.83 a	2.82 a	61.00 a	63.00 a	36.63 a	34.54 a	0.117 a	0.121 a

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

Furthermore, Rhizobacterien-inoculated trees produced more expanded leaves as compared with those resulted from Nitrobien-inoculated ones.

On the other hand, the interaction between organic manure and method of organic manure application reveals that poultry manure applied particularly in trenches or superficially exerted the highest positive effect on leaf surface area of Balady mandarin trees in both seasons, **(Table, 23).** Other studied interactions gave nearly more or less similar values in this respect.

In addition, **Table (24)** illustrates that the interaction between organic manure source and biofertilization took nearly the same trend of interaction between organic manure source and method of organic manure application, hence poultry manured trees, inoculated with Rhizobacterien, followed descendingly by poultry manured, inoculated with Nitrobien produced the most expanded leaves. Combination of cattle and sheep manure induced statistically similar effect in this respect, except for cattle manure applied superficially which showed the lowest leaf surface area values from the statistical standpoint.

Furthermore, trench application of organic manure associated with Rhizobacterien-inoculation exerted the highest stimulative effect on leaf surface area, followed descendingly by those provided with Nitrobien **(Table, 25).** Besides, the application of organic manure superficially and supporting with Rhizobacterien enhanced leaf surface area rather than the association with Nitrobien inoculation.

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other

Table (23): Effect of interaction between organic manure source and application method on some leaf parameters of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Leaf surface area (cm^2)		Leaf shape index (L/W)		Leaf chlorophyll (mg/L) (a)		Leaf chlorophyll (mg/L) (b)		Leaf dry weight (g)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Surface	4.38 d	4.41 e	2.83 a	2.83 a	56.85 c	58.85 d	32.18 d	30.10 d	0.105 b	0.108 a
	Trench	4.42 cd	4.44 de	2.83 a	2.84 a	58.55 bc	60.55 cd	33.75 cd	31.75 cd	0.114 ab	0.118 ab
Poultry	Surface	4.51 b	4.53 b	2.85 a	2.81 a	62.00 ab	64.00 ab	38.65 ab	36.15 ab	0.119 ab	0.122 ab
	Trench	4.61 a	4.63 a	2.84 a	2.83 a	64.50 a	66.50 a	4.015 a	38.15 a	0.122 a	0.124 a
Sheep	Surface	4.44 c	4.47 cd	2.83 a	2.81 a	59.55 bc	61.38 bcd	35.65 bcd	33.65 bc	0.113 ab	0.117 ab
	Trench	4.46 c	4.49 c	2.82 a	2.82 a	60.60 b	62.60 bc	37.25 abc	35.58 ab	0.116 ab	0.119 ab

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

Table (24): Effect of interaction between organic manure source and biofertilization on some leaf parameters of Balady mandarin trees(2000 and 2001 seasons).

Organic manure Source	Biofertilizer	Leaf surface area (cm^2)		Leaf shape index (L/W)		Leaf chlorophyll (mg/L) (a)		Leaf chlorophyll (mg/L) (b)		Leaf dry weight (g)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Nitrobien	4.39 e	4.42 e	2.83 a	2.83 a	57.30 b	59.30 b	32.60 c	30.60 c	0.104 b	0.107 b
	Rhizobacterien	4.41 de	4.43 de	2.82 a	2.84 a	58.10 b	60.10 b	33.33 bc	31.25 bc	0.115 ab	0.119 ab
Poultry	Nitrobien	4.53 b	4.56 b	2.84 a	2.88 a	62.25 ab	64.25 ab	39.15 a	37.15 a	0.119 a	0.122 a
	Rhizobacterien	4.59 a	4.61 a	2.84 a	2.82 a	64.25 a	66.25 a	39.65 a	37.15 a	0.122 a	0.124 a
Sheep	Nitrobien	4.44 cd	4.47 cd	2.82 a	2.82 a	59.50 ab	61.33 ab	36.0 abc	34.00 ab	0.113 ab	0.116 ab
	Rhizobacterien	4.47 c	4.49 c	2.83 a	2.81 a	60.65 ab	62.65 ab	36.90 ab	35.23 a	0.116 ab	0.120 ab

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

Table (25): Effect of interaction between application method of organic manure and biofertilization on some leaf parameters of Balady mandarin trees(2000 and 2001 seasons).

Application method	Biofertilizer	Leaf surface area (cm^2)		Leaf shape index (L/W)		Leaf chlorophyll (mg/L) (a)		Leaf chlorophyll (mg/L) (b)		Leaf dry weight (g)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Surface	Nitrobien	4.43 c	4.46 c	2.83 a	2.82 a	59.00 a	60.89 a	35.00 a	33.00 a	0.108 a	0.111 a
	Rhizobacterien	4.46 bc	4.48 bc	2.84 a	2.82 a	59.93 a	61.93 a	35.99 a	33.60 a	0.116 a	0.120 a
Trench	Nitrobien	4.48 b	4.50 ab	2.83 a	2.83 a	60.37 a	62.37 a	36.83 a	34.83 a	0.116 a	0.119 a
	Rhizobacterien	4.52 a	4.54 a	2.82 a	2.83 a	62.07 a	62.07 a	37.27 a	35.49 a	0.119 a	0.122 a

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

combinations (cattle and sheep) in enhancing leaf surface area with the superiority of trench application on the expense of surface application and Rhizobacterien inoculation on the expense of Nitrobien inoculation. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 26).**

4.1.5.2. Leaf shape index

It is clear from **Tables (22 – 26)** that neither the three tested factors (organic manure sources, method of organic manure application and biofertilizer) levelly nor their different combinations succeeded in exerting a distinctive effect on leaf shape index of Balady mandarin trees.

4.1.5.3. Leaf chlorophyll (*a* & *b*)

Table (22) shows that leaves of poultry manured trees had the highest values of chlorophyll *a* & *b*, followed descendingly by those of sheep manured ones and finally those of cattle manured trees. However, the differences between the three organic manure sources in this respect were obvious to be significant at 5% level.

Furthermore, method of organic manure application failed to induce and positive effect on leaf chlorophyll *a* & *b* of Balady mandarin trees in both seasons.

Additionally, biofertilization failed to induce any positive effect on leaf chlorophyll *a* & *b* of Balady mandarin trees in both seasons.

Table (26): Effect of interaction between organic manure source, application method of organic manure and biofertilization on some leaf parameters of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer N-fixing bacteria	Leaf surface area (cm^2)		Leaf shape index (L / W)		Leaf chlorophyll (mg/L) (a)		(b)		Leaf dry weight (g)	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	Nitrobien	4.37 g	4.40 g	2.83 a	2.82 a	56.50 b	58.50 b	31.70 d	29.70 e	0.095 b	0.098 b
		Rhizobacterien	4.40 fg	4.42 fg	2.83 a	2.83 a	57.20 b	59.20 b	32.67 cd	30.50 de	0.115 a	0.119 a
	Trench	Nitrobien	4.41 efg	4.44 efg	2.84 a	2.84 a	58.10 ab	60.10 ab	33.50 bcd	31.50 cde	0.114 a	0.117 a
		Rhizobacterien	4.43 defg	4.45 defg	2.81 a	2.84 a	59.00 ab	61.00 ab	34.00 bcd	32.00 cde	0.115 a	0.119 a
Poultry manure	Surface	Nitrobien	4.49 cd	4.52 cd	2.85 a	2.81 a	61.50 ab	63.50 ab	38.30 ab	36.30 abc	0.118 a	0.121 a
		Rhizobacterien	4.53 bc	4.55 bc	2.84 a	2.82 a	62.50 ab	64.50 ab	39.00 ab	36.00 abc	0.120 a	0.124 a
	Trench	Nitrobien	4.58 b	4.60 b	2.84 a	2.83 a	63.00 ab	65.00 ab	40.00 a	38.00 ab	0.120 a	0.123 a
		Rhizobacterien	4.65 a	4.67 a	2.84 a	2.83 a	66.00 ab	68.00 a	40.00 a	38.30 a	0.125 a	0.125 a
Sheep manure	Surface	Nitrobien	4.43 defg	4.46 defg	2.82 a	2.82 a	59.00 ab	60.67 ab	35.00 abcd	33.00 bcde	0.112 ab	0.115 ab
		Rhizobacterien	4.46 cdef	4.48 cdef	2.84 a	2.80 a	60.10 ab	62.10 ab	36.30 abcd	34.30 abcde	0.115 a	0.119 a
	Trench	Nitrobien	4.45 def	4.48 cdef	2.83 a	2.81 a	60.00 ab	62.00 ab	37.00 abcd	35.00 abcd	0.115 a	0.118 a
		Rhizobacterien	4.48 cde	4.50 cde	2.81 a	2.83 a	61.20 ab	63.20 ab	37.50 abc	36.17 abc	0.117 a	0.121 a

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

On the other hand, **Table (23)** reveals that poultry manure when applied in trenches gave the highest values of leaf chlorophyll *a* & *b*, followed by superficial application. Besides, the combinations of sheep manure surpassed cattle manure in enhancing leaf chlorophyll *a* & *b* with the superiority to trench application.

Furthermore, **Table (24)** shows that poultry manure provided with Rhizobacterien proved to be the most efficient interaction in improving leaf chlorophyll *a* & *b*, followed by poultry manure supported with Nitrobien. Besides, sheep manure combinations surpassed cattle manure combination with the superiority to Rhizobacterien inoculation.

On the other hand, trench application of organic manure provided with Rhizobacterien or Nitrobien exerted more positive effect on leaf chlorophyll *a* & *b* than did surface application supported with Rhizobacterien or Nitrobien inoculation **(Table, 25)**.

Finally, the interaction between the three studied factors **(Table, 26)** demonstrates that the combinations of poultry manure gave the highest values of leaf chlorophyll *a* & *b* with the superiority in the side of trench application and Rhizobacterien inoculation. Besides, the interactions of sheep manure surpassed the corresponding ones of cattle manure with the superiority to trench and Rhizobacterien inoculation.

4.1.5.4. Leaf dry weight

It is clear that leaves of poultry and sheep manured trees had similarly higher values of dry weight than those produced by cattle manured ones, **(Table, 22)**.

Furthermore, neither the method of organic manures application (trench and surface) nor the biofertilization type (Rhizobacterien and Nitrobien) induced distinctive and remarkable effect on leaf dry weight of Balady mandarin trees.

As for the interaction between organic manure source and method of organic manure application, **Table (23)** reveals that the combination of poultry in trenches exerted higher positive effect on leaf dry weight as compared with those arised from cattle manure applied superficially. Besides, sheep manure combination had intermediate values between other testes of study.

Furthermore, the interaction between organic manure source and biofertilization illustrates that poultry manured trees provided with Rhizobacterien and Nitrobien gave similar and higher values of leaf dry weight as compared with cattle manure x Nitrobien in both seasons of study. Besides, sheep manure combination had intermediate values between other tested interaction, **(Table, 24).**

Additionally, **Table (25)** reveals that when the method of organic manure application interacted with biofertilization, it failed to add an additional remarkable effect on leaf dry weight of Balady mandarin trees.

Finally, the interaction between the three studied factors (organic manure source, method of organic manure application and biofertilization) reveals that all studied interactions induced nearly similar and higher values of leaf dry weight as compared with cattle manure applied superficially and supported with Rhizobacterien in both seasons of study **(Table, 26)**.

Conclusively, poultry sheep manure proved to be the most efficient organic manure source in enhancing tree growth of

Balady mandarin trees expressed as the longest growth cycles duration, the highest growth cycles intensity, the longest shoots of different growth cycles, the highest number of leaves per shoot of different growth cycles, the largest leaf surface area, the richest leaves in chlorophyll (a & b) content and the heaviest leaf dry weight. Cattle manure induced the least positive effect, whereas sheep manure exerted intermediate effect in this concern.

Moreover, trench application of organic manure surpassed surface application in improving the previously mentioned tree growth parameters.

Furthermore, Rhizobacterien-inoculated trees showed better growth and higher values of the studied growth parameters as compared with Nitrobien-inoculation.

The enhancement in tree growth due to organic manure in general and poultry manure in particular, may be attributed to the fact that manures often improve the structure of soil; they may do this directly through their action as bulky diluents in compacted soils, or indirectly when the waste products of animals or micro-organisms cement soil particles together. These structural improvements increase the amount of water useful to crops that soils can hold; they also improve aeration and drainage and encourage good root growth by providing enough pores of the right sizes and preventing the soil becoming too rigid when dry or completely waterlogged and devoid of air when wet. Consequently, the positive effects of organic manure on growth may be due to: (1) its prospective physical effects on soil conditions, (2) the nutrients it supplies and (3) the way it supplies the nutrients. Besides, poultry manure is characterized by containing twice as much nitrogen as

farmyard manure, they are much richer in phosphorus and contains as much potassium as farmyard manure, **(Cooke, 1982).** Moreover, **Li *et al.* (1998)** pointed out that organic manure increased the soil content of IAA and cytokinins and stimulated plant growth.

On the other hand, the enhancement of tree growth due to trench application of organic manure rather than surface application may be due to the fact that the uric acid in fresh manure is decomposed by micro-organisms to give ammonia, which is easily lost if the manure is exposed **(Cooke, 1982).** Losses of nitrogen by volatilization, of course, will still unless the manure is plowed under or disked in immediately **(Tisdale and Nelson, 1956).**

Furthermore, the improvement of tree growth as a result of biofertilization may be due to the production of growth regulators as well as to N-fixation **(Rao and Dass, 1989).**

The results of organic manure source in enhancing tree growth are confirmed by the findings of **Mukherjee *et al.* (1983)** on jack fruit, **Sekiya *et al.* (1983)** on apple, **Darfeld and Lenz (1985)** on pear, **Pil'Shchikov (1986)** on apple, **Villasurda and Baluyut (1990)** on guava, **Awad *et al.* (1993)** on olive, **Li *et al.* (1993)** on pummelo, **Smith (1994)** on banana, **Abou-Sayed-Ahmed (1997)** on pear, **Li *et al.* (1998)** on apple, **Takahashi *et al.* (1998)** on mulberry, **Ashinov and Bekanov (1999)** on plum, cherry, peach, apricot and wild cherry, **El-Kobbia (1999)** on Balady mandarin, **Grassi *et al.* (1999)** on Rangpur lime seedlings and recently **Moustafa (2002)** on Washington navel orange trees. They concluded that leaf surface area, leaf fresh and dry weights as well as photosynthetic pigment content, *i.e.* chlorophyll *a* and *b*, total chlorophyll and carotene were superior with organic manure particularly poultry and cattle manure.

On the other hand, the results of organic manure application method in this respect go in line with the reports of **Makhmadbekov *et al.* (1984)** on lemon and **Fisun and Kodzokov (1991)** on plum and **Moustafa (2002)** on Washington navel orange.

Furthermore, positive effect of tested biofertilizers on tree growth are in harmony with the findings of **Ball *et al.* (1983)** on groundnut, **Nagarajan *et al.* (1989)** on mulberry, **Haggag and Azzozy (1996)** on mango, **Ahmed *et al.* (1997)** on grapevines, **Sharma and Bhutani (1998)** on apple, **Fernandez *et al.* (1998)** on banana, **Mansour (1998)** on Anna apple, **Wange and Ranawade (1998)** on grape, **Mahmoud and Mahmoud (1999)** on peach and **Moustafa (2002)** on Washington navel orange. They showed that biofertilizers, *i.e.* Rhizobacterien and Nitrobien caused material improvement in shoot length, leaf-area and cane thickness.

4.2. Leaf mineral content

Leaf mineral content (N, P, K, Ca, Mg, Fe, Zn, Mn and Cu) of Balady mandarin trees during 2000 and 2001 seasons in response to organic manure source (cattle, poultry and sheep), method of organic manure application (surface and trench) and biofertilization (Rhizobacterien and Nitrobien) as well as their interactions is reported in **Tables (27 -36).**

4.2.1. Nitrogen

It is clear from **Table (27)** that leaves of poultry manured trees had higher values of nitrogen content (2.68 & 2.67%) as compared with those manured with cattle (2.44 & 2.40%) in the first and second seasons, respectively. Besides, leaves of sheep

manured trees scored inbetween values of nitrogen content (2.56 & 2.54%) in 2000 and 2001 seasons, respectively. Anyhow, the differences between the three studied organic manure sources in this regard were obvious to be significant.

In addition, the application of the three studied organic manure sources in trenches induced higher positive effect on leaf nitrogen content rather than superficial application **(Table,27).**

Furthermore, fertilizing Balady mandarin trees with Rhizobacterien improved leaf nitrogen content rather than the inoculation with Nitrobien.

Moreover, the interaction between organic manure source and method of organic manure application demonstrates that leaf nitrogen content showed more response to organic manure source rather than to method of organic manure application, hence poultry manure applied firstly in trenches and/or secondly superficially induced the highest positive effect on leaf nitrogen content, followed descendingly by the combinations of sheep manure and lastly by the interactions of cattle manure **(Table, 28).**

Additionally, **Table (29)** indicates that leaf nitrogen content responded largely to organic manure source rather than biofertilizers, where poultry manured trees supported firstly with

Table (27): Specific effect of organic manure source, application method and biofertilization on leaf N, P, K, Ca and Mg content of Balady mandarin trees(2000 and 2001 seasons).

Factor	Elements concentration in dried leaves (%)									
	Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source										
Cattle manure	2.44 c	2.40 c	0.135 a	0.136 a	0.745 c	0.750 c	3.1 c	3.1 c	0.33 c	0.35 c
Poultry manure	2.68 a	2.67 a	0.141 a	0.141 a	1.029 a	1.037 a	4.0 a	4.2 a	0.52 a	0.53 a
Sheep manure	2.56 b	2.54 b	0.140 a	0.139 a	0.892 b	0.905 b	3.4 b	3.4 b	0.43 b	0.45 b
b. Effect of application method										
Surface	2.55 b	2.52 b	0.138 a	0.138 a	0.871 b	0.876 b	3.4 b	3.4 b	0.41 b	0.42 b
Trench	2.58 a	2.56 a	0.139 a	0.140 a	0.906 a	0.917 a	3.6 a	3.7 a	0.45 a	0.46 a
c. Effect of biofertilization										
Nitrobien	2.53 b	2.51 b	0.138 a	0.138 a	0.867 b	0.876 b	3.3 b	3.4 b	0.41 b	0.43 b
Rhizobacterien	2.59 a	2.57 a	0.140 a	0.140 a	0.910 a	0.918 a	3.6 a	3.7 a	0.45 a	0.46 a

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

Table (28): Effect of interaction between organic manure source and application method on leaf N, P, K, Ca and Mg content of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Elements concentration in dried leaves (%)									
		Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Surface	2.44 d	2.39 f	0.136 a	0.135 a	0.725 f	0.730 f	3.1 c	3.0 d	0.31 f	0.33 f
	Trench	2.44 d	2.42 e	0.135 a	0.138 a	0.765 e	0.770 e	3.1 c	3.2 d	0.35 e	0.37 e
Poultry	Surface	2.66 b	2.64 b	0.140 a	0.141 a	1.020 b	1.025 b	3.8 ab	4.0 b	0.50 b	0.52 b
	Trench	2.71 a	2.70 a	0.143 a	0.141 a	1.038 a	1.048 a	4.3 a	4.5 a	0.45 a	0.55 a
Sheep	Surface	2.55 c	2.53 d	0.140 a	0.138 a	0.870 d	0.875 d	3.4 bc	3.5 c	0.42 d	0.44 d
	Trench	2.28 c	2.56 c	0.140 a	0.140 a	0.915 c	0.935 c	3.4 bc	3.5 c	0.44 c	0.46 c

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

Table (29): Effect of interaction between organic manure source and biofertilization on leaf N, P, K, Ca and Mg content of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Biofertilizer	Elements concentration in dried leaves (%)									
		Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle →	Nitrobien	2.43 d	2.39 e	0.135 a	0.136 a	0.720 c	0.725 c	3.0 e	3.0 f	0.31 f	0.33 f
	Rhizobacterien	2.45 d	2.42 e	0.136 a	0.136 a	0.770 c	0.775 c	3.1 de	3.2 e	0.35 e	0.37 e
Poultry →	Nitrobien	2.64 b	2.62 b	0.140 a	0.140 a	1.003 a	1.008 a	3.8 b	4.0 b	0.50 b	0.52 b
	Rhizobacterien	2.73 a	2.71 a	0.143 a	0.143 a	1.055 a	1.065 a	4.3 a	4.4 a	0.55 a	0.56 a
Sheep →	Nitrobien	2.54 c	2.52 d	0.140 a	0.138 a	0.880 b	0.895 d	3.3 cd	3.4 d	0.42 d	0.44 d
	Rhizobacterien	2.59 bc	2.57 c	0.140 a	0.140 a	0.905 b	0.915 b	3.4 c	3.5 c	0.44 c	0.46 c

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

Rhizobacterien or secondly with Nitrobien scored the highest values of leaf nitrogen content, followed descendingly by those of sheep manure and lastly by the combinations of cattle manure.

Moreover, **Table (30)** reveals that the application of organic manure in trenches and Rhizobacterien fertilization proved to be most efficient interaction in enhancing leaf nitrogen content of Balady mandarin trees. Other tested combinations induced similar effect on leaf nitrogen content from the statistical standpoint.

Finally, the interaction between organic manure source, method of organic manure application and biofertilization shows that the interactions of poultry manure, particularly when poultry manure applied in trenches and supported with Rhizobacterien induced the highest positive effect on leaf nitrogen content. On the contrary, the combinations of cattle manure exerted the least positive effect on leaf nitrogen content. Besides, the combinations of sheep manure occupied inbetween positions in this respect **(Table, 31)**.

4.2.2. Phosphorus

Table (27-31) demonstrates that the three studied factors *i.e.* organic manure source (cattle, poultry and sheep), method of organic manure application (surface and trench) and biofertilization alone or in different combinations failed to show any distinctive effect on leaf phosphorus content of Balady mandarin trees during 2000 and 2001 seasons.

Table (30): Effect of interaction between application method of organic manure and biofertilization on leaf N, P, K, Ca and Mg content of Balady mandarin trees(2000 and 2001 seasons).

Application method	Biofertilizer	Elements concentration in dried leaves (%)									
		Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Surface	Nitrobien	2.53 b	2.50 c	0.138 a	0.137 a	0.856 b	0.866 c	3.3 c	3.3 c	0.396 c	0.413 c
	Rhizobacterien	2.57 b	2.55 b	0.138 a	0.138 a	0.886 b	0.886 b	3.5 b	3.6 b	0.432 b	0.450 b
Trench	Nitrobien	2.54 b	2.52 bc	0.137 a	0.138 a	0.878 b	0.885 b	3.5 b	3.6 b	0.426 b	0.450 b
	Rhizobacterien	2.61 a	2.60 a	0.141 a	0.141 a	0.933 a	0.950 a	3.7 a	3.9 a	0.463 a	0.474 a

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

Table (31): Effect of interaction between organic manure source, application method and biofertilization on leaf N, P, K, Ca and Mg content of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer N-fixing bacteria	Elements concentration in dried leaves (%)									
			Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	Nitrobien	2.43 g	2.38 f	0.136 a	0.136 a	0.700 f	0.710 l	3.0 f	2.9 f	0.29 l	0.30 l
		Rhizobacterien	2.44 g	2.41 f	0.136 a	0.133 a	0.750 ef	0.750 h	3.1 ef	3.1 f	0.34 h	0.36 h
	Trench	Nitrobien	2.42 g	2.40 f	0.133 a	0.136 a	0.740 ef	0.740 h	3.1 ef	3.1 f	0.34 h	0.37 gh
		Rhizobacterien	2.47 fg	2.44 f	0.136 a	0.140 a	0.790 de	0.800 g	3.2 def	3.3 e	0.37 g	0.38 g
Poultry manure	Surface	Nitrobien	2.63 bcd	2.61 cd	0.140 a	0.140 a	1.000 ab	1.010 c	3.6 c	3.8 c	0.49 c	0.51 c
		Rhizobacterien	2.69 b	2.67 b	0.140 a	0.143 a	1.040 a	1.040 b	4.0 b	4.2 b	0.52 b	0.54 b
	Trench	Nitrobien	2.65 bc	2.64 bc	0.140 a	0.140 a	1.007 ab	1.007 c	4.0 b	4.2 b	0.51 b	0.53 b
		Rhizobacterien	2.77 a	2.76 a	0.146 a	0.143 a	1.070 a	1.090 a	4.5 a	4.7 a	0.57 a	0.57 a
Sheep manure	Surface	Nitrobien	2.53 ef	2.51 e	0.140 a	0.136 a	0.870 cd	0.880 f	3.3 cdef	3.4 de	0.41 f	0.43 f
		Rhizobacterien	2.58 cde	2.56 de	0.140 a	0.140 a	0.870 cd	0.870 f	3.4 cde	3.5 de	0.43 e	0.45 e
	Trench	Nitrobien	2.55 def	2.53 e	0.140 a	0.140 a	0.890 c	0.910 e	3.3 cdef	3.4 de	0.43 e	0.45 e
		Rhizobacterien	2.61 bcde	2.59 cd	0.140 a	0.140 a	0.940 bc	0.960 d	3.5 cd	3.6 d	0.45 d	0.47 d

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

4.2.3. Potassium

It is clear that fertilizing Balady mandarin trees with poultry manure enriched leaf potassium content (1.02 & 1.03%) as compared with those manured with sheep (0.89 & 0.90%) and cattle manured trees (0.74 & 0.75%) in 2000 and 2001 seasons, respectively. Anyhow, the differences between the three organic manure sources in this respect were obvious to be significant, **(Table, 27).**

Furthermore, the application of the three studied organic manure sources in trenches induced higher positive effect on leaf potassium content rather than superficial application **(Table, 27).**

Moreover, **Table (27)** reveals that fertilizing Balady mandarin trees with Rhizobacterien improved leaf potassium content rather than Nitrobien fertilization.

Furthermore, **Table (28)** shows that leaf potassium content responded largely to organic manure source rather than method of organic manure application, when their interactions were concerned, thereupon poultry manure whether applied superficially or in trenches induced similarly higher positive effect on leaf potassium content followed descendingly by the combinations of sheep manure and lastly the corresponding ones of cattle manure in both seasons of study.

In addition, the interaction between organic manure source and biofertilization demonstrates that the upper hand for the effect on leaf potassium content was organic manure source rather than biofertilization. Thereupon, poultry manured trees supported with Rhizobacterien or Nitrobien induced statistically

similar and higher positive effect on leaf potassium content, followed descendingly by those of sheep manure and lastly the interactions of cattle manure **(Table, 29).**

On the other side, **Table (30)** reveals that out of interactions between method of organic manure application and biofertilization. Trench application x Rhizobacterien scored statistically higher values of leaf potassium content. Other tested combinations produced similar effect on leaf potassium content from the statistical stand point in both seasons of study.

Finally, the interaction between the three studied factors *i.e.* organic manure source, method of organic manure application and biofertilization demonstrates that the interactions of poultry manure exerted similarly higher positive effect on leaf potassium content of Balady mandarin trees, followed descendingly by those of sheep manure, and lastly, the interactions of cattle manure in the first and second seasons **(Table, 31)**.

4.2.4.Calcium

It is obvious from **Table (27)** that leaves of poultry manured trees had higher values of calcium (4.0 & 4.2%) , followed by those manured with sheep (3.3& 3.4%) and lastly those of cattle manured trees (3.1 & 3.1 %) in 2000 and 2001 seasons, respectively. The differences between the three studied organic manure sources, regarding leaf calcium content were remarkable to be significant at 5% level.

In addition, the application of the three studied organic manure source in trenches induced higher positive effect on leaf nitrogen content rather than superficial application **(Table,27).**

Furthermore, inoculating Balady mandarin trees with Rhizobacterien enriched leaf calcium content rather than the inoculation with Nitrobien.

As for the interaction between organic manure source and application method of organic manure, **Table (28)** reveals that poultry manure applied firstly in trenches and secondly superficially showed to be the most efficient combinations in enhancing leaf calcium content. Bedsides, the interactions of sheep manure surpassed the corresponding ones of cattle manure in improving leaf calcium content of Balady mandarin trees in both seasons.

Regarding the interaction between organic manure source and biofertilization, **Table(29)** demonstrates that Rhizobacterien combinations surpassed Nitrobien followed descendingly by those manured with the same organic manure source and provided with Nitrobien. Besides, the combinations of sheep manure took not only the same trend, but also surpassed the analogous ones of cattle manure.

Furthermore, **Table (30)** shows that the application of organic manure in trenches provided with Rhizobacterien inoculation enhanced leaf calcium content , followed descendingly by surface application supported with Rhizobacterien. On the other hand, trench application of organic manure associated with Nitrobien inoculation surpassed surface application provided with the same biofertilizer in enhancing leaf calcium content.

Finally, **Table (31)** illustrates that the interaction between the three studied factors i.e. organic manure source, application method of organic manure and biofertilization on leaf calcium content. Briefly, poultry manure x trench application x Rhizobacterien, followed by poultry manure x trench or surface application x Rhizobacterien or Nitrobien gave the highest values of leaf calcium content. On the other side, the combinations of sheep manure surpassed the corresponding ones of cattle manure in improving leaf calcium content of Balady mandarin trees.

4.2.5. Magnesium

Table (27-31) shows that the specific effect of organic manure source, application method of organic manure and biofertilization **(Table, 27),** the interaction effect between organic manure source and application method **(Table, 28),** the interaction effect between organic manure source and biofertilization **(Table, 29),** the interaction effect between method of organic manure application and biofertilization **(Table, 30)** and the interaction effect between the three studied factors, i.e. organic manure source, method of application and biofertilization, **(Table, 31)** took nearly similar trend to that of leaf calcium content of Balady mandarin trees in 2000 and 2001 seasons.

4.2.6. Iron, Manganese and Zinc

It is obvious from **Table (32)** that leaves of poultry manured trees had the highest values of leaf Fe, Mn and Zn

Table (32): Specific effect of organic manure source, application method and biofertilization on leaf Fe, Mn, Zn, and Cu content of Balady mandarin trees(2000 and 2001 seasons).

Factor	Elements concentration in dried leaves (ppm)							
	Iron		Manganese		Zinc		Copper	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source								
Cattle manure	70 c	67 c	46 c	49 c	41 c	43 c	5 a	6 a
Poultry manure	91 a	87 a	73 a	74 a	68 a	70 a	5 a	6 a
Sheep manure	81 b	78 b	63 b	65 b	56 b	58 b	5 a	6 a
b. Effect of application method								
Surface	79 b	75 b	58 b	61 b	53 b	54 b	5 a	6 a
Trench	82 a	79 a	63 a	65 a	58 a	60 a	5 a	6 a
c. Effect of biofertilization								
Nitrobien	78 b	75 b	57b	58 b	53 b	55 b	5 a	6 a
Rhizobacterien	83 a	79 a	64 a	67a	58 a	59 a	5 a	6 a

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

content, followed descendingly by those of sheep manured ones lastly those fertilized with cattle manure. However, the differences between the three tested organic manure source in this concern were remarkable to be significant.

Furthermore, the application of organic manure in trenches enhancd leaf Fe, Mn and Zn content rather than surface application.

Moreover, inoculating Balady mandarin trees with Rhizobacterien exerted more positive effect on leaf Fe, Mn and Zn rather than Nitrobien inoculation.

Additionally, **Table (33)** reveals that the application of poultry manure firstly in trenches and secondly superficially exerted the highest stimulative effect on leaf Fe, Mn and Zn content. On the contrary, the application of cattle manure either in trenches or superficially induced the lowest values in this respect. The interactions of sheep manure occupied an intermediate position inl this sphere.

Table (34) shows that the interaction between organic manure source and biofertilization took the same trend of interaction between organic manure source and method of organic manure application regarding leaf Fe, Mn and Zn content. Thereupon, leaves of poultry manured trees in general, manured in trenches in particular or superficially were the richest ones in their content of Fe, Mn and Zn. Besides, the combinations of sheep manure induced higher positive effect on leaf Fe, Mn and Zn content as compared with those of cattle manure.

It is quite evident from **Table (35)** that the application of organic manure in trenches, provided with Rhizobacterien

Table (33): Effect of interaction between organic manure source and application method on leaf Fe, Mn, Zn, and Cu content of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Elements concentration in dried leaves (ppm)							
		Iron		Manganese		Zinc		Copper	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	68 c	65 d	44 f	46 d	38 f	40 e	5 a	6 a
	Trench	71 c	68 d	49 e	52 c	45 e	46 e	5 a	6 a
Poultry manure	Surface	89 a	84 b	69 b	73 a	66 b	68 b	5 a	6 a
	Trench	93 a	90 a	77 a	75 a	71 a	72 a	5 a	6 a
Sheep manure	Surface	80 b	77 c	61 d	64 b	54 d	56 d	5 a	6 a
	Trench	82 b	79 c	65 c	67 b	59 c	61 c	5 a	6 a

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

Table (34): Effect of interaction between organic manure source and biofertilization on leaf Fe, Mn, Zn, and Cu content of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Biofertilizer	Elements concentration in dried leaves (ppm)							
		Iron		Manganese		Zinc		Copper	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Nitrobien	67 d	64 c	43 f	45 d	38 e	40 d	5 a	6 a
	Rhizobacterien	72 d	69 c	50 e	54 c	45 d	46 c	5 a	6 a
Poultry manure	Nitrobien	88 b	85 a	69 b	67 b	66 b	68 a	5 a	6 a
	Rhizobacterien	94 a	89 a	77 a	81 a	71 a	72 a	5 a	6 a
Sheep manure	Nitrobien	80 c	77 b	61 d	63 b	55 c	57 b	5 a	6 a
	Rhizobacterien	82 c	79 b	65 c	68 b	58 c	60 b	5 a	6 a

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

Table (35): Effect of interaction between organic manure application method and biofertilization on leaf Fe, Mn, Zn, and Cu content of Balady mandarin trees(2000 and 2001 seasons).

Application method	Biofertilizer	Elements concentration in dried leaves (ppm)							
		Iron		Manganese		Zinc		Copper	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Surface	Nitrobien	77 b	74 b	55 c	58 c	51 c	52 c	5 a	6 a
	Rhizobacterien	80 b	76 b	61 b	64 b	55 b	56 b	5 a	6 a
Trench	Nitrobien	79 b	76 b	60 b	58 c	55 b	57 b	5 a	6 a
	Rhizobacterien	85 a	82 a	67 a	71 a	61 a	62 a	5 a	6 a

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

inoculated recorded the highest values of leaf Fe, Mn and Zn content. Moreover, trench application of organic manure supported with Rhizobacterien exerted similar positive effect on leaf Fe, Mn and Zn content to that of surface application of organic manure associated with Nitrobien inoculation. On the contrary, trees manured superficially and inoculated with Nitrobien had the lowest leaf Fe, Mn and Zn content.

Lastly, the interaction between organic manure source, method of organic manure application and biofertilization, **(Table, 36)** reveals that the poultry manured trees, inoculated with Rhizobactrien and fertilized in trenches in particular and/or superficially followed descendingly by the corresponding ones inoculated with Nitrobien and manured firstly in trenches and secondly superficially showed the highest values of leaf Fe, Mn and Zn content. Besides, the combinations of sheep manure proved to be more efficient in enhancing leaf Fe, Mn and Zn content than the analogous of cattle manure.

4.2.7. Copper

It is clear from **Table (32-36)** that the three studied factors, i.e. organic manure source, method of organic manure application and biofertilization whether concerned lonely or in their different studied combination failed to induce a distinctive effect on leaf copper content of Balady mandarin trees during 2000 and 2001 seasons.

Abstractly, poultry manure proved to be the superior organic manure source in enhancing leaf N, K, Ca, Mg, Fe, Mn and Zn content. Besides, the application of organic manure in

Table (36): Effect of interaction between organic manure source, application method and biofertilization on leaf Fe, Mn, Zn and Cu content of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer {N-fixing bacteria}	Elements concentration in dried leaves (PPM)							
			Iron		Manganese		Zinc		Copper	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	Nitrobien	66 g	63 g	41 g	42 f	37 g	38 g	5 a	6 a
		Rhizobacterien	71 fg	68 fg	47 f	51 ef	40 g	42 g	5 a	7 a
	Trench	Nitrobien	69 fg	66 fg	45 fg	48 ef	40 g	42 g	5 a	6 a
		Rhizobacterien	74 ef	71 ef	53 e	57 de	50 f	50 f	6 a	6 a
Poultry manure	Surface	Nitrobien	88 bc	85 bc	67 bc	70 bc	64 bc	66 bc	5 a	6 a
		Rhizobacterien	91 ab	84 bc	72 b	76 b	69 ab	70 ab	5 a	6 a
	Trench	Nitrobien	88 bc	87 b	72 b	64 cd	69 ab	70 ab	5 a	6 a
		Rhizobacterien	98 a	95 a	82 a	87 a	73 a	45 a	6 a	7 a
Sheep manure	Surface	Nitrobien	79 de	76 de	59 d	63 cd	52 ef	54 ef	5 a	6 a
		Rhizobacterien	81 cde	78 cde	63 cd	66 bcd	56 def	58 de	5 a	6 a
	Trench	Nitrobien	81 cde	78 cde	63 cd	64 cd	58 cde	60 cde	5 a	6 a
		Rhizobacterien	84 bcd	81bcd	67 bc	70 bc	61 cd	63 cd	5 a	6 a

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

trenches exerted more positive effect on leaf Ca, Mg, Fe, Mn and Zn than surface application. Moreover, Rhizobacterien inoculation surpassed Nitrobien inoculation in improving leaf N, K, Ca, Mg, Fe, Mn and Zn content .

The improvement in leaf nutrient content due to poultry manure may be explained by the fact that it induced positive effect on physical condition of the soil; creates favourable conditions for root growth and nutrients absorption; it supplies much nutrients, and it facilitates the absorption of fixed nutrients by tree roots. Besides, poultry manure contains twice as much nitrogen as farmyard manure, they are much richer in phosphorus and contain as potassium as farmyard manure **(Cook, 1982).**

Furthermore, the enhancement of leaf nutrient content due to trench application of organic manure, may be due to the fact that the incorporation of manure in the soil provided a protection against nutrients losses **(Cook, 1982).**

Briefly, the results of leaf mineral content due to organic manure source are in accordance with the findings of **Sekiya et al. (1993)** on Satsuma mandarin, **Kalu-Singh et al. (1984)** on mango. **Noack (1984)** on apple, **Darfeld and Lenz (1985)** on pear, **Umemiya and Sekiya (1985)** on persimmon, **Villasurda and Baluyut (1990)** on guava, **Ben-Ya-Acov et al. (1992)** on avocado, **Awad et al. (1993)** on olive, **Alvarez etal. (1993)** on pinapple, **Smith (1994)** on banana, **Abu-Sayed Ahmed (1997)** on Balady mandarin **El-Kobbia (1999)** on Balady mandarin and **Moustafa (2002)** on Washington navel orange . They reported

that organic manure, particularly, poultry manure enhanced leaf mineral content.

Besides, the obtained results of leaf mineral content attributed to the effect of method of organic manure application are in harmony with the findings of **Thachuk (1983)** on apple, **Bhangoo et al. (1988)** on grape, **Goede (1993)** on mango and **Moustafa (2002)** on Washington navel orange. Moreover, the results of biofertilization regarding leaf mineral content are in agreement with the findings of **Pmares et al. (1983)** on oranges, **Chokha et al. (1993)** on orange, **Haggag and Azzazy (1996)** on mango, **Ahmed et al. (1997)** on grape, **Awashi et al. (1998)** on peach, **Fernandez et al. (1998)** on banana, **Mansour (1998)** on Anna apple, **Mahmoud and Mahmoud (1999)** on peach **Tiwary et al. (1999)** on banana and **Moustafa (2002)** on Washington navel orange. They mentioned that Rhizobacterien enhanced most leaf mineral content.

4.3. Tree fruiting

Data presented in **Tables (37 – 47)** show the effect of organic manure sources, *i.e.* cattle, poultry and sheep, methods of organic manure application (surface and trench) and biofertilization (Rhizobacterien and Nitrobien) as well as their interactions on tree fruiting parameters *i.e.*, fruit set, fruit drop percentages, number of fruits per tree, yield (kg/tree) and biennial bearing index of Balady mandarin trees during 2000 and 2001 seasons.

4.3.1. Fruit set percentages

It is quite evident from **Table (37)** that poultry and sheep manured-Balady mandarin trees set higher percentages of fruits (26.92 & 24.04) and (26.92 & 24.10) respectively, and finally cattle manured (26.15 & 23.18) in 2000 and 2001 seasons, respectively. However, the differences between poultry manure and cattle manure in this respect were obvious to be significant at 5% level. On the other hand, the differences between sheep manure and both poultry and cattle manure in this concern were so small to reach the significance level.

Furthermore, the application of organic manures method in trenches surpassed superficially to set higher percentage of fruit of Balady mandarin trees in both seasons of study **(Table, 37).**

In addition, biofertilization failed to induce any significant effect on fruit set of Balady mandarin trees in both seasons.

As for the effect of interaction between organic manure source and method of application on fruit set percentages of Balady mandarin trees, **Table (38)** demonstrates that in both seasons of study, poultry manure applied in trenches gave the highest values on fruit set percentage, followed descendingly by sheep manure in trenches. On the contrary, cattle manure applied on the surface gave the lowest values in this concern.

The interaction between organic manure source and biofertilization, **(Table, 39)** failed to induce a pronounced effect on fruit set percentage from the statistical standpoint in both seasons.

Table (37): Specific effect of organic manure source, application method and biofertilization on fruit set and fruit shedding percentage of Balady mandarin trees(2000 and 2001 seasons).

Factor	Fruit set (%)		Fruit shedding(%)							
			May, 1st-May,31th		June,1st –July.1st		July,2nd –Augsut,1st		August,2nd –September,1st	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source										
Cattle manure	26.15 b	23.18 b	55.21 a	53.07 a	18.74 a	15.64 a	12.70 a	10.59 a	4.69 a	4.47 a
Poultry manure	26.92 a	24.04 a	52.94 b	50.81 b	18.38 b	15.28 b	12.30 b	10.22 b	4.30 b	4.09 b
Sheep manure	26.92 a	24.10 a	52.97 b	50.78 b	18.38 b	15.29 b	12.27 b	10.25 b	4.30 b	4.10 b
b. Effect of application method										
Surface	26.23 b	23.33 b	54.38 a	52.15 a	18.63 a	15.53 a	12.56 a	10.45 a	4.58 a	4.36 a
Trench	27.09 a	24.22 a	53.13 b	50.90 b	18.38 b	15.28 b	12.28 b	10.26 b	4.28 b	4.08 b
c. Effect of biofertilization										
Nitrobien	26.04 a	23.09 a	55.12 a	52.92 a	18.59 a	15.49 a	12.46 a	10.37 a	4.46 a	4.24 a
Rhizobacterien	27.28 a	24.46 a	52.29 b	50.18 b	18.41 b	15.32 b	12.38 a	10.34 a	4.39 a	4.20 a

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

Table (38): Effect of interaction between organic manure source and application method on fruit set and fruit shedding percentage of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Fruit set (%)		Fruit shedding(%)							
				May, 1st-May,31th		June,1st –July.1st		July,2nd –Augsut,1st		August,2nd –September,1st	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Surface	25.89 b	22.90 b	55.68 a	53.55 a	18.83 a	15.73 a	12.77 a	10.63 a	4.76 a	4.54 a
	Trench	26.40 ab	23.47 ab	54.73 ab	52.59 ab	18.66 b	15.56 b	12.63 a	10.55 ab	4.62 ab	4.40 b
Poultry	Surface	26.40 ab	23.47 ab	53.58 bc	51.47 bc	18.52 b	15.43 b	12.48 a	10.39 bc	4.49 b	4.27 c
	Trench	27.44 a	24.61 a	52.31 c	50.15 c	18.24 c	15.14 c	12.11 b	10.06 e	4.11 c	3.91 d
Sheep	Surface	26.40 ab	23.62 ab	53.58 bc	51.43 bc	18.52 b	15.43 b	12.43 ab	10.32 cd	4.48 b	4.28 c
	Trench	27.43 a	24.59 a	52.35 c	50.13 c	18.24 c	15.16 c	12.11 b	10.18 de	4.11 c	3.92 d

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

Table (39): Effect of interaction between organic manure source and biofertilization on fruit set and fruit shedding percentage of Balady mandarin trees (2000 and 2001 seasons).

Organic manure Source	Biofertilizer	Fruit set (%)		Fruit shedding(%) May, 1st-May,31th		June,1st –July.1st		July,2nd –Augsut,1st		August,2nd –September,1st	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Nitrobien	25.59 a	22.55 a	56.71 a	54.57 a	18.85 a	15.76 a	12.74 a	10.64 a	4.73 a	4.51 a
	Rhizobacterien	26.70 a	23.85 a	53.71 ab	51.57 ab	18.63 ab	15.52 ab	12.66 a	10.54 a	4.65 ab	4.43 a
Poultry	Nitrobien	26.26 a	23.38 a	54.31 ab	52.10 ab	18.46 bc	15.36 bc	12.34 a	10.26 a	4.33 bc	4.10 b
	Rhizobacterien	27.58 a	24.69 a	51.58 b	49.52 b	18.30 c	12.20 c	12.26 a	10.19 a	4.27 c	4.08 b
Sheep	Nitrobien	26.26 a	23.35 a	54.35 ab	52.10 ab	18.46 bc	12.36 bc	12.31 a	10.23 a	4.34 bc	4.12 b
	Rhizobacterien	27.58 a	24.86 a	51.59 b	49.47 b	18.30 c	15.22 c	12.22 a	10.28 a	4.26 c	4.08 b

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

Regarding the effect of interaction between method of organic manure application and biofertilization, failed to induce a pronounced effect on fruit set percentage from the statistical standpoint in both seasons,(**Table, 40).**

Regarding the interaction between organic manure source, method of organic manure application and biofertilizers, **Table (41)** indicates that nearly all the studied combinations failed to induce a pronounced effect on fruit set percentage of Balady mandarin trees from the statistical standpoint in both seasons.

4.3.2. Fruit drop percentages

Table (37) reveals that in both seasons cattle manured trees recorded higher percentages of fruit dropping during May, 1^{st} – May, 31^{st}, June, 1^{st} – July, 1^{st}, July, 2^{nd} – August, 1^{st} and August, 2^{nd} – September, 1^{st} as compared with those fertilized with poultry or sheep manure. Besides, poultry and sheep manured trees shed lesser percentages of fruits during May, 1^{st} – May, 31^{st}, June, 1^{st} – July, 1^{st}, July, 2^{nd} – August, 1^{st} and August, 2^{nd} – September, 1^{st}.

Furthermore, the application of organic manures in trenches succeeded in reducing fruit shedding during the fourth studied periods of fruit dropping, *i.e.* May, 1^{st} – May, 31^{st}, June, 1^{st} – July, 1^{st}, July, 2^{nd} – August, 1^{st} and August, 2^{nd} – September, 1^{st} as compared with surface application in both seasons.

Additionally, biofertilization in the form of Rhizobacterien surpassed Nitrobien in reducing fruit shedding

Table (40): Effect of interaction between application method of organic manure and biofertilization on fruit set and fruit shedding percentage of Balady mandarin trees(2000 and 2001 seasons).

Application method	Biofertilizer	Fruit set (%)		Fruit shedding(%)							
				May, 1st-May,31th		June,1st –July.1st		July,2nd –Augsut,1st		August,2nd –September,1st	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Surface	Nitrobien	25.63 a	22.62 a	55.15 a	53.01 a	18.70 a	15.60 a	12.58 a	10.47 a	4.60 a	4.39 a
	Rhizobacterien	26.33 a	24.03 a	53.42 ab	51.29ab	18.55 a	15.45 at	12.53 a	10.42 a	4.56 a	4.34 a
Trench	Nitrobien	26.45 a	23.57 a	55.09 a	52.84 a	18.49 a	15.39 b	12.34 a	10.27 a	4.33 ab	4.10 b
	Rhizobacterien	27.73 a	24.80 a	51.16 b	49.08 b	18.26 a	15.18 c	12.22 a	10.25 a	4.23 b	4.65 b

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

Table (41): Effect of interaction between organic manure source, application method of organic manure and biofertilizer on fruit set and fruit shedding percentage of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer {N-fixing bacteria}	Fruit set (%)		Fruit shedding(%) May, 1st-May,31th		June,1st –July.1st		July,2nd –Augsut,1st		August,2nd –September,1st	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	Nitrobien	25.28 a	22.13 a	57.20 a	55.07 a	18.95 a	15.85 a	12.81 a	10.67 a	4.81 a	4.59 a
		Rhizobacterien	26.50 a	23.67 a	54.16 ab	52.03 ab	18.70 abc	15.60 abc	12.72 a	10.59 a	4.72 ab	4.50 a
	Trench	Nitrobien	25.90 a	22.97 a	56.21 ab	54.07 ab	18.76 ab	15.66 ab	12.67 a	10.60 a	4.65 ab	4.43 a
		Rhizobacterien	26.90 a	23.97 a	53.25 ab	51.10 ab	18.55 bc	15.45 bc	12.59 a	10.49 a	4.59 abc	4.37 a
Poultry manure	Surface	Nitrobien	25.80 a	22.87 a	54.12 ab	51.93 ab	18.57 bc	15.47 bc	12.49 a	10.39 a	4.49 abc	4.28 ab
		Rhizobacterien	27.00 a	24.07 a	53.05 ab	51.00 ab	18.48 bcd	15.38 bcd	12.46 a	10.38 a	4.50 abc	4.27 ab
	Trench	Nitrobien	26.72 a	23.90 a	54.49 ab	52.27 ab	18.35 cd	15.25 cd	12.18 a	10.12 a	4.18 bc	3.93 b
		Rhizobacterien	28.15 a	25.32 a	50.12 b	48.03 b	18.12 d	15.02 d	12.05 a	10.00 a	4.05 c	3.90 b
Sheep manure	Surface	Nitrobien	25.80 a	22.87 a	54.12 ab	52.03 ab	18.57 bc	15.47 bc	12.45 a	10.35 a	4.50 abc	4.30 ab
		Rhizobacterien	27.00 a	24.37 a	53.05 ab	50.83 ab	18.48 bcd	15.38 bcd	12.40 a	10.30 a	4.47 abc	4.27 ab
	Trench	Nitrobien	26.72 a	23.83 a	54.57 ab	52.17 ab	18.35 cd	15.25 cd	12.18 a	10.10 a	4.18 bc	3.95 b
		Rhizobacterien	28.15 a	25.35 a	50.12 b	48.10 b	18.12 d	15.07 d	12.03 a	10.27 a	4.05 c	3.90 b

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

during the May, 1st – May, 31st and June, 1st – July, 1st of fruit dropping in 2000 and 2001 seasons **(Table, 37).**

Concerning the effect of interaction between organic manure source and method of application, **Table (38)** demonstrates that in general, the application of poultry and sheep manure either superficially or in trenches induced nearly similar and negative effect on fruit dropping during May, 1st – May, 31st , June, 1st – July, 1st , July, 2nd – August, 1st and August, 2nd – September, 1st as compared with cattle manure when applied superficially in both seasons.

As for the effect of interaction between organic manure source and biofertilization, it is clear from **Table (39)** that in both seasons cattle manured trees whether inoculated with Rhizobacterien and Nitrobien shed comparatively higher percentages of fruits as compared with other tested combinations during May, 1st , May, 31st , June, 1st – July, 1st , July, 2nd – August, 1st and August, 2nd – September, 1st. On the other hand, other tested interactions induced relatively similar effect in this respect during most studied periods.

Table (40) shows that the interaction between method of organic manure application and biofertilization failed to induce an obvious trend regarding their effect on fruit drop percentage during May, 1st – May, 31st , June, 1st – July, 1st , July, 2nd – August, 1st and August, 2nd – September, 1st in both seasons of study.

Additionally, the interaction between organic manure source, method of organic manure application and biofertilization shows that cattle manured-trees applied superficially or in trenches and supported with Rhizobacterien or

Nitrobien recorded higher values of fruit shedding during the three studied periods *i.e.* May, 1st – May, 31st , June, 1st – July, 1st , July, 2nd – August, 1st and August, 2nd – September, 1st. Besides, other tested combinations namely, poultry and sheep manure whether applied superficially or in trenches and supported with Rhizobacterien or Nitrobien exerted nearly similar effect on fruit shedding during the studied *i.e.* periods May, 1st – May, 31st , June, 1st – July, 1st , July, 2nd – August, 1st and August, 2nd – September, 1st.

4.3.3. No. of fruits/tree

Table (42) indicates that in both seasons, the three studied organic manure sources *i.e.* cattle, poultry and sheep exerted statistically similar effect on number of produced fruits per tree.

Furthermore, application method of organic manure in trenches gave the highest remarkable positive effect on number of produced fruit per tree in the second season (2001).

Moreover, biofertilization exerted statistically similar effect on number of produced fruits per tree in both seasons of study.

Furthermore, **Table (43)** shows that out of all interactions between organic manure source and method of organic manure application, poultry manure applied in trenches gave the highest remarkable positive effect on number of produced fruits/tree in the second season (2001).

In addition, **Table (44)** reveals that the interactions between organic manure source and biofertilization failed to show a distinctive trend in number of fruits/tree in both seasons.

Table (42): Specific effect of organic manure source, application method and biofertilization on fruiting of Balady mandarin trees(2000 and 2001 seasons).

Factor	No. of fruits/ tree		Yield (kg)/ tree	
	(2000)	(2001)	(2000)	(2001)
		a. Effect of organic manure source		
Cattle manure	349 a	141 a	49.33 b	19.41 b
Poultry manure	355 a	162 a	54.25 a	24.25 a
Sheep manure	354 a	154 a	51.69 ab	22.11 ab
		b. Effect of application method		
Surface	349 a	148 b	51.02 a	21.08 b
Trench	351 a	156 a	52.49 a	22.76 a
		c. Effect of biofertilization		
Nitrobien	347 a	146 a	50.90 a	20.90 a
Rhizobacterien	357 a	158 a	52.61 a	22.94 a

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

Table (43): Effect of interaction between organic manure source and application method on some fruiting parameters of Balady mandarin trees (2000 and 2001 seasons).

Organic manure source	Application method	No. of fruits/ tree		Yield (kg)/ tree	
		(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	350 a	143 cd	19. 59 c	49.39 b
	Trench	347 a	139 d	19.26 c	49.26 b
Poultry manure	Surface	346 a	150 bc	22.01 b	52.01 b
	Trench	363 a	174 a	26.48 a	56.48 a
Sheep manure	Surface	350 a	152 bc	21.67 b	51.67 b
	Trench	357 a	156 b	22.35 b	51.72 b

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

Table (44): Effect of interaction between organic manure source and biofertilization on some fruiting parameters of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Biofertilizer	No. of fruits/ tree		Yield (kg)/ tree	
		(2000)	(2001)	(2000)	(2001)
Cattle manure	Nitrobien	342 a	132 a	48.22 b	18.22 b
	Rhizobacterien	355 a	149 a	50.43 ab	20.60 ab
Poultry manure	Nitrobien	350 a	155 a	53.01 ab	23.01 ab
	Rhizobacterien	359 a	169 a	55.48 a	25.48 a
Sheep manure	Nitrobien	350 a	151 a	51.47 ab	21.48 ab
	Rhizobacterien	358 a	157 a	51.91 ab	22.74 ab

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

It is obvious from **Table (45)** that all interactions between method of organic manure application and biofertilization failed to induce any positive effect on number of fruits/tree in both seasons.

Table (46) demonstrates that the interaction between organic manure source, method of organic manure application and biofertilization failed to induce any positive effect on number of fruits/tree in both seasons.

4.3.4. Yield (kg)/tree

It is quite evident from **Table (42)** that poultry manure resulted in increasing tree yield as compared with those manured with cattle manure in 2000 and 2001 seasons. Besides, sheep manure induced an intermediate values in this respect.

Moreover, trench application of organic manure surpassed the superficial in enhancing yield in both seasons of study.

Furthermore, the application of the two studied biofertilizers namely Rhizobacterien and Nitrobien scored statistically similar values of tree yield in the first and second seasons.

In addition, the interaction between organic manure source and method of organic manure reveals that out of all studied interactions poultry manure applied in trenches showed distinctive and higher values of tree yield in both seasons. On the contrary, cattle manure whether applied in trenches or superficially recorded the lowest values of tree yield . The

Table (45): Effect of interaction between application method of organic manure and biofertilization on some fruiting parameters of Balady mandarin trees(2000 and 2001 seasons).

Application method	Biofertilizer	No. of fruits/ tree		Yield (kg)/ tree	
		(2000)	(2001)	(2000)	(2001)
Surface	Nitrobien	342 a	140 a	49.88 a	19.88 a
	Rhizobacterien	356 a	157 a	52.17 a	22.28 a
Trench	Nitrobien	352 a	152 a	51.92 a	21.92 a
	Rhizobacterien	359 a	160 a	53.05 a	23.61 a

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

Table (46): Effect of interaction between organic manure source, application method and biofertilization on fruiting of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer {N-fixing bacteria}	No. of fruit / tree (2000)	No. of fruit / tree (2001)	Yield (Kg) / tree (2000)	Yield (Kg) / tree (2001)
Cattle manure	Surface	Nitrobien	342 a	133 a	48.27 b	18.27 b
		Rhizobacterien	358 a	153 a	50.51 ab	20.84 ab
	Trench	Nitrobien	342 a	132 a	48.16 b	18.16 b
		Rhizobacterien	353 a	146 a	50.36 ab	20.36 ab
Poultry manure	Surface	Nitrobien	340 a	142 a	50.65 ab	20.65 ab
		Rhizobacterien	353 a	159 a	50.37 ab	23.37 ab
	Trench	Nitrobien	360 a	168 a	55.37 ab	25.37 ab
		Rhizobacterien	366 a	180 a	57.60 a	27.50 a
Sheep manure	Surface	Nitrobien	344 a	145 a	50.71 ab	20.71 ab
		Rhizobacterien	357 a	159 a	52.62 ab	22.62 ab
	Trench	Nitrobien	355 a	157 a	52.24 ab	22.24 ab
		Rhizobacterien	358 a	155 a	51.19 ab	22.86 ab

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

combinations of sheep manure showed inbetween values in this respect **(Table, 43)**.

Table (44) demonstrates that the interaction between organic manure source and biofertilization exerted that poultry manure provided with Rhizobacterien proved to be the most effective combination in enhancing tree productivity of Balady mandarin. On the contrary, cattle manure interactions showed to be the lowest effective combination in this concern. Besides, other studied interactions produced an intermediate effect on tree yield in both seasons of study.

It is obvious from **Table (45)** that out of all interactions between method of organic manure application and biofertilization failed to induce any positive effect on tree yield in both seasons.

Finally, the interaction between organic manure source, method of application and biofertilization, indicates that out of the tested combinations, poultry manure applied in trenches and supported with Rhizobacterien showed a remarkable and higher positive effect on number of produced fruits per tree compared with cattle manure applied in (surface or trench) supported with Nitrobien. Other tested interactions gave statistically similar values in this respect.

Abstractly, poultry manure proved to be the most efficient organic manure source in enhancing tree fruiting of Balady mandarin trees, hence it increased fruit set percentage, reduce fruit dropping waves and improved tree yield (No. of fruits/tree and yield (kg)/tree). Besides, trench application of organic manure reduced the waves of fruit dropping as compared with

surface application. Moreover, Rhizobacterien inoculation enhanced fruit set percentage and reduced fruit shedding percentage as compared with Nitrobien inoculation.

The enhancement of tree productivity as a result of using organic manure in general and poultry manure in particular may be due to the following facts (1) manure improves soil physical conditions, (2) it creates more favourable conditions for plant growth and nutrient absorption, (3) it supplies much higher nutrient elements with poultry manure, (4) it releases much more or less available elements (particularly, P, Fe, Zn, and Mn), (5) it increases the soil content of IAA and cytokinins **(Li et al, 1998).**

In addition the improvement of tree fruiting as a result of biofertilization may be due to the production of growth regulators as well as N-fixation **(Rao and Dass, 1989).**

The results of tree fruiting induced by organic manure source are emphasized by the findings of **Bach and Abo-Hassan (1983)** on date palm, **Marecek and Moravek (1983)** on apple, **Mukherjee et al. (1983)** on jack fruit. **Sekiya et al (1983)** on Satsuma mandarin, **Tanas'ev and Balan (1983)** on apple, **Gasanor (1984)** on persimmon, **Kalu-singh et al (1984)** on mango. **Kopytko (1984)** on apple. **Motskobili (1984)** on Satsuma, **Tanas'ev (1984)** on apple, **Darfeld and Lenz (1985)** on pear, **Pil'Shchikov (1986)** on apple, **Bussi and Defrance (1987)** on peach, **Gadelha and Vieira (1988)** on pineapple, **Piatkowski et al. (1990)** on apple, **Villasurda and Baluyut (1990), Davitaze (1991), Wang et al. (1991)** on grape, **Ben-Ya-Acov et al.(1992)** on avocado, **Bussi et al. (1992)** on peach, **Gouda et al (1992)** on grape, **Alvarez et al (1993)** on pineapple, **Rabeh et al (1993)** on Balady mandarin, **Prabhuram and**

Sathiamoorthy (1993) on banana. **Li et al (1997)** on pear, **Song et al. (1999)** on apple and **Ye-Jianwin et al.(1999)** on pummelo. In this respect, **Ben-Ya-Acov et al. (1992)** mentioned that the combination of the better rootstock and organic manure application increased yield by 135 % compared with the other rootstocks without organic manure application. Besides, **Gouda et al. (1992)** reported that the best result of combines treatments on yield were poultry manure and cattle manure at 3.5 and 12 t/fed, respectively. Recently, **Moustafa (2002)** on Washington navel orange, realized the highest yield was produced by rabbit manure.

The obtained results regarding the effect of organic manure appliction method on tree fruiting go in line with those mentioned by **Tsipko (1982)** on apple, **Tkachuk (1983)** on apple, **Bhangoo et al. (1988)** on grape , **Fisun and Kodzokov (1991)** on plum and **Goede (1993)** on mango.

In addition, tree fruiting results produced by biofertilizers are in harmony with the findings of **Ball et al(1983)** on groundnut, **Chang (1983)** on peanuts, **Pomares et al (1993)** on orange, **Akl et al (1997), Fernandez et al (1998), Mansour (1998)** on apple and **Moustafa (2002)** on Washington navel orange.

4.4.1. Fruit physical properties

The effect of organic manure source, method of organic manure application and biofertilization as well as their interactions on fruit physical properties expressed as fruit weight, length, diameter, juice weight and peel thickness of

Balady mandarin trees during 2000 and 2001 seasons is reported in **Tables (47 – 51).**

4.4.1.1. Fruit weight

It is clear from **Table (47)** that poultry manured trees produced heavier fruit (152.5 & 148.8 g) than those produce by sheep manure ones (148.0 &143.0 g) and finally those produce by cattle manured trees (141.5 & 137.3 g) in 2000 and 2001 seasons, respectively. The difference between the three studie organic manure sources were obvious to be significant.

In addition, fertilizing Balady mandarin trees with Rhizobacterien significantly increased fruit weight than fertilizing with Nitrobien.

Furthermore, the interaction between organic manure source and method of organic manure application reveals that poultry manure applied in trenches proved to be the most effective interaction in enhancing fruit weight of Balady mandarin trees. On the contrary, cattle manure whether applied in trenches or superficially proved to be the least effective interaction in enhancing fruit weight. Other combinations induced intermediate effect in this concern **(Table, 48).**

Moreover, the interaction between method of organic manure application and biofertilization shows that out of all studied interactions, the application of organic manure in trenches and supporting with Rhizobacterien induced the highest positive effect on fruit weight. Other combinations induced statistically similar effect in this concern **(Table,49).**

In addition, **Table (50)** demonstrates that out of all interactions between organic manure source and biofertilization,

Table (47): Specific effect of organic manure source, application method and biofertilization on fruit physical properties of Balady mandarin trees(2000 and 2001 seasons).

Factor	Fruit characteristics									
	Weight (g)		Length (cm)		Diameter (cm)		Peel thickness(cm)		Juice weight (g)	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source										
Cattle manure	141 c	137 c	4.62 a	4.72 a	5.05 a	5.15 a	0.18 a	0.18 a	26.50 b	28.50 b
Poultry manure	152 a	148 a	4.65 a	4.75 a	5.05 a	5.15 a	0.18 a	0.18 a	28.83 a	30.75 a
Sheep manure	148 b	143 b	4.63 a	4.72 a	5.05 a	5.15 a	0.18 a	0.18 a	26.50 b	28.50 b
b. Effect of application method										
Surface	146 b	141 b	4.60 b	4.70 b	5.05 a	5.15 a	0.18 a	0.18 a	26.89 a	28.83 a
Trench	149 a	145 a	4.67 a	4.76 a	5.05 a	5.15 a	0.18 a	0.18 a	27.67 a	29.67 a
c. Effect of biofertilization										
Nitrobien	146 b	142 b	4.55 b	4.65 b	5.03 a	5.13 a	0.18 a	0.18 a	26.00 b	28.00 b
Rhizobacterien	148 a	144 a	4.72 a	4.81 a	5.06 a	5.16 a	0.18 a	0.18 a	28.56 a	30.50 a

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

Table (48): Effect of interaction between organic manure source and application method on fruit physical properties of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Fruit characteristics									
		Weight (g)		Length (cm)		Diameter (cm)		Peel thickness(cm)		Juice weight (g)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	141 c	136 d	4.60 c	4.70 c	5.05 a	5.15 a	0.18 a	0.18 a	25.50 b	27.50 b
	Trench	142 c	138 d	4.65 b	4.75 b	5.05 a	5.15 a	0.18 a	0.18 a	27.50 ab	29.50 ab
Poultry manure	Surface	150 b	146 b	4.60 c	4.70 c	5.05 a	5.15 a	0.18 a	0.18 a	28.17 ab	30.00 ab
	Trench	155 a	152 a	4.70 a	4.80 a	5.05 a	5.15 a	0.18 a	0.18 a	29.50 a	31.50 a
Sheep manure	Surface	147 b	142 c	4.60 c	4.70 c	5.05 a	5.15 a	0.18 a	0.18 a	27.00 ab	29.00 ab
	Trench	149 b	144 bc	4.66 ab	4.75 b	5.05 a	5.15 a	0.18 a	0.18 a	26.00 b	28.00 ab

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

Table (49): Effect of interaction between application method and biofertilization on fruit physical properties of Balady mandarin trees(2000 and 2001 seasons).

Application method	Biofertilizer	Fruit characteristics									
		Weight (g)		Length (cm)		Diameter (cm)		Peel thickness(cm)		Juice weight (g)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Surface →	Nitrobien	145 b	141 b	4.50 b	4.60 b	5.03 a	5.13 a	0.18 a	0.18 a	25.67 c	27.67 c
	Rhizobacterien	146 ab	142 b	4.70 a	4.80 a	5.06 a	5.16 a	0.18 a	0.18 a	28.11 ab	30.00 ab
Trench →	Nitrobien	147 ab	142 b	4.60 ab	4.70 ab	5.03 a	5.13 a	0.18 a	0.18 a	26.33 bc	28.33 bc
	Rhizobacterien	150 a	146 a	4.74 a	4.83 a	5.06 a	5.16 a	0.18 a	0.18 a	29.00 a	31.00 a

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

Table (50): Effect of interaction between organic manure source and biofertilization on fruit physical properties of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Biofertilizer	Fruit characteristics									
		Weight (g)		Length (cm)		Diameter (cm)		Peel thickness(cm)		Juice weight (g)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Nitrobien	141 d	137 d	4.55 b	4.65 b	5.03 a	5.13 a	0.18 a	0.18 a	25.50 b	27.50 b
	Rhizobacterien	142 cd	137 d	4.70 ab	4.80 ab	5.06 a	5.16 a	0.18 a	0.18 a	27.50 b	29.50 b
Poultry manure	Nitrobien	151 ab	147 ab	4.55 b	4.65 b	5.03 a	5.13 a	0.18 a	0.18 a	27.00 b	29.00 b
	Rhizobacterien	154 a	150 a	4.75 a	4.85 a	5.06 a	5.16 a	0.18 a	0.18 a	30.67 a	32.50 a
Sheep manure	Nitrobien	147 bc	141 c	4.55 b	4.65 b	5.03 a	5.13 a	0.18 a	0.18 a	25.50 b	27.50 b
	Rhizobacterien	149 ab	144 bc	4.71 ab	4.80 ab	5.06 a	5.16 a	0.18 a	0.18 a	27.50 b	29.50 b

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

poultry manure supported with Rhizobacterien proved to be the most efficient interaction in enhancing fruit weight. On the contrary, the interactions of cattle manure gave the lowest values of fruit weight. Besides, the combinations of sheep manure exerted an intermediate effect in this respect.

As for the interaction between the three studied factors namely organic manure source, method of organic manure application and biofertilization reveals that out of all interactions poultry manure applied in trenches provided with Rhizobacterien proved to be the most effective interaction in enhancing fruit weight. On the other hand, all combinations of cattle manure induced the lowest values of fruit weight. Besides, other tested combinations exerted an intermediate effect in this respect.

4.4.1.2. Fruit length

It is clear that organic manure source i.e. cattle, poultry and sheep failed to exert a distinctive effect on fruit length of Balady mandarin trees **(Table, 47).**

Furthermore, the application of organic manure in trenches surpassed superficial application in enhancing fruit length of Balady mandarin during both seasons of study.

Moreover, Rhizobacterien inoculated trees produced longer fruits as compared with Nitrobien inoculated ones.

Furthermore, the interaction between organic manure source and method of organic manure application reveals that poultry manure applied in trenches proved to be the most effective interaction in enhancing fruit length of Balady mandarin trees. On the contrary, cattle manure whether applied

superficially or in trenches proved to be the least effective interactions in enhancing fruit length. Other combinations induced an intermediate effect in this concern **(Table, 48).**

Additionally, the interaction between method of organic manure application and biofertilization shows that Balady mandarin trees manured in trenches or superficially and inoculated with Rhizobacterien produced the longest fruits. On the contrary, fruits of Balady mandarin trees manured superficially and inoculated with Nitrobien had the lowest values of fruit length. Other combinations produced intermediate values of fruit length, **(Table, 49).**

In addition, **Table (50)** demonstrates that out of all interactions between organic manure source and biofertilization, poultry manure supported with Rhizobacterien proved to be the most efficient interaction in enhancing fruit length. On the contrary, the interactions of cattle manure gave the lowest values of fruit length. Besides, the combinations of sheep manure exerted an intermediate effect in this respect.

As for the interaction between the three studied factors namely organic manure source, method of organic manure application and biofertilization reveals that out of all interactions (poultry, sheep and cattle manure) applied in trenches or superficially provided with Rhizobacterien proved to be the most effective interactions in enhancing fruit length. On the other hand, all combinations of (poultry, sheep and cattle manure) applied superficially provided with Nitrobien induced the lowest values of fruit length.

4.4.1.3. Fruit diameter

Table (47-51) demonstrates that the three studied factors i.e. organic manure source (cattle, poultry and sheep), method of organic manure application (surface and trench) and biofertilization alone or in different combinations failed to show any distinctive effect on fruit diameter of Balady mandarin trees during 2000 and 2001 seasons.

4.4.1.4. Peel thickness

Table (47-51) reveals that the three studied factors i.e. organic manure source (cattle, poultry and sheep), method of organic manure application (surface and trench) and biofertilization alone or in different combinations failed to show any distinctive effect on fruit diameter of Balady mandarin trees during 2000 and 2001 seasons.

4.4.1.5. Juice weight

It is clear that organic manure source i.e. poultry manure exert a distinctive positive effect on juice weight of Balady mandarin trees. Besides, sheep manure and cattle manure showed similar effect on juice weight, **(Table, 47).**

Furthermore, the application of organic manure superficially or in trenches failed to induce any positive effect on juice weight of Balady mandarin trees.

Moreover, Rhizobacterien inoculated trees enhanced fruit juice content as compared with the analogous ones inoculated with Nitrobien.

Table (51): Effect of interaction between organic manure source, application method and biofertilization on fruit physical properties of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer {N-fixing bacteria}	Fruit characteristics									
			Weight (g)		Length (cm)		Diameter (cm)		Peel thickness (cm)		Juice weight (g)	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	Nitrobien	141 d	137 ef	4.50 b	4.60 b	5.03 a	5.13 a	0.18 a	0.18 a	25 c	27 b
		Rhizobacterien	141 d	136 f	4.70 ab	4.80 ab	5.06 a	5.16 a	0.18 a	0.18 a	26 bc	28 b
	Trench	Nitrobien	141 d	137 ef	4.60 ab	4.70 ab	5.03 a	5.13 a	0.18 a	0.18 a	26 bc	28 b
		Rhizobacterien	143 cd	139 ef	4.70 ab	4.80 ab	5.06 a	5.16 a	0.18 a	0 18 a	29 abc	31 ab
Poultry manure	Surface	Nitrobien	149abcd	145 bcd	4.50 b	4.60 b	5.03 a	5.13 a	0.18 a	0.18 a	27 bc	29 b
		Rhizobacterien	151 abc	147 bc	4.70 ab	4.80 ab	5.06 a	5.16 a	0.18 a	0.18 a	29 ab	31 ab
	Trench	Nitrobien	154 ab	150 ab	4.60 ab	4.70 ab	5.03 a	5.13 a	0.18 a	0.18 a	27 bc	29 b
		Rhizobacterien	157 a	153 a	4.80 a	4.90 a	5.06 a	5.16 a	0.18 a	0.18 a	32 a	34 a
Sheep manure	Surface	Nitrobien	147 bcd	142 cde	4.50 ab	4.60 b	5.03 a	5.13 a	0.18 a	0.18 a	25 c	27 b
		Rhizobacterien	147 bcd	142 cde	4.70 ab	4.80 ab	5.06 a	5.16 a	0.18 a	0.18 a	29 abc	31 ab
	Trench	Nitrobien	147 bcd	141 def	4.60 ab	4.70 ab	5.03 a	5.13 a	0.18 a	0.18 a	26 bc	28 b
		Rhizobacterien	151 abc	147 bc	4.73 ab	4.80 ab	5.06 a	5.16 a	0.18 a	0.18 a	26 bc	28 b

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

As for the interaction between organic manure source and method of organic manure application, **Table (48)** shows that poultry manure applied in trenches proved to be the most effective interaction in enhancing fruit juice content of Balady mandarin trees, compared with cattle manure applied superficially in both seasons.

Additionally, the interaction between method of organic manure application and biofertilization shows that Balady mandarin trees manured in trenches and / or superficially and inoculated with Rhizobacterien enhanced fruit juice content. On the contrary, fruits of Balady mandarin trees manured superficially and / or in trenches and inoculated with Nitrobien had the lowest values of fruit juice content, **(Table, 49).**

In addition, **Table (50)** demonstrates that the interaction between organic manure source and biofertilization, poultry manure supported with Rhizobacterien proved to be the most efficient interaction in enhancing fruit juice content. On the other hand, poultry manure supported with Nitrobien and (sheep and cattle manure) supported with Rhizobacterien and Nitrobien had similar fruit juice content from the statistical standpoint.

Finally, the interaction between the three studied factors, i.e. organic manure source, method of organic manure application and biofertilization reveals that out of these studied combination poultry manure x trench application x Rhizobacterien induced the most pronounced distinctive effect on fruit juice content of Balady mandarin trees in both seasons of study **(Table, 51).**

Abstractly, fruit weight and juice weight were only the parameter out of all studied fruit physical characteristics (fruit length, diameter and peel thickness) that positively responded to poultry manure. Moreover, trench application of organic manure enhanced fruit weight and fruit length as compared with surface application. Also, Rhizobacterien inoculation improved fruit weight, length and juice weight as compared with Nitrobien.

4.4.2. Fruit chemical properties

Tables (52-56) show the effect of organic manure (cattle, poultry and sheep), method of organic manure application (surface and trench) and biofertilization (Rhizobacterien and Nitrobien) as well as their interactions on some fruit chemical properties *i.e.* total soluble solids (TSS) percentage total acidity. TSS:acid ratio and ascorbic acid of Balady mandarin trees during 2000 and 2001 seasons.

4.4.2.1. Total soluble solids (TSS)

It is quite evident that poultry manured trees produced fruits richer in their total soluble solids content (12.93 & 12.85%) as compared with those produced by sheep manured trees (12.60 & 12.40%) and cattle manured trees (12.50 & 12.35%) in 2000 and 2001 seasons, respectively. However, the differences between the three organic manure sources in this respect were obvious to be significant **(Table, 52)**.

Furthermore, the application of organic manure in trenches succeeded in enhancing fruit content of total soluble

Table (52): Specific effect of organic manure source, application method and biofertilization on fruit chemical properties of Balady mandarin trees(2000 and 2001 seasons).

Factor	Fruit characteristics							
	T.S.S. (%)		Total acidity (%)		T.S.S. : acid ratio		Ascorbic acid mg/100 juice	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
	a. Effect of organic manure source							
Cattle manure	12.50 b	12.35 b	1.013 a	1.014 a	12.35 b	12.18 c	47 b	45 b
Poultry manure	12.93 a	12.85 a	1.011 a	1.013 a	12.79 a	12.69 a	53 a	51 a
Sheep manure	12.60 b	12.40 b	1.013 a	1.011 a	12.44 b	12.26 b	49 b	47 ab
	b. Effect of application method							
Surface	12.64 a	12.43 b	1.014 a	1.012 a	12.47 b	12.29 a	49 a	47 a
Trench	12.71 a	12.63 a	1.010 a	1.013 a	12.59 a	12.46 a	50 a	48 a
	c. Effect of biofertilization							
Nitrobien	12.68 a	12.50 a	1.013 a	1.014 a	12.51 a	12.32 a	49 a	47 a
Rhizobacterien	12.68 a	12.57 a	1.011 a	1.011 a	12.55 a	12.43 a	50 a	48 a

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

solids than the application of organic manure superficially in the second season (2001) **(Table, 52)**.

In addition, the type of biofertilizer *i.e.* Rhizobacterien or Nitrobien failed to induce a pronounced effect on fruit total soluble solids content in both seasons of study.

Additionally, **Table (53)** demonstrates that poultry manure applied superficially or in trenches produced not only similar but also higher positive effect on fruit total soluble solids content, followed descendingly by sheep manure whether applied superficially or in trenches. Lastly, cattle manure applied in trenches or superficial induced similarly the lowest positive effect on fruit total soluble solids content of Balady mandarin trees.

On the other side, **Table (54)** reveals that organic manure source showed to be more effective in enhancing fruit total soluble solids content rather than biofertilizer type, where poultry manure whether provided with Rhizobacterien or Nitrobien induced nearly similar and higher positive effect on fruit total soluble solids content, followed descendingly by sheep manure either supported with Rhizobacterien or Nitrobien and lastly cattle manure whether enriched with Rhizobacterien or Nitrobien.

On the other hand, the interaction between organic manure application method and biofertilization showed that the application of organic manure in trenches and fertilizing with Rhizobacterien proved to be the most efficient interaction in enhancing fruit total soluble solids content. On the contrary, superficial application of organic manure and fertilizing with

Table (53): Effect of interaction between organic manure source and application method on fruit chemical properties of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Fruit characteristics							
		T.S.S. (%)		Total acidity (%)		T.S.S. : acid ratio		Ascorbic acid mg/100 juice	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	12.40 c	12.20 d	1.013 a	1.012 a	12.24 c	12.06 c	47 c	45 d
	Trench	12.60 b	12.50 bc	1.012 a	1.017 a	12.46 b	12.29 bc	47 c	46 cd
Poultry manure	Surface	12.93 a	12.70 b	1.012 a	1.013 a	12.78 a	12.53 ab	51 b	50 b
	Trench	12.93 a	13.00 a	1.010 a	1.012 a	12.80 a	12.85 a	54 a	52 a
Sheep manure	Surface	12.60 b	12.40 cd	1.017 a	1.010 a	12.39 b	12.27 bc	49 c	47 c
	Trench	12.60 b	12.40 cd	1.008 a	1.012 a	12.49 b	12.24 bc	50 bc	47 c

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

Table (54): Effect of interaction between organic manure source and biofertilization on fruit chemical properties of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Biofertilizer	Fruit characteristics							
		T.S.S. (%)		Total acidity (%)		T.S.S. : acid Ratio		Ascorbic acid mg/100 juice	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Nitrobien	12.50 b	12.30 b	1.015 a	1.015 a	12.32 b	12.12 b	47 c	45 c
	Rhizobacterien	12.50 b	12.40 b	1.010 a	1.013 a	12.38 b	12.23 b	47 c	45 c
Poultry manure	Nitrobien	12.93 a	12.80 a	1.012 a	1.015 a	12.78 a	12.61 a	52 ab	50 ab
	Rhizobacterien	12.93 a	12.90 a	1.010 a	1.010 a	12.81 a	12.77 a	54 a	52 a
Sheep manure	Nitrobien	12.60 b	12.40 b	1.013 a	1.012 a	12.43 b	12.24 b	48 bc	47 c
	Rhizobacterien	12.60 b	12.40 b	1.012 a	1.010 a	12.45 b	12.27 b	50 bc	48 bc

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

Nitrobien took the other way around. Other studied interactions took an intermediate position between the previously two mentioned categories during the second season, **(Table, 55)**.

On the other hand, the interaction between organic manure source, method of organic manure application and biofertilization exerted that the application of poultry manure in trenches or superficially and provided with Rhizobacterien and/or Nitrobien gave the highest values of fruit total soluble solids content. On the contrary, cattle manure whether applied in trenches or superficially and supported with Rhizobacterien or Nitrobien produced the lowest values of fruit total soluble solids content. Other studied combinations of sheep manure showed inbetween values in this respect.

4.4.2.2. Total acidity

Table (52-56) demonstrated that the three studied factors i.e. organic manure source (cattle, poultry and sheep), method of organic manure application (surface and trench) and biofertilization alone or in different combinations failed to show any distinctive effect on fruit total acidity content of Balady mandarin trees during 2000 and 2001 seasons .

4.4.2.3 TSS:acid ratio

It is obvious from **Table (52)** that fruits produced by poultry manured trees had higher TSS:acid ratio (12.79 & 12.69)

Table (55): Effect of interaction between method of application and biofertilization on fruit chemical properties of Balady mandarin trees(2000 and 2001 seasons).

Application Method	Biofertilizer	Fruit characteristics							
		T.S.S. (%)		Total acidity (%)		T.S.S. : acid ratio		Ascorbic acid mg/100 juice	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Surface	Nitrobien	12.64 a	12.40 b	1.017 a	1.012 a	12.44 a	12.25 b	49 a	47 a
	Rhizobacterien	12.64 a	12.47 ab	1.011 a	1.011 a	12.51 a	12.33 ab	49 a	47 a
Trench	Nitrobien	12.71 a	12.60 ab	1.010 a	1.016 a	12.58 a	12.40 ab	49 a	47 a
	Rhizobacterien	12.71 a	12.67 a	1.010 a	1.011 a	12.59 a	12.53 a	51 a	49 a

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

followed descendingly by the corresponding ones resulted from sheep manured trees (12.44 & 12.26) and lastly those produced by cattle manured trees (12.35 & 12.18) in 2000 and 2001 seasons, respectively. The differences between the three studied organic manure sources were more obvious to be significant.

Moreover, the application of organic manure in trenches succeeded in improving fruit TSS:acid ratio rather than the application of organic manure superficially.

Furthermore, **Table (52)** demonstrates that in both seasons biofertilizers failed to show any distinctive effect on fruit TSS:acid ratio of Balady mandarin trees.

On the other side, **Table (53)** shows that the effect of organic manure source predominated the effect of method of application regarding fruit TSS:acid ratio, hence poultry manure whether applied in trenches or superficially induced the highest positive effect in this concern, followed descendingly by sheep manure applied either superficial or in trenches and lastly cattle manure applied in trenches or superficially.

Furthermore, **Table (54)** reveals that in both seasons, the effect of organic manure source predominated the effect of biofertilizers hence poultry manure whether provided with Rhizobacterien or Nitrobien produced nearly a similar and higher positive effect on fruit TSS:acid ratio, followed descendingly by sheep manure whether supported with Rhizobacterien or Nitrobien and lastly, cattle manure enriched with Rhizobacterien or Nitrobien.

In addition, the interaction between the method of organic manure application and biofertilization indicates that fruit TSS:acid ratio responded mainly to biofertilizer type rather than the method of organic manure application, hence fertilizing Balady mandarin trees with Rhizobacterien and whether the organic manure was added superficially or in trenches gave the highest values of fruit TSS:acid ratio rather than inoculating the soil with Nitrobien, regardless whether the organic manure was added superficially or in trenches in the second season (2001), **(Table, 55)**.

As for the interaction between organic manure source, method of organic manure application and biofertilization, **Table (56)** demonstrates that poultry manure combinations in general and those applied in trenches or superficially and inoculated with Rhizobacterien in particular recorded the highest values of fruit TSS/acid ratio. Other tested combinations of cattle and sheep manure gave nearly more or less similar effect in this respect.

4.4.2.4. Ascorbic acid

It is quite evident from **Table (52)** that in both seasons, poultry manured trees produced fruits richer in their ascorbic acid content (53 & 51 mg/100 ml juice) as compared with those resulted from sheep (49 & 47 mg/100 ml juice) and cattle manured trees (47 & 45 mg/100 ml juice) in 2000 and 2001 seasons, respectively. The differences between cattle and sheep manure in this respect were lacking from the statistical standpoint.

Table (56): Effect of interaction between organic manure source, application method and biofertilization on fruit chemical properties of Balady mandarin trees(2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer {N-fixing bacteria}	T.S.S. (%)		Total acidity (%)		T.S.S.:acid ratio		Ascorbic mg/100 juice	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	Nitrobien	12.40 b	12.20 c	1.020 a	1.010 a	12.16 c	12.08 d	47 b	45 c
		Rhizobacterien	12.40 b	12.20 c	1.007 a	1.013 a	12.32 c	12.04 d	47 b	45 c
	Trench	Nitrobien	12.60 ab	12.40 c	1.010 a	1.020 a	12.47abc	12.15 d	47 b	46 bc
		Rhizobacterien	12.60 ab	12.60 bc	1.013 a	1.013 a	12.44abc	12.43bcd	48 b	46 bc
Poultry manure	Surface	Nitrobien	12.93 a	12.60 bc	1.010 a	1.017 a	12.80 a	12.39 cd	52 b	50 b
		Rhizobacterien	12.93 a	12.80 ab	1.013 a	1.010 a	12.77 a	12.67abc	51 b	50 b
	Trench	Nitrobien	12.93 a	13.00 a	1.013 a	1.013 a	12.76 ab	12.83 ab	52 b	50 b
		Rhizobacterien	12.93 a	13.00 a	1.007 a	1.010 a	12.85 a	12.87 a	57 a	55 a
Sheep manure	Surface	Nitrobien	12.60 ab	12.40 c	1.020 a	1.010 a	12.35 bc	12.28 cd	48 b	47 bc
		Rhizobacterien	12.60 ab	12.40 c	1.013 a	1.010 a	12.43abc	12.27 cd	50 b	48 bc
	Trench	Nitrobien	12.60 ab	12.40 c	1.007 a	1.013 a	12.58abc	12.21 d	49 b	47 bc
		Rhizobacterien	12.60 ab	12.40 c	1.010 a	1.010 a	12.47abc	12.28 cd	50 b	48 bc

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

On the other hand, the method of organic manure application and biofertilization failed to induce a reasonable effect on fruit ascorbic acid content of Balady mandarin trees.

Additionally, the interaction between organic manure source and method of organic manure application reveals that poultry manure applied in trenches gave the highest ascorbic acid values as compared with those applied superficially, followed descendingly by sheep manure applied either superficially or in trenches and finally, cattle manure applied trenchly or superficially.

On the other side, **Table (54)** shows that the values of fruit ascorbic acid content resulted from interaction between organic manure source and biofertilization were attributed mainly the predominating effect of organic manure source rather than biofertilization. Thereupon, poultry manure supported with Rhizobacterien or Nitrobien scored the highest values of fruit ascorbic acid content, followed descendingly by the combinations of sheep manure and lastly by those of cattle manure.

In addition, it is clear from **Table (55)** that the interaction between method of organic manure application (surface and trench) and biofertilizers (Rhizobacterien and Nitrobien) failed to give an additive effect on fruit ascorbic acid content of Balady mandarin trees in 2000 and 2001 seasons.

In summary, the interactions between organic manure source, method of organic manure application and biofertilization show that poultry manure applied in trenches with Rhizobacterien gave the highest values followed descendingly by poultry manure applied in trenches provided

with Nitrobien and poultry manure applied superficially x (Rhizobacterien and Nitrobien) induced similarly higher positive effect on fruit ascorbic acid content of Balady mandarin trees in both seasons of study. Other studied combinations of sheep and cattle manure showed more or less similar effect in this respect, **(Table, 56)**.

Part II: Experiment II: Effect of organic manure source, organic manure irradiation and method of organic manure application on growth and leaf mineral content of Sour orange and Volkamer lemon seedlings.

4.2.1. Sour orange seedlings

4.2.1.1 Plant growth parameters

Table (57-66) shows that growth parameters, i.e. seedling height, stem diameter, leaf chlorophyll (a & b) , No. of leaves /seedling, leaf surface area, root length, No. of root /seedling, stem dry weight, leaves dry weight, root dry weight, total seedling dry weight and top /root ratio.

4.2.1.1.1. Seedling height

It is clear from **Table (57)** that poultry manured seedlings produced more height seedlings as compared with those arised from cattle manured ones in both seasons. On the contrary, cattle manured seedlings had the lowest values in this respect.

Table (57): Specific effect of organic manure source, irradiation and application method on some growth parameters Sour orange seedlings (2000 and 2001 seasons)

Factor	Seedling height (cm)		Stem diameter (cm)		Leaf chlorophyll (mg/L) (a)		(b)		No. of leaves /seedling	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source										
Cattle manure	52 c	49 c	0.66 c	0.62 c	6.43 b	6.38 b	2.77 b	2.72 a	60 c	75 c
Poultry manure	87 a	75 a	0.89 a	0.84 a	6.52 a	6.47 a	2.87 a	2.80 a	94 a	110 a
Sheep manure	67 b	59 b	0.79 b	0.72 b	6.47 ab	6.42ab	2.82 ab	2.78 a	76 b	88 b
b. Effect of Irradiation										
Non-irradiation	64 b	57 b	0.75 b	0.70 a	6.35 b	6.31 b	2.67 b	2.64 a	73 b	85 b
Irradiation	74 a	65 a	0.81 a	0.76 a	6.60 a	6.54 a	2.97 a	2.90 a	81 a	97 a
c. Effect of application method										
Soil application	72 a	63 a	0.80 a	0.75 a	6.55 a	6.49 a	2.90 a	2.83 a	79 a	93 a
Water extract	66 b	58 b	0.77 b	0.71 b	6.40 b	6.36 b	2.75 b	2.70 b	74 b	89 b

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

Moreover, irradiating organic manure surpassed non-irradiated organic manure to exert a distinctive positive effect on seedling height in both seasons.

Furthermore, soil application of organic manure succeeded to induce a distinctive effect on seedling height as compared water extract of organic manure in this respect.

In addition, **Table (58)** illustrates that the interaction between organic manure source and irradiating organic manure, reveals that irradiating poultry manure induced more positive effect on seedling height in both seasons descendingly by non-irradiation and / or irradiating cattle manure had the lowest distinctive effect in this respect.

On the other hand, the interaction between organic manure and method of organic manure application reveals that poultry manure applied particularly as soil application or secondly as water extract of organic manure exerted the highest positive effect on seedling height of Sour orange seedlings in both seasons, **(Table, 59).**

Furthermore, irradiating organic manure and application as soil application exerted the highest stimulative effect on seedling height, followed descendingly by those applied as water extract of organic manure. On the contrary, non-irradiation of organic manure, applied as soil application and / or as water extract had the lowest positive effect on seedling height in both seasons **(Table, 60).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other combinations (cattle and sheep) in enhancing seedling height with the superiority of irradiating poultry manure on the

Table (58): Effect of interaction between organic manure source and irradiation on some growth parameters Sour orange seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Seedling height (cm)		Stem diameter (cm)		Leaf chlorophyll (mg/L) (a)		Leaf chlorophyll (mg/L) (b)		No. of leaves /seedling	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Non-irradiation	49 f	46 e	0.63 f	0.59 d	6.35 d	6.30 c	2.62 d	2.57 a	56 f	71 f
	Irradiation	56 e	52 d	0.69 e	0.66 cd	6.52 c	6.47 b	2.9 b	2.87 a	65 e	79 e
Poultry	Non-irradiation	82 b	70 b	0.36 b	0.82 ab	6.36 d	6.32 c	2.72 c	2.67 a	90 b	101 b
	Irradiation	93 a	80 a	0.92 a	0.87 a	6.67 a	6.61 a	3.02 a	2.92 a	99 a	120 a
Sheep	Non-irradiation	46 d	54 d	0.77 d	0.70 bcd	6.35 d	6.30 c	2.67 cd	2.97 a	73 d	84 d
	Irradiation	72 c	63 c	0.82 c	0.75 abc	6.60 b	6.55 ab	2.97 ab	2.90 a	79 c	92 c

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

Table (59): Effect of interaction between organic manure source and application method on some growth parameters Sour orange seedlings (2000 and 2001 seasons).

Organic manure Source	Application method	Seedling height (cm)		Stem diameter (cm)		Leaf chlorophyll (mg/L) (a)		(b)		No. of leaves /seedling	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Soil application	54 e	51 d	0.68 c	0.64 c	6.50 bc	6.45abc	2.85 abc	2.80 ab	63 d	76 c
	Water extract	51 e	47 d	0.65 c	0.61 c	6.37 d	6.32 d	2.70 d	2.65 c	58 e	74 c
Poultry	Soil application	91 a	77 a	0.91 a	0.86 a	6.60 a	6.54 a	2.95 a	2.87 a	96 a	113 a
	Water extract	84 b	74 a	0.88 a	0.83 a	6.44 cd	6.40bcd	2.80 bcd	2.72 bc	93 a	107 a
Sheep	Soil application	70 c	63 b	0.81 b	0.74 b	6.55 ab	6.50 ab	2.90 ab	2.82 ab	79 b	91 b
	Water extract	65 d	55 c	0.78 b	0.71 b	6.40 d	6.35 cd	2.75 cd	2.75 bc	73 c	86 b

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

Table (60): Effect of interaction between Effect of interaction between irradiation and application method on some growth parameters Sour orange seedlings (2000 and 2001 seasons).

Irradiation	Application method	Seedling height (cm)		Stem diameter (cm)		Leaf chlorophyll (mg/L) (a)		(b)		No. of leaves /seedling	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Non-irradiation	Soil application	66 c	59 c	0.77 b	0.71 bc	6.40 c	6.35 c	2.75 c	2.70 c	75 c	87 c
	Water extract	62 d	45 d	0.74 c	0.69 c	6.31 d	6.27 c	2.60 d	2.58 d	70 d	84 c
irradiation	Soil application	77 a	67 a	0.83 a	0.78 a	6.70 a	6.64 a	3.05 a	2.96 a	83 a	100 a
	Water extract	71 b	63 b	0.80 ab	0.74 b	6.50 b	6.45 b	2.90 b	2.83 b	79 b	94 b

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

expense of non-irradiated poultry manure applied as soil application on the expense of water extract application of organic manure. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 61).**

4.2.1.1.2. Stem diameter

It is clear from **Table (57)** that poultry manured seedlings had the highest distinctive effect on stem diameter as compared with those arised from cattle manured ones in both seasons. On the contrary, cattle manured seedlings had the lowest values in this respect.

Moreover, irradiating organic manure surpassed non-irradiation organic manure to exert a distinctive effect on stem diameter in both seasons.

Furthermore, soil application of organic manure succeeded to induce a distinctive effect on stem diameter as compared water extract of organic manure in this respect.

In addition, **Table (58)** illustrates that the interaction between organic manure source and irradiating organic manure , reveals that irradiating poultry manure induced a distinctive effect on stem diameter in both seasons followed descendingly by non-irradiation and / or irradiating cattle manure had the lowest distinctive effect in this respect.

On the other hand, the interaction between organic manure and method of organic manure application reveals that poultry manure applied as soil application or water extract

exerted the highest positive effect on stem diameter of Sour orange seedlings, followed descendingly by sheep manure applied as soil application or water extract in both seasons, **(Table, 59).**

Furthermore, irradiating organic manure and application as soil application exerted the highest stimulative effects on stem diameter, followed descendingly by those applied as water extract. On the contrary, non-irradiating organic manure and applied as soil application or water extract of organic manure had the lowest positive effect on stem diameter in both seasons, **(Table, 60).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other combinations (cattle and sheep) in enhancing stem diameter with the superiority of irradiating poultry manure on the expense of non-irradiating poultry manure applied as soil application on the expense of water extract application of organic manure. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 61).**

4.2.1.1.3. leaf chlorophyll (a & b)

Table (57) shows that leaves of poultry manured seedlings had the highest values of chlorophyll (a) followed descendingly by those of sheep manured ones and finally cattle manured seedlings in both seasons .Besides, leaves of poultry manured seedlings had the highest values of chlorophyll (b)

followed descendingly by these of sheep manured ones and finally cattle manured seedlings in first season, only.

Moreover, irradiating organic manure surpassed nonirradiating organic manure in exerting a distinctive positive effect on chlorophyll (a) in both seasons. Besides, irradiating organic manure surpassed non-irradiating organic manure in inducing a distinctive positive effect on chlorophyll (b) in first season only.

Furthermore, soil application of organic manure succeeded to induce a distinctive stimulative effect on chlorophyll (a & b) as compared with water extract application of organic manure in this respect.

In addition, **Table (58)** illustrates that the interaction between organic manure source and irradiating organic manure reveals that irradiating poultry manure increased leaf chlorophyll (a) in both seasons followed descendingly by non-irradiation and / or irradiating cattle manure had the lowest distinctive effect in this respect. Besides, irradiating poultry manure induced more chlorophyll (b) in the first season followed descendingly by non-irradiation whereas irradiating cattle manure had the lowest positive effect in this respect.

On the other hand, the interaction between organic manure and method of organic manure application reveals that poultry manure applied particularly as soil application or secondly as water extract of organic manure exerted the highest positive effect on leaf chlorophyll (a & b) of Sour orange seedlings application in both seasons, **(Table, 59).**

Furthermore, irradiating organic manure and application as soil application exerted the highest stimulative effect on

chlorophyll a& b , followed descendingly by those applied in water extract. On the contrary, non-irradiating organic manure, applied as soil application and / or water extract had the lowest positive effect on chlorophyll (a & b) in both seasons **(Table, 60).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other combination (cattle and sheep) in enhancing chlorophyll (a & b) with the superiority of irradiating poultry manure on the expense of non-irradiating poultry manure and applied as soil application on the expense of water extract of application. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 61).**

4.2.1.1.4. No. of leaves/seedling

It is clear from **Table (57)** that poultry manured seedlings produced higher No. of leaves/seedling as compared with those arised from cattle manured ones in both seasons. On the contrary, cattle manured seedlings had the lowest values in this respect.

Moreover, irradiating organic manure surpassed nonirradiating organic manure to exerted a distinctive effect on No. of leaves/seedling in both seasons.

Furthermore, soil application of organic manure succeeded in inducing a distinctive positive effect on No. of leaves/seedling as compared water extract in this respect.

Table (61): Effect of interaction between organic manure source, irradiation and application method some growth parameters Sour orange seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Application method	Seedling height (cm)		Stem diameter (cm)		Leaf chlorophyll (mg/L) (a)		(b)		No. of leaves /seedling	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Non-irradiation	Soil application	50 hi	48 f	0.65 gh	0.61 gh	6.40 efg	6.35 def	2.70 fghi	2.65 def	58 ij	73 gh
		Water extract	48 I	45 f	0.62 h	0.58 h	6.30 g	6.25 f	2.55 I	2.50 f	54 j	70 h
	irradiation	Soil application	58 g	54 de	0.71 fg	0.68 ef	6.60 bc	6.55 bc	3.00 abc	2.95 ab	68 gh	80 fg
		Water extract	55 gh	50 ef	0.68 g	0.64 fg	6.45 def	6.40 cdef	2.85 cdef	2.80 bcd	62 hi	78 fgh
Poultry manure	Non-irradiation	Soil application	85 bc	72 b	0.88 bc	0.83 bc	6.40 efg	6.35 def	2.80 defg	2.75 cde	92 bc	102 c
		Water extract	80 cd	69 b	0.85 cd	0.81 bc	6.33 fg	6.30 ef	2.65 ghi	2.60 ef	88 cd	100 c
	irradiation	Soil application	99 a	82 a	0.94 a	0.89 a	6.80 a	6.733 a	3.10 a	3.00 a	100 a	125 a
		Water extract	88 b	79 a	0.91 ab	0.86 ab	6.55 cd	6.50 bcd	2.95 abcd	2.85 abc	98 ab	115 b
Sheep manure	Non-irradiation	Soil application	66 f	59 cd	0.79 de	0.71 e	6.40 efg	6.35 def	2.75 efgh	2.70 cde	76 ef	87 def
		Water extract	60 g	50 ef	0.75 ef	0.69 ef	6.30 g	6.26 f	2.60 hi	2.65 def	70 fg	82 efg
	irradiation	Soil application	75 de	67 b	0.83 cd	0.78 cd	6.70 ab	6.65 ab	2.05 ab	2.95 ab	82 de	95 cd
		Water extract	70 ef	60 c	0.81 d	0.73 de	6.50 cde	6.45 cde	2.90 bcde	2.85 abc	77 e	90 de

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

In addition, **Table (58)** illustrates that the interaction between organic manure source and irradiating organic manure, illustrates that irradiating poultry manure gave higher No. of leaves/seedling in both seasons, whereas non-irradiating or irradiating cattle manure had produced the lowest values in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, declares that poultry manure applied as soil application or water extract exerted the highest positive effect on No. of leaves/seedling of Sour orange seedlings followed descendingly by sheep manure applied as soil application or water extract in both seasons, **(Table, 59).**

Furthermore, applying irradiating organic manure, as soil application exerted the highest stimulative effect on No. of leaves/seedling, followed descendingly by those applied as water extract. On the contrary, non-irradiating organic manure and applied as soil application or water extract had the lowest positive effect on No. of leaves/seedling in both seasons **(Table, 60).**

Finally, the interaction between the three studied factors indicates that the interaction of poultry manure surpassed the other tested combinations in enhancing No. of leaves/seedling with the superiority of irradiating poultry manure on the expense of nonirradiating poultry manure and applied as soil application on the expense of water extract of organic manure. Besides, sheep manure combinations surpassed cattle manure interactions

in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 61).**

4.2.1.1.5. Root length

It is clear from **Table (62)** that poultry manured seedlings produced longer as compared with those produced by cattle manured ones in both seasons.

Moreover, irradiating organic manure surpassed non-irradiating treatment in produced pronounced effect on root length in both seasons.

Furthermore, soil application of organic manure succeeded to induce a remarkable positive effect on root length as compared water extract application method.

In addition, **Table (63)** illustrates that the interaction between organic manure source and irradiating organic manure , declared that irradiating poultry manure produced longer roots in both seasons whereas by non-irradiating or irradiating cattle manure gave the lowest values in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, shows that poultry manure applied as soil application or water extract exerted the highest positive effect on root length of Sour orange seedlings in both seasons, **(Table, 64).**

Furthermore, applying irradiated organic manure and as soil application exerted the highest stimulative effect on root length, followed descendingly by those applied as water extract. On the contrary, non-irradiating organic manure applied as

Table (62): Specific effect of organic manure source, irradiation and application method on leaf area, root length and No. of roots/seedling of Sour orange seedlings (2000 and 2001 seasons).

Factor	Leaf area (cm^2)		No. of roots/seeding		Root length (cm)	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source						
Cattle manure	16.22 a	16.42 a	1.90 b	2.01 a	15.6 b	15.4 c
Poultry manure	16.37 a	16.52 a	1.95 a	2.05 a	16.4 a	16.1 a
Sheep manure	16.30 a	16.50 a	1.93 ab	2.02 a	16 ab	15.7 b
b. Effect of irradiation						
Nonirradiation	15.96 b	16.16 b	1.83 a	1.93 b	15.0 b	14.8 b
Irradiation	16.63 a	16.80 a	2.02 a	2.12 a	16.9 a	16.7 a
c. Effect of application method						
Soil application	16.47 a	16.63 a	1.97 a	2.07 a	16.4 a	16.2 a
Water extract	16.13 b	16.33 b	1.88 a	1.92 b	15.5 b	15.2 b

Means within each column, followed by the same letter(s) are not significantly different at 5% level

Table (63): Effect of interaction between organic manure source and irradiation on leaf area, root length and No. of roots/seedling of Sour orange seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Leaf area (cm^2)		No. of roots/seeding		Root length (cm)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Non-irradiation	16.0 c	16.2 b	1.84 a	1.95 b	14.6 d	14.4 f
	Irradiation	16.45 b	16.65 a	1.97 a	2.07 a	16.5 b	16.3 c
Poultry manure	Non-irradiation	15.95 c	16.15 b	1.82 a	1.92 b	15.4 c	15.1 d
	Irradiation	16.80 a	16.90 a	2.07 a	2.17 a	17.4 a	17.1 a
Sheep manure	Non-irradiation	15.95 c	16.15 b	1.82 a	1.92 b	15.0 cd	14.8 e
	Irradiation	16.65 ab	16.85 a	2.02 a	2.11 a	16.9 ab	16.6 b

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

Table (64): Effect of interaction between organic manure source and application method on leaf area, root length and No. of roots/seedling of Sour orange seedlings (2000 and 2001 seasons).

Organic manure source	Application method	Leaf area (cm^2)		No. of roots/seeding		Root length (cm)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Soil application	16.40 ab	16.60 a	1.95 a	2.05 abc	16.0 bc	15.8 bc
	Water extract	16.03 b	16.25 a	1.86 a	1.975 c	15.1 d	14.9 d
Poultry manure	Soil application	16.55 a	16.65 a	2.00 a	2.1 a	16.9 a	16.6 a
	Water extract	16.20 ab	16.40 a	1.90 a	2.0 bc	15.9 bcd	15.6 bc
Sheep manure	Soil application	16.45 ab	16.65 a	1.97 a	2.07 ab	16.4 ab	16.2 ab
	Water extract	16.15 ab	16.35 a	1.87 a	1.96 c	15.5 cd	15.2 cd

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

application or water extract had the least enhancing effect on root length in both seasons **(Table, 65).**

Finally, the interaction between the three studied factors indicates that the interaction of poultry manure surpassed the other combinations in enhancing root length with the superiority to irradiating poultry manure on the expense of non-irradiating poultry manure and applied as soil application on the expense of water extract of organic manure. Besides, sheep manure combination surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons**, (Table, 66).**

4.2.1.1.6. No. of roots / seedling

It is clear from **Table (62)** that poultry manured seedlings produced higher No. of roots / seedling as compared with those produced by from cattle manured ones in the first season **(2000).**

Moreover, irradiating organic manure surpassed non-irradiating treatment in producing to exerted a remarkable positive effect on No. of roots / seedling in the second season **(2001).**

Furthermore, soil application of organic manure succeeded in exerting a positive effect on No. of roots / seedling as compared with water extract application method in this respect in the second season **(2001).**

In addition, **Table (63)** illustrates that the interaction between organic manure source and irradiating organic manure, exerted that irradiating (poultry, sheep and cattle manure) induced higher No. of roots / seedling in the second season

(2001). On the contrary, non-irradiating poultry, sheep and cattle manure induced the lowest values in this respect in the second season **(2001).**

On the other hand, the interaction between organic manure and method of organic manure application, declared that application of poultry manure applied or water extract exerted the highest positive effect on No. of roots / seedling of Sour orange seedlings, in second season, **(Table, 64).**

Furthermore, irradiating organic manure and applied as soil application exerted the highest stimulative effect on No. of roots / seedling, followed descendingly by those applied as water extract. On the contrary, non-irradiating organic manure applied as soil application or water extract had the lowest values in both seasons **(Table, 65).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other combinations in enhancing No. of roots / seedling with the superiority of irradiating poultry manure on the expense of non-irradiating poultry manure and applied as soil application on the expense of water extract application method. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in the second season, **(Table, 66).**

4.2.1.1.7. Leaf area

It is clear from **Table (62)** that organic manure source failed to induce a distinctive effect on leaf area in both seasons.

Table (65): Effect of interaction between irradiation and application method of organic manure on leaf area, root length and No. of roots/seedling of Sour orange seedlings (2000 and 2001 seasons).

Irradiation	Application method	Leaf area (cm^2)		No. of roots/seeding		Root length (cm)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Non-irradiation	Soil application	16.03 c	16.13 c	1.85 b	1.93 c	15.5 c	15.3 c
	Water extract	15.90 c	16.10 c	1.81 b	1.91 c	14.5 d	14.3 d
Irradiation	Soil application	16.90 a	17.03 a	2.10 a	2.20 a	17.4 a	17.1 a
	Water extract	16.37 b	16.56 b	1.95 ab	2.04 b	16.5 b	16.2 b

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

Table (66): Effect of interaction between organic manure source, irradiation and application method on leaf area, root length and No. of roots/seedling of Sour orange seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Application method	Leaf area (cm^2)		No. of roots/seeding		Root length (cm)	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Non-irradiation	Soil application	16.10 d	16.30 bc	1.85 a	1.95 ef	15.1 efg	14.9 efg
		Water extract	15.90 d	16.10 c	1.83 a	1.95 ef	14.2 g	14.0 g
	Irradiation	Soil application	16.70 abc	16.90 ab	2.05 a	2.15 abc	17.0 abc	16.7 abc
		Water extract	16.20 cd	16.40 bc	1.90 a	2.00 def	16.1 cde	15.9 cd
Poultry manure	Non-irradiation	Soil application	16.00 d	16.20 c	1.85 a	1.95 f	15.9 cde	15.7 de
		Water extract	15.90 d	16.10 c	1.80 a	1.90 f	14.9 efg	14.6 fg
	Irradiation	Soil application	17.10 a	17.10 a	2.15 a	2.25 a	17.9 a	17.6 a
		Water extract	16.50 bcd	16.70 abc	2.00 a	2.10 bcd	16.9 abc	16.7 abc
Sheep manure	Non-irradiation	Soil application	16.00 d	16.20 c	1.85 a	1.95 ef	15.5 def	15.3 def
		Water extract	15.90 d	16.10 c	1.80 a	1.90 f	14.6 fg	14.3 c
	Irradiation	Soil application	16.90 ab	17.10 a	2.10 a	2.20 ab	17.4 ab	17.1 ab
		Water extract	16.40 bcd	16.60 abc	1.95 a	2.03 cde	16.5 bcd	16.2 bcd

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

Moreover, irradiating organic manure surpassed non-irradiating treatment in induced a pronounced positive effect on leaf area in both seasons.

Furthermore, soil application of organic manure succeeded to induce a remarkable enhancing effect on leaf area as compared water extract treatment in this respect.

In addition, **Table (63)** illustrates that the interaction between organic manure source and irradiating organic manure , demonstrated that irradiating poultry manure produced more expanded leaf in both seasons whereas non-irradiation or irradiating cattle manure gave the lowest values in this respect.

On the other hand, the interaction between organic manure source and method of organic manure application, declared that poultry manure applied either as soil application or water extract exerted the highest positive effect on leaf area of Sour orange seedlings, in the first season, **(Table, 64).**

Furthermore, applying irradiated organic manure and as soil application exerted the highest stimulative effect on leaf area, followed descendingly by those applied as water extract. On the contrary, non-irradiation of organic manure and applied as soil application or water extract induced the lowest positive effect on leaf area in both seasons **(Table, 65).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other studied combinations in enriching leaf area with the superiority to irradiating poultry manure on the expense of non-irradiation of poultry manure and applied as soil application on the expense of water extract application method. Besides, sheep

manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 66).**

4.2.1.1.8 Stem dry weight

It is clear from **Table (67)** that poultry manured seedlings had the highest values of stem dry weight as compared with those produced by from cattle manured ones in both seasons. Besides, sheep manured seedlings had intermediate values in this respect.

Moreover, irradiated organic manure surpassed non-irradiating organic manure in increasing stem dry weight in both seasons.

Furthermore, soil application of organic manure increased stem dry weight as compared water extract of organic manure in both seasons.

In addition, **Table (68)** illustrates that the interaction between organic manure source and irradiating organic manure , declared that irradiated poultry manure had the highest stem dry weight values in both seasons. Non-irradiation and irradiation of cattle manure had the lowest values in this respect.

On the other hand, the interaction between organic manure source and method of organic manure application, showed that poultry manure applied as soil application or water extract induced the highest positive effect on stem dry weight of Sour orange seedlings in both seasons, **(Table, 69).**

Furthermore, applying irradiating organic manure as soil application exerted the highest stimulative effect on stem dry

Table (67): Specific effect of organic manure source, irradiation and application method on plant dry weight parameters of Sour orange seedlings (2000 and 2001 seasons).

Factor	Stem dry Weight (g)		Leaves dry weight (g)		Root dry Weight (g)		Total seedling dry weight (g)		Top :root Ratio	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source										
Cattle manure	3.57 c	3.44 c	3.20 c	3.55 c	3.58 c	3.70 c	10.36 c	11.02 c	1.88 b	1.96 b
Poultry manure	4.53 a	4.74 a	4.96 a	4.73 a	4.65 a	4.75 a	14.06 a	14.14 a	2.03 a	1.98 b
Sheep manure	44.26 b	4.50 b	4.42 b	3.36 b	4.19 b	4.28 b	12.86 b	13.15 b	2.06 a	2.06 a
b. Effect of Irradiation										
Non-irradiation	3.89 b	4.12 b	3.96 b	4.02 b	3.97 b	4.07 b	11.76 b	12.17 b	1.96 b	1.99 b
Irradiation	4.34 a	4.55 a	4.43 a	4.40 a	4.31 a	4.41 a	13.10 a	13.37 a	2.02 a	2.02 a
c. Effect of application method										
Soil application	4.22 a	4.44 a	4.32 a	4.33 a	4.22 a	4.33 a	12.77 a	13.05 a	2.01 a	2.01 a
Water extract	4.02 b	4.23 b	4.06 b	4.10 b	4.06 b	4.15 b	12.08 b	12.49 b	1.97 b	1.99 a

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

Table (68): Effect of interaction between organic manure source and irradiation on plant dry weight parameters of Sour orange seedlings (2000 and 2001 seasons).

Organic manure Source	Irradiation	Stem dry Weight (g)		Leaves dry weight (g)		Root dry Weight (g)		Total seedling dry weight (g)		Top :root Ratio	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001,	(2000)	(2001)
Cattle	Non-irradiation	3.27 f	3.50 f	2.95 f	3.10 e	3.42 f	3.52 f	9.65 e	10.34 e	1.81 d	1.92 e
	Irradiation	3.87 e	4.05 e	3.45 e	3.79 d	3.74 e	3.87 e	11.07 d	11.72 d	1.95 c	2.01 c
Poultry	Non-irradiation	4.31 c	4.51 c	4.78 b	4.58 b	4.45 b	4.56 b	13.36 b	13.48 b	2.04 b	1.99 d
	Irradiation	4.74 a	4.96 a	5.15 a	4.88 a	4.85 a	4.94 a	14.75 a	14.79 a	2.03 b	1.98 d
Sheep	Non-irradiation	4.10 d	4.36 d	4.15 d	4.17 c	4.05 d	4.15 d	12.25 c	12.69 c	2.03 b	2.05 b
	Irradiation	4.42 b	4.64 b	4.70 c	4.55 b	4.34 c	4.41 c	13.47 b	13.61 b	2.10 a	2.08 a

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

Table (69): Effect of interaction between organic manure source and application method plant dry weight parameters of Sour orange seedlings (2000 and 2001 seasons).

Organic manure source	Application method	Stem dry Weight (g)		Leaves dry weight (g)		Root dry Weight (g)		Total seedling dry weight (g)		Top:root Ratio	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Soil application	3.68 e	3.87 d	3.25 e	3.66 e	3.66 e	3.80 e	10.60 e	11.34 e	1.88 c	1.98 b
	Water extract	3.46 f	3.67 e	3.15 f	3.43 f	3.51 f	3.60 f	10.14 f	10.71 f	1.88 c	1.95 b
Poultry	Soil application	4.62 a	4.84 a	5.08 a	4.83 a	4.75 a	4.83 a	14.44 a	14.32 a	2.03 b	1.98 b
	Water extract	4.43 b	4.64 b	4.85 b	4.63 b	4.55 b	4.67 b	13.67 b	13.95 b	2.03 b	1.98 b
Sheep	Soil application	4.35 c	4.61 b	4.65 c	4.49 c	4.27 c	4.37 c	13.27 c	13.48 c	2.09 a	2.07 a
	Water extract	4.17 d	4.39 c	4.20 d	4.23 d	4.12 d	4.19 d	12.44 d	12.82 d	2.03 b	2.05 a

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

weight, followed descendingly by those applied as water extract. On the contrary, non-irradiation of organic manure and applied as soil application and water extract had the lowest positive effect on stem dry weight in both seasons **(Table, 70).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other combinations in enhancing stem dry weight with the superiority to irradiating poultry manure on the expense of non-irradiation treatment applied as soil application on the expense of water extract of organic manure. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 71).**

4.2.1.1.9 Leaves dry weight

It is clear from **Table (67)** that poultry manured seedlings had the highest leaves dry weight as compared with those arised from cattle manured ones in both seasons. Besides, sheep manured seedlings came in between in this respect.

Moreover, irradiated organic manure surpassed non-irradiated ones in increasing leaves dry weight in both seasons.

Furthermore, soil application of organic manure succeeded to induce a positive effect on leaves dry weight as compared water extract of organic manure.

In addition, **Table (68)** illustrates that the interaction between organic manure source and irradiation of organic

Table (70): Effect of interaction between irradiation and application method of organic manure on plant dry weight parameters of Sour orange seedlings (2000 and 2001 seasons).

Irradiation	Application method	Stem dry Weight (g)		Leaves dry weight (g)		Root dry Weight (g)		Total seedling dry weight (g)		Top :root Ratio	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Non-irradiation	Soil application	3.99 c	4.22 c	4.08 c	4.12 c	4.06 c	4.16 c	12.13 c	12.39 c	1.97 c	1.99 ab
	Water extract	3.80 d	4.03 d	3.83 d	3.92 d	3.89 d	3.99 d	11.38 d	11.94 d	1.95 d	1.98 b
Irradiation	Soil application	4.44 a	4.65 a	4.56 a	4.53 a	4.39 a	4.50 a	13.41 a	13.70 a	2.04 a	2.03 a
	Water extract	4.24 b	4.44 b	4.30 b	4.28 b	4.23 b	4.31 b	12.79 b	13.05 b	2.01 b	2.01 ab

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

Table (71): Effect of interaction between organic manure source, irradiation and application method on plant dry weight parameters of Sour orange seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Application method	Stem dry Weight (g)		Leaves dry weight (g)		Root dry Weight (g)		Total seedling dry weight (g)		Top:root Ratio	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Non-irradiation	Soil application	3.40 l	3.60 l	3.00 j	3.46 j	3.52 k	3.62 k	9.92 l	10.68 j	1.81 g	1.94 de
		Water extract	3.15 j	3.40 j	2.9 k	3.16 k	3.33 l	3.43 l	9.39 j	9.99 k	1.81 g	1.91 e
	Irradiation	Soil application	3.97 g	4.15 g	3.50 h	3.87 h	3.80 l	3.98 l	11.27 g	12.00 h	1.96 e	2.01 bc
		Water extract	3.77 h	3.95 h	3.41 l	3.71 l	3.69 j	3.77 j	10.88 h	11.43 l	1.94 f	2.00 bcd
Poultry manure	Non-irradiation	Soil application	4.38 d	4.58 d	4.96 c	4.67 c	4.51 c	4.66 c	13.87 c	13.55 d	2.04 bc	1.97 bcd
		Water extract	4.25 ef	4.45 e	4.60 d	4.50 d	4.34 e	4.46 e	12.86 d	13.41 de	2.04 bc	2.01 bcd
	Irradiation	Soil application	4.87 a	5.10 a	5.20 a	5.00 a	4.94 a	5.00 a	15.01 a	15.09 a	2.03 c	2.00 bcd
		Water extract	4.62 b	4.83 b	5.10 b	4.72 b	4.77 b	4.89 b	14.49 b	14.49 b	2.03 c	1.96 cde
Sheep manure	Non-irradiation	Soil application	4.20 f	4.50 de	4.30 f	4.25 f	4.10 g	4.20 g	12.60 e	12.95 f	2.05 b	2.08 a
		Water extract	4.00 g	4.23 f	4.00 g	4.10 g	4.00 h	4.10 h	11.90 f	12.43 g	2.00 d	2.03 ab
	Irradiation	Soil application	4.50 c	4.72 c	5..00 c	4.74 b	4.44 d	4.54 d	13.94 c	14.00 c	2.013 a	2.08 a
		Water extract	4.34 de	4.58 d	4.40 e	4.36 e	4.25 f	4.29 f	12.99 d	13.22 ef	2.05 b	2.07 a

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

manure, demonstrated that irradiating poultry manure gave the highest leaves dry weight in both seasons, whereas non-irradiation and irradiating cattle manure induced the least enhancing effect in this respect.

On the other hand, the interaction between organic manure source and method of organic manure application, showed that poultry manure applied particularly as soil application or water extract exerted the highest positive effect on leaves dry weight of Sour orange seedlings in both seasons, **(Table, 69).**

Furthermore, applying irradiated organic manure as soil application exerted the highest stimulative effect on leaves dry weight, followed descendingly by those applied as water extract. On the contrary, non-irradiation of organic manure applied as soil application and / or water extract had the lowest positive effect on leaves dry weight in both seasons **(Table, 70).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other studied combinations in increasing leaves dry weight with the superiority of irradiating poultry manure on the expense of non-irradiation treatment and soil application on the expense of water extract of organic manure. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 71).**

4.2.1.1.10 Root dry weight

It is clear from **Table (67)** that poultry manured seedlings produced heavier root dry weight as compared with that given by cattle manured ones in both seasons. Other side, sheep manured seedlings had intermediate values in this respect.

Moreover, irradiated organic manures surpassed non-irradiated ones in exerting a positive effect on root dry weight in both seasons.

Furthermore, soil application of organic manure succeeded to induce a pronounced positive effect on root dry weight as compared with water extract of organic manure.

In addition, **Table (68)** illustrates that the interaction between organic manure source and irradiation of organic manure , declared that irradiating poultry manure induced heavier root dry weight in both seasons. On the contrary, non-irradiation and irradiating cattle manure had the lowest values in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, illustrated that poultry manure applied as soil application or water extract exerted the highest positive effect on root dry weight of Sour orange seedlings in both seasons**, (Table, 69).**

Furthermore, irradiated organic manure applied as soil application exerted the highest stimulative effect on root dry weight, followed descendingly by those applied as water extract. On the contrary, non-irradiating of organic manure applied as soil application or water extract had the lowest values of root dry weight in both seasons **(Table, 70).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other tested combination in improving root dry weight with the superiority to irradiating poultry manure on the expense of non-irradiation treatment and soil application on the expense of water extract application method. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 71).**

4.2.1.1.11. Total seedling dry weight

It is clear from **Table (67)** that poultry manured seedlings produced higher total seedling dry weight as compared with those produced by from cattle manured ones in both seasons.

Moreover, irradiating organic manures surpassed non-irradiating ones in increasing total seedling dry weight in both seasons.

Furthermore, soil application of organic manure succeeded to increase on total seedling dry weight as compared with water extract application method.

In addition, **Table (68)** illustrates that the interaction between organic manure source and irradiating organic manure , reveals that irradiating poultry manure induced higher total seedling dry weight in both seasons. On contrast non-irradiation and irradiating cattle manure gave the lowest values in this respect.

On the other hand, the interaction between organic manure source and method of organic manure application, shows

that poultry manure applied particularly as soil application or water extract exerted the highest positive effect on total seedling dry weight of Sour orange seedlings, in both seasons, **(Table, 69).**

Furthermore, applying irradiating organic manure as soil application exerted the highest stimulative effect on total seedling dry weight, followed descendingly by those applied as water extract. On the contrary, non-irradiation of organic manure applied as soil application and water extract had the lowest positive effect on total seedling dry weight in both seasons **(Table, 70).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other tested combination in increasing total seedling dry weight with the superiority to irradiating poultry manure on the expense of non-irradiating treatment and applied as soil application on the expense of water extract of organic manure. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 71).**

4.2.1.1.12. Top: root ratio

It is clear from **Table (67)** that sheep manured seedlings produced higher top : root ratio as compared with those given by cattle manured ones in both seasons. On the hand, sheep manured seedlings gave intermediate values in this respect.

Moreover, irradiating organic manure surpassed non-irradiating in enhancing top : root ratio in both seasons.

Furthermore, soil application of organic manure succeeded to significantly increase top: root ratio as compared water extract application method.

In addition, **Table (68)** illustrates that the interaction between organic manure source and irradiating organic manure, declared that irradiating sheep manure induced higher top : root ratio in both seasons whereas non-irradiation or irradiating cattle manure gave the lowest values in this respect.

On the other hand, the interaction between organic manure source and method of organic manure application, shows that sheep manure applied as soil application or water extract exerted the highest positive effect on top: root ratio of Sour orange seedlings in both seasons, **(Table, 69).**

Furthermore, applying irradiating organic manure as soil application exerted the highest stimulative effect on top : root ratio, followed descendingly by those applied as water extract. On the contrary, non-irradiation of organic manure, applied as soil application or water extract had the lowest positive effect on top : root ratio in both seasons **(Table, 70).**

Finally, the interaction between the three studied factors indicates that the interactions of sheep manure surpassed the other tested combination in enhancing top : root ratio with the superiority of irradiating sheep manure on the expense of non-irradiating sheep manure and soil application on the expense of water extract application method. Besides, poultry manure combination surpassed cattle manure interactions in this respect and took the same pattern of sheep manure combinations in both seasons, **(Table, 71).**

4.2.1.2. Leaf mineral content

Leaf mineral content (N, P, K, Ca, Mg, Fe, Zn and Mn) of Sour orange seedlings during 2000 and 2001 seasons in response to organic manure source (cattle, poultry and sheep), irradiation and/or non-irradiation of dry organic manner and method of organic manure application (soil application and water extract) as well as their interactions is reported in **Tables (72 - 81).**

4.2.1.2.1. Nitrogen

It is clear from **Table (72)** that leaves of poultry manured seedlings had higher values of nitrogen content (2.60 & 2.62%) as compared with those manured with cattle (2.43 & 2.48%) in the first and second seasons, respectively. Besides, leaves of sheep manured seedlings scored inbetween values of nitrogen content (2.53 & 2.52%) in 2000 and 2001 seasons, respectively. Anyhow, the differences between the three studied organic manure sources in this regard were obvious to be significant.

Furthermore, irradiation of dry organic manures enhanced leaf nitrogen content rather than non-irradiation of dry organic manuers.

In addition, the application of organic manure as soil application induced higher positive effect on leaf nitrogen content rather than water extract application method, **(Table,72).**

Furthermore, the interaction between organic manure source and irradiation of dry organic manure demonstrates that leaf nitrogen content showed more response to organic manure

Table (72): Specific effect of organic manure source, irradiation and application method on leaf N, P, K, Ca and Mg content of Sour orange seedlings (2000 and 2001 seasons).

Factor	Elements concentration in dried leaves (%)									
	Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source										
Cattle manure	2.43 c	2.48 c	0.125 b	0.125 b	0.765 c	0.755 c	3.3 c	3.2 c	0.35 c	0.36 c
Poultry manure	2.60 a	2.62 a	0.145 a	0.145 a	0.978 a	0.980 a	4.3 a	4.3 a	0.54 a	0.54 a
Sheep manure	2.53 b	2.52 c	0.132 b	0.132 a	0.850 b	0.890 b	3.9 b	3.8 b	0.44 b	0.45 b
b. Effect of Irradiation										
Non-irradiation	2.49 b	2.49 b	0.130 a	0.130 b	0.820 b	0.827 b	3.7 b	3.5 b	0.43 a	0.44 a
Irradiation	2.55 a	2.58 a	0.138 a	0.138 a	0.908 a	0.923 a	4.1 a	4.1 a	0.45 a	0.46 a
c. Effect of application method										
Soil application	2.55 a	2.55 a	0.138 a	0.138 a	0.883 a	0.897 a	4.1 a	4.0 a	0.46 a	0.46 a
Water extract	2.50 b	2.52 a	0.130 b	0.130 b	0.845 b	0.853 b	3.7 b	3.7 b	0.42 b	0.43 b

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

source rather than to irradiation of dry organic manures, hence, irradiated poultry manure, non-irradiated poultry manure and irradiated sheep manure scored the highest values of leaf nitrogen content in descending order.

Moreover, the interaction between organic manure source and method of organic manure application demonstrates that leaf nitrogen content showed more response to organic manure source rather than to method of organic manure application, hence poultry manure applied as soil application or as water extract induced the highest positive effect on leaf nitrogen content, followed descendingly by the combinations of sheep manure and lastly by the interactions of cattle manure **(Table, 74).**

Moreover, **Table (75)** reveals that the interactions between irradiation of organic manure and method of organic manure application shows that interactions of irradiation of organic manure and soil application method enhanced leaf nitrogen content followed descendingly by irradiated organic manure applied as water extract.

Finally, the interaction between organic manure source, irradiation of organic manure and method of organic manure application reveals that the interactions of poultry manure, particularly when poultry manure irradiated and applied as soil application induced the highest positive effect on leaf nitrogen content. On the contrary, the combinations of cattle manure exerted the least positive effect on leaf nitrogen content. Besides,

Table (73): Effect of interaction between organic manure source and irradiation on leaf N, P, K, Ca and Mg content of Sour orange seedlings (2000 and 2001 seasons).

Organic manure Source	Irradiation	Elements concentration in dried leaves (%)									
		Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Non-irradiation	2.41 e	2.42 c	0.125 b	0.125 b	0.745 e	0.735 f	3.3 b	3.1 e	0.33 c	0.34 c
	Irradiation	2.45 d	2.53 b	0.125 b	0.125 b	0.785 d	0.775 e	3.4 b	3.3 de	0.36 c	0.37 c
Poultry	Non-irradiation	2.55 bc	2.56 b	0.135 b	0.135 b	0.925 b	0.935 c	4.2 a	4.0 c	0.53 a	0.52 a
	Irradiation	2.65 a	2.67 a	0.155 a	0.155 a	1.030 a	1.025 a	4.4 a	4.6 a	0.55 a	0.55 a
Sheep	Non-irradiation	2.51 c	2.51 b	0.130 b	0.130 b	0.790 d	0.810 d	3.6 b	3.4 d	0.43 b	0.44 b
	Irradiation	2.56 b	2.53 b	0.135 b	0.135 b	0.910 c	0.970 b	4.3 a	4.3 b	0.45 b	0.46 b

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

Table (74): Effect of interaction between organic manure source and application method on leaf N, P, K, Ca and Mg content of Sour orange seedlings (2000 and 2001 seasons).

Organic manure source	Application method	Elements concentration in dried leaves (%)									
		Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle →	Soil application	2.45 c	2.52 bc	0.130 bc	0.130 bc	0.780 d	0.765 d	3.5 c	3.3 d	0.37 e	0.38 d
	Water Extract	2.41 c	2.44 c	0.120 c	0.120 c	0.750 d	0.745 d	3.2 d	3.2 d	0.32 f	0.33 e
Poultry →	Soil application	2.64 a	2.63 a	0.150 a	0.150 a	1.010 a	1.015 a	4.5 a	4.5 a	0.56 a	0.56 a
	Water Extract	2.56 b	2.60 ab	0.140 b	0.140 ab	0.945 b	0.945 b	4.1 b	4.1 b	0.52 b	0.52 b
Sheep →	Soil application	2.55 b	2.52 bc	0.135 b	0.135 b	0.860 c	0.910 b	4.1 b	4.0 b	0.45 c	0.45 c
	Water Extract	2.52 b	2.52 bc	0.130 bc	0.130 bc	0.840 c	0.870 c	3.7 c	3.7 c	0.43 d	0.44 c

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

Table (75): Effect of interaction between irradiation and application method of organic manure on leaf N, P, K, Ca and Mg content of Sour orange seedlings (2000 and 2001 seasons).

Irradiation	Application method	Elements concentration in dried leaves (%)									
		Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Non-irradiation	Soil application	2.50 b	2.50 b	0.133 ab	0.133 ab	0.837 c	0.840 c	3.9 b	3.6 c	0.45 b	0.45 b
	Water Extract	2.47 c	2.49 b	0.127 b	0.127 b	0.803 d	0.813 c	3.5 c	3.4 d	0.42 d	0.43 b
Irradiation →	Soil application	2.58 a	2.61 a	0.143 a	0.143 a	0.930 a	0.953 a	4.3 a	4.3 a	0.47 a	0.48 a
	Water Extract	2.53 b	2.55 ab	0.133 ab	0.133 ab	0.887 b	0.893 b	3.8 b	3.9 b	0.43 c	0.44 b

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

the combinations of sheep manure occupied inbetween positions in this respect **(Table, 76)**.

4.2.1.2.2. Phosphorus

It is clear from **Table (72)** that leaves of poultry manured seedlings had higher values of phosphorus content (0.145 & 0.145%) as compared with those manured with cattle (0.125 & 0.125%) in the first and second seasons, respectively. Besides, leaves of sheep manured seedlings scored inbetween values of phosphorus content (0.132 & 0.132%) in 2000 and 2001 seasons, respectively. The differences between the three studied organic manure sources in this regard were remarkable to be significant.

Furthermore, irradiation of dry organic manures enhanced leaf phosphorus content rather than non-irradiation treatment.

In addition, the application of organic manure as soil application enhanced leaf phosphorus content rather than water extract application method, **(Table,72).**

Furthermore, **Table (73)** indicates that the interaction between organic manure and irradiation of dry organic manner source demonstrate that leaf phosphorus content showed more response to organic manure source rather than to irradiation of dry organic manures, hence, irradiated poultry manure followed by non-irradiated dry poultry manure and irradiated sheep manure scored the highest values of leaf phosphorus content.

Moreover, the interaction between organic manure source and method of organic manure application declared that leaf phosphorus content showed more response to organic manure source rather than to method of organic manure application,

Table (76): Effect of interaction between organic manure source, irradiation and application method on leaf N, P, K, Ca and Mg content of Sour orange seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Application method	Elements concentration in dried leaves (%)									
			Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Non-irradiation	Soil application	2.42 g	2.43 de	0.130 c	0.130 c	0.770 de	0.750 ef	3.5 efg	3.2 fg	0.36 g	0.37 fg
		Water extract	2.40 g	2.42 e	0.120 c	0.120 c	0.720 e	0.720 f	3.1 g	3.1 g	0.30 l	0.32 g
	Irradiation	Soil application	2.48 ef	2.61 abc	0.130 c	0.130 c	0.790 d	0.780 def	3.6 ef	3.4 fg	0.38 f	0.39 ef
		Water extract	2.43 fg	2.46 de	0.120 c	0.120 c	0.780 de	0.770 def	3.3 fg	3.3 fg	0.34 h	0.35 fg
Poultry manure	Non-irradiation	Soil application	2.58 bc	2.57 abcd	0.140 bc	0.140 bc	0.940 bc	0.950 bc	4.4 abc	4.2 bc	0.54 b	0.53 b
		Water extract	2.52 cde	2.55 bcde	0.130 c	0.130 c	0.910 c	0.920 c	4.0 cd	3.8 de	0.52 c	0.52 bc
	Irradiation	Soil application	2.70 a	2.69 a	0.160 a	0.160 a	1.080 a	1.080 a	4.7 a	4.8 a	0.58 a	0.59 a
		Water extract	2.61 b	2.65 ab	0.150 ab	0.150 ab	0.980 b	0.970 bc	4.2 bcd	4.5 ab	0.52 c	0.52 bc
Sheep manure	Non-irradiation	Soil application	2.52 cde	2.52 bcde	0.130 c	0.130 c	0.800 d	0.820 d	3.8 de	3.5 ef	0.44 e	0.43 de
		Water extract	2.50 de	2.50 cde	0.130 c	0.130 c	0.780 de	0.800 de	3.4 efg	3.4 fg	0.43 e	0.44 de
	Irradiation	Soil application	2.58 bc	2.53 bcde	0.140 bc	0.140 bc	0.920 c	1.000 b	4.5 ab	4.6 a	0.46 d	0.47 cd
		Water extract	2.55 bcd	2.54 bcde	0.130 c	0.130 c	0.920 c	0.940 bc	4.1 bcd	4.0 cd	0.44 e	0.45 de

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

whereas poultry manure applied firstly as soil application followed by the analogous ones applied as water extract induced the highest positive effect on leaf phosphorus content, followed descendingly by the combinations of sheep manure and lastly by the interactions of cattle manure **(Table, 74).**

Moreover, **Table (75)** reveals that the interaction between irradiation of organic manure and method of organic manure application shows that interactions of irradiation of organic manure and soil application method improved leaf phosphorus content, followed descendingly by irradiation of organic manure interaction with water extract application method.

Finally, the interaction between organic manure source, irradiation of organic manure and method of organic manure application reveals that the interactions of poultry manure, particularly when poultry manure irradiated and applied as soil application induced the highest positive effect on leaf phosphorus content. On the contrary, the combinations of cattle manure exerted the least positive effects on leaf nitrogen content. Besides, the combinations of sheep manure occupied inbetween positions in this respect **(Table, 76)**.

4.2.1.2.3. Potassium

It is clear from **Table (72)** that fertilizing Sour orange seedlings poultry manure enriched leaf potassium content (0.978 & 0.980%) as compared with those manured with sheep (0.850 & 0.890%) and cattle manured seedlings (0.765 & 0.755%) in 2000 and 2001 seasons, respectively. Anyhow, the differences

between the three organic manure sources in this respect were obvious to be significant.

Furthermore, irradiation of dry organic manures enhanced leaf potassium content rather than non-irradiation treatment.

In addition, the soil application of organic manure enhanced leaf potassium content rather than water extract application method, **(Table,72).**

Moreover, **Table (73)** indicates that the interaction between organic manure and irradiation of dry organic manure demonstrated that leaf potassium content showed more response to organic manure source rather than to irradiation of dry organic manuers, where irradiated poultry manure and the secondly irradiated sheep manure recorded the highest values of leaf potassium content.

Furthermore, the interaction between organic manure source and method of organic manure application demonstrates that leaf potassium content showed more response to organic manure source rather than to method of organic manure application, hence poultry manure applied as soil application followed by water extract induced the highest positive effect on leaf potassium content, followed descendingly by the combinations of sheep manure and lastly by the interactions of cattle manure **(Table, 74).**

Moreover, **Table (75)** reveals that the interaction between irradiation of organic manure and method of organic manure application shows that interactions of irradiation of organic manure and soil application method enhanced leaf potassium content followed descendingly by irradiation of organic manure and water extract application.

Finally, the interaction between organic manure source, irradiation of organic manure and method of organic manure application shows that the interactions of poultry manure, particularly when poultry manure irradiated and applied as soil application induced the highest positive effect on leaf potassium content. followed descendingly by sheep manure irradiated and applied as soil application. On the contrary, the combinations of cattle manure exerted the least positive effects on leaf potassium content. Besides, the combinations of sheep manure occupied inbetween positions in this respect **(Table, 76)**.

4.2.1.2.4. Calcium

It is clear that fertilizing Sour orange seedlings poultry manure enriched leaf calcium content (4.3 & 4.3%) as compared with those manured with sheep (3.9 & 3.8%) and cattle manure (3.3 & 3.2%) in 2000 and 2001 seasons, respectively. Anyhow, the differences between the three organic manure sources in this respect were pronounced to be significant.

Furthermore, irradiation of dry organic manures enhanced leaf calcium content rather than non-irradiation treatment.

In addition, the soil application of organic manure source enhanced leaf calcium content rather than water extract application method, **(Table,72).**

Moreover, **Table (73)** indicates that the interaction between organic manure source and irradiation of dry organic manner demonstrated that leaf calcium content showed more response to organic manure source rather than to irradiation of dry organic manuers, where, irradiated poultry manure poultry

manure and the irradiated sheep manure gave the highest values in this respect.

Furthermore, the interaction between organic manure source and method of organic manure application declared that leaf calcium content showed more response to organic manure source rather than to method of organic manure application, hence soil application of poultry manure applied in soil application water extract induced the highest positive effect on leaf calcium content, followed descendingly by the combinations of sheep manure and lastly by the interactions of cattle manure **(Table, 74).**

Moreover, **Table (75)** reveals that the interaction between irradiation of organic manure source and method of organic manure application shows that interactions of irradiation of organic manure source and method of organic manure application as soil application enhanced leaf calcium content followed descendingly by irradiation of organic manure and water extract application method.

Finally, the interaction between organic manure source, irradiation of organic manure and method of organic manure application shows that the interactions of poultry manure, particularly when poultry manure irradiated and applied as soil application induced the highest positive effect on leaf calcium content. followed descendingly by sheep manure irradiated and applied as soil application. On the contrary, the combinations of cattle manure exerted the least positive effect on leaf calcium content. Besides, the combinations of sheep manure occupied inbetween positions in this respect **(Table,76)**.

4.2.1.2.5. Magnesium

It is clear from **Table (72)** that leaves of poultry manured Sour orange seedlings had higher values of magnesium content (0.54 & 0.54%) as compared with those manured with cattle (0.35 & 0.36%) in the first and second seasons, respectively. Besides, leaves of sheep manured seedlings scored inbetween values of magnesium content (0.44 & 0.45%) in 2000 and 2001 seasons, respectively. Anyhow, the differences between the three studied organic manure sources in this regard were remarkable to be significant.

Furthermore, irradiation of dry organic manures enhanced leaf magnesium content rather than non-irradiation of dry organic manures.

In addition, the application method of organic manure failed to induce any positive effect on leaf magnesium content in both seasons **(Table,72).**

Furthermore, the interaction between organic manure source and irradiation of dry organic manure demonstrates that leaf magnesium content showed more response to organic manure source rather than to irradiation of dry organic manuers, hence, irradiated poultry manure, non-irradiated poultry manure and irradiated sheep manure showed the highest values in this respect.

Moreover, the interaction between organic manure source and method of organic manure application demonstrates that leaf magnesium content showed more response to organic manure source rather than to method of organic manure application, hence poultry manure applied firstly as soil application or water

extract induced the highest positive effect on leaf magnesium content, followed descendingly by the combinations of sheep manure and lastly by the interactions of cattle manure **(Table, 74).**

Moreover, **Table (75)** reveals that the interaction between irradiation of organic manure and method of organic manure application shows that interactions of irradiation of organic manure and soil application method enhanced leaf magnesium content followed descendingly by irradiation of organic manure source and method of organic manure application in soil application of water extract.

Finally, the interaction between organic manure source, irradiation of organic manure source and method of organic manure application shows that the interactions of poultry manure, particularly when poultry manure irradiated and applied as soil application induced the highest positive effect on leaf magnesium content. On the contrary, the combinations of cattle manure exerted the least positive effect on leaf magnesium content. Besides, the combinations of sheep manure occupied inbetween positions in this respect **(Table, 76)**.

4.2.1.2.6. Iron, Manganese and Zinc

It is obvious from **Table (77)** that leaves of poultry manured seedlings had the highest values of leaf Fe, Mn and Zn content, followed descendingly by those of sheep manured ones and lastly those fertilized with cattle manure. However, the differences between the three tested organic manure sources in this concern were remarkable to be significant.

Table (77): Specific effect of organic manure source, irradiation and application method on leaf Fe, Mn and Zn content of Sour orange seedlings (2000 and 2001 seasons).

Factor	Elements concentration in dried leaves (ppm)					
	Iron		Manganese		Zinc	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source						
Cattle manure	74 c	73 c	48 c	46 c	44 c	43 c
Poultry manure	94 a	93 a	74 a	74 a	72 a	67 a
Sheep manure	84 b	82 b	65 b	62 b	58 b	56 b
b. Effect of irradiation						
Non-irradiation	82 b	81 b	59 b	57 b	55 b	52 b
Irradiation	86 a	84 a	66 a	65 a	61 a	59 a
c. Effect of application method						
Soil application	86 a	84 a	65 a	63 a	61 a	57 a
Water extract	82 b	80 b	60 b	58 b	55 b	54 b

Means within each column, followed by the same letter(s) are not significantly different at 5% level

Moreover, irradiation of organic manure enhanced leaf Fe, Mn and Zn content rather than non-irradiation of organic manure source.

Furthermore, the soil application of organic manure enhancd leaf Fe, Mn and Zn content rather than water extract application method.

Additionally, **Table (78)** reveals that the application of irradiated poultry manure and non-irradiated exerted the highest stimulative effect on leaf Fe, Mn and Zn content. On the contrary, the application of cattle manure either irradiated or non-irradiated induced the lowest values in this respect. The interactions of sheep manure occupied an intermediate position in this sphere.

Table (79) shows that the application of poultry manure as soil application and water extract exerted the highest stimulative effect on leaf Fe, Mn and Zn content. On the contrary, the application of cattle manure either as soil application or soil application water extract induced the lowest values in this respect. The interactions of sheep manure occupied an intermediate position in this sphere.

Table (80) shows that leaves of irradiated organic manure seedlings general manured superficial or water extract were the richest ones in their content of Fe, Mn and Zn as compared with those of non-irradiated manured seedlings.

Lastly, the interaction between organic manure source, irradiation of organic manure and method of organic manure application, **(Table,81)** reveals that the poultry manured

Table (78): Effect of interaction between organic manure source and irradiation on leaf Fe, Mn and Zn content of Sour orange seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Elements concentration in dried leaves (ppm)					
		Iron		Manganese		Zinc	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure →	Non-irradiation	74 e	73 c	40 d	38 f	45 e	43 f
	Irradiation	75 e	73 c	49 c	49 e	52 d	50 e
Poultry manure →	Non-irradiation	92 b	91 a	70 a	64 b	71 b	69 b
	Irradiation	97 a	95 a	74 a	70 a	78 a	78 a
Sheep manure →	Non-irradiation	82 d	80 b	56 b	54 d	63 c	60 d
	Irradiation	87 c	84 b	60 b	59 c	68 b	65 c

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

Table (79): Effect of interaction between organic manure source and application method on leaf Fe, Mn and Zn content of Sour orange seedlings (2000 and 2001 seasons).

Organic manure source	Application method	Elements concentration in dried leaves (ppm)					
		Iron		Manganese		Zinc	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Soil application	78 d	76 d	51 e	49 e	48 d	45 e
	Water extract	71 e	70 e	46 f	44 f	40 e	42 e
Poultry manure	Soil application	97 a	95 a	77 a	77 a	73 a	69 a
	Water extract	92 b	90 b	71 b	71 b	71 b	65 b
Sheep manure	Soil application	85 c	83 c	67 c	64 c	61 b	58 c
	Water extract	84 c	81 c	63 d	61 d	55 c	55 d

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

Table (80): Effect of interaction between irradiation and application method of organic manure on leaf Fe, Mn and Zn content of Sour orange seedlings (2000 and 2001 seasons).

Irradiation	Application method	Elements concentration in dried leaves (ppm)					
		Iron		Manganese		Zinc	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Non-irradiation	Soil application	85 b	83 b	61 b	59 c	57 b	53 c
	Water extract	80 c	79 c	57 c	55 d	54 c	51 c
Irradiation	Soil application	88 a	86 a	69 a	67 a	64 a	61 a
	Water extract	84 b	81 bc	63 b	62 b	57 b	57 b

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

Table (81): Effect of interaction between organic manure source, irradiation and application method on leaf Fe, Mn and Zn content of Sour orange seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Application method	Elements concentration in dried leaves (PPM)					
			Iron		Manganese		Zinc	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Non-irradiation	Soil application	78 d	76 f	47 hi	45 h	42 fg	40 g
		Water extract	70 e	70 g	43 I	41 I	38 g	37 g
	Irradiation	Soil application	78 d	76 f	56 g	53 g	55 de	50 f
		Water extract	72 e	70 g	49 h	47 h	43 f	48 f
Poultry manure	Non-irradiation	Soil application	95 b	93 b	73 bc	72 c	71 b	65 bc
		Water extract	90 bc	89 bc	69 cde	67 d	70 b	64 bc
	Irradiation	Soil application	100 a	98 a	82 a	82 a	76 a	73 a
		Water extract	94 b	92 b	74 b	75 b	72 ab	67 b
Sheep manure	Non-irradiation	Soil application	82 d	80 ef	65 ef	61 f	59 cd	56 de
		Water extract	82 d	80 ef	61 f	59 f	54 e	52 ef
	Irradiation	Soil application	88 c	86 cd	70 bcd	67 d	63 c	61 cd
		Water extract	87 c	82 de	66 de	64 e	57 de	58 d

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

seedlings, irradiated and manured superficial or as water extract followed descendingly by the corresponding ones non-irradiated and manured as soil application and water extract showed the highest values of leaf Fe, Mn and Zn content. Besides, the combinations of sheep manure proved to be more efficient in enhancing leaf Fe, Mn and Zn content than the analogous ones of cattle manure.

Briefly, the results of leaf mineral content due to organic manure source are in accordance with the findings of **Sekiya et al. (1993)** on Satsuma mandarin, **Kalu-Singh et al. (1984)** on mango. **Noack (1984)** on apple, **Darfeld and Lenz (1985)** on pear, **Umemiya and Sekiya (1985)** on persimmon, **Villasurda and Baluyut (1990)** on guava, **Ben-Ya-Acov et al. (1992)** on avocado, **Awad et al. (1993)** on olive, **Alvarez etal. (1993)** on pinapple, **Smith (1994)** on banana, **Abu-Sayed Ahmed (1997)** on Balady mandarin and **El-Kobbia (1999)** on Balady mandarin and **Moustafa (2002)** on Washington navel orange. They reported that organic manures particularly, poultry manure enhanced leaf mineral content.

Besides, the obtained results of leaf mineral content attributed to the effect of method of organic manure application are in harmony with the findings of **Thachuk (1983)** on apple, **Bhangoo et al. (1988)** on grape and **Goede (1993)** on mango. Moreover, the results of biofertilization regarding leaf mineral content are in agreement with the findings of **Pmares et al. (1983)** on oranges, **Chokha et al. (1993)** on orange, **Haggag and Azzazy (1996)** on mango, **Ahmed et al. (1997)** on grape, **Awashi et al. (1998)** on peach, **Fernandez et al. (1998)** on banana, **Mansour (1998)** on Anna apple, **Mahmoud and**

Mahmoud (1999) on peach **Tiwary et al. (1999)** on banana and **Moustafa (2002)** on Washington navel orange. They mentioned that Rhizobacterien enhanced most leaf mineral content.

4.2.2. Volkamer lemon seedlings

4.2.2.1. Plant growth parameters

Tables (82-96) shows that growth parameters, i.e. seedling height, stem diameter, leaf chlorophyll (a & b), No. of leaves /seedling, leaf surface area, root length, No. of root /seedling, stem dry weight, leaves dry weight, root dry weight, total seedling dry weight and top:root ratio of Volkamer lemon seedlings in response to organic manure source irradiation and non-irradiation and method of organic manure application during 2000 & 2001 seasons.

4.2.2.1.1. Seedling height

It is clear from **Table (82)** that poultry manured seedlings produced taller stem as compared with those arised from cattle manured ones in both seasons. On the other hand, sheep manured seedlings had intermediate values in this respect.

Moreover, irradiating organic manure surpassed non-irradiated ones in exerting a distinctive positive effect on seedling height in both seasons.

Furthermore, soil application of organic manure succeeded in inducing a distinctive effect on seedling height as compared water extract application of organic manure .

In addition, **Table (83)** illustrates that the interaction between organic manure source and irradiating organic manure,

Table (82): Specific effect of organic manure source, irradiation and application method on some growth parameters of leaves Volkamer lemon seedlings (2000 and 2001 seasons)

Factor	Seedling height (cm)		Stem diameter (cm)		Leaf chlorophyll (mg/L) (a)		Leaf chlorophyll (mg/L) (b)		No. of leaves /seedling	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source										
Cattle manure	42 c	41 c	0.61 c	0.72 c	6.08 b	6.13 b	2.57 b	2.52 a	78 c	67 c
Poultry manure	75 a	73 a	0.99 a	1.01 a	6.17 a	6.22 a	2.67 a	2.60 a	115 a	97 a
Sheep manure	62 b	59 b	0.74 b	0.88 b	6.13 ab	6.17 ab	2.62 ab	2.58 a	92 b	83 b
b. Effect of Irradiation										
Non-irradiation	56 b	52 b	0.74 b	0.84 b	6.01 b	6.05 b	2.47 b	2.44 b	87 b	78 b
Irradiation	64 a	63 a	0.82 a	0.89 a	6.25 a	6.30 a	2.77 a	2.70 a	103 a	87 a
c. Effect of application method										
Soil application	62 a	60 a	0.80 a	0.88 a	6.19 a	6.25 a	2.70 a	2.63 a	99 a	85 a
Water extract	58 b	55 b	0.76 b	0.85 b	6.06 b	6.10 b	2.55 b	2.51 b	91 b	79 b

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

Table (83): Effect of interaction between organic manure source and irradiation on some growth parameters of leaves Volkamer lemon seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Seedling height (cm)		Stem diameter (cm)		Leaf chlorophyll (mg/L) (a)		(b)		No. of leaves /seedling	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Non-irradiation	39 e	38 e	0.58 f	0.69 f	6.00 c	6.05 d	2.42 d	2.37 c	74 f	63 f
	irradiation	46 d	45 d	0.63 e	0.74 e	6.17 b	6.22 c	2.72 b	2.67 a	82 e	71 e
Poultry	Non-irradiation	69 b	65 b	0.96 b	0.98 b	6.02 c	6.06 d	2.52 c	2.47 b	99 b	92 b
	irradiation	81 a	81 a	1.03 a	1.04 a	6.32 a	6.37 a	2.82 a	2.72 a	131 a	103 a
Sheep	Non-irradiation	59 c	55 c	0.69 d	0.85 d	6.00 c	6.05 d	2.47 cd	2.47 b	89 d	79 d
	irradiation	65 b	64 b	0.79 c	0.80 c	6.27 ab	6.30 b	2.77 ab	2.70 a	96 c	87 c

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

reveals that irradiating poultry manure induced more longer seedlings in both seasons followed descendingly by non-irradiating or irradiating cattle manure.

On the other hand, the interaction between organic manure and method of organic manure application, reveals that poultry manure applied particularly as soil application or secondly as water extract exerted the highest positive effect on seedling height of Volkamer lemon seedlings in both seasons, **(Table, 84).**

Furthermore, irradiating organic manure and manuring as soil application exerted the highest positive effect on seedling height, followed descendingly by those applied as water extract. On the contrary, non-irradiation of organic manure and applied as soil application or water extract induced the lowest positive effect on seedling height in both seasons **(Table, 85).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other combinations (cattle and sheep) in enhancing seedling height with the superiority of irradiating poultry manure on the expense of non-irradiating poultry manure and applied as soil application on the expense of water extract of organic manure. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 86).**

4.2.2.1.2. Stem diameter

It is clear from **Table (82)** that poultry manured seedlings had the highest stem diameter values as compared with those

Table (84): Effect of interaction between organic manure source and application method on some growth parameters of leaves Volkamer lemon seedlings (2000 and 2001 seasons)

Organic manure Source	Application method	Seedling height (cm)		Stem diameter (cm)		Leaf chlorophyll (mg/L) (a)		Leaf chlorophyll (mg/L) (b)		No. of leaves /seedling	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Soil application	44 d	43 d	0.63 e	0.73 c	6.15 abc	6.20 bc	2.65 abc	2.60 ab	81 e	70 e
	Water extract	41 d	39 d	0.59 f	0.70 c	6.02 c	6.07 d	2.50 d	2.45 c	75 f	64 f
Poultry	Soil application	77 a	75 a	1.01 a	1.03 a	6.24 a	6.30 a	2.75 a	2.67 a	121 a	101 a
	Water extract	72 b	71 a	0.97 b	0.99 a	6.10 bc	6.14 cd	2.60 bcd	2.52 bc	109 b	94 b
Sheep	Soil application	63 c	62 b	0.76 c	0.89 b	6.20 ab	6.25 ab	2.70 ab	2.62 ab	95 c	85 c
	Water extract	61 c	57 c	0.73 d	0.87 b	6.07 bc	6.10 d	2.55 cd	2.55 bc	90 d	81 d

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

Table (85): Effect of interaction between organic manure source and application method on some growth parameters of leaves Volkamer lemon seedlings (2000 and 2001 seasons)

Irradiation	Application method	Seedling height (cm)		Stem diameter (cm)		Leaf chlorophyll (mg/l) (a)		(b)		No. of leaves /seedling	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Non-irradiation	Soil application	56 c	55 c	0.76 c	0.85 bc	6.05 c	6.10 c	2.55 c	2.50 c	89 c	81 b
	Water extract	54 c	50 d	0.73 d	0.83 c	5.97 c	6.01 d	2.40 d	2.38 d	85 d	75 c
Irradiation	Soil application	66 a	65 a	0.84 a	0.92 a	6.34 a	6.40 a	2.85 a	2.76 a	109 a	90 a
	Water extract	61 b	61 b	0.80 b	0.87 b	6.16 b	6.20 b	2.70 b	2.63 b	97 b	84 b

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

Table (86): Effect of interaction between organic manure source, irradiation and application method on some growth parameters of leaves Volkamer lemon seedlings (2000 and 2001 seasons)

Organic manure source	Irradiation	Application method	Seedling height (cm)		Stem diameter (cm)		Leaf chlorophyll (mg/L) (a)		(b)		No. of leaves /seedling	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Non-irradiation	Soil application	40 g	39 f	0.61 j	0.70 g	6.05 def	6.10 efg	2.50 fgh	2.45 def	78 g	67 h
		Water extract	38 g	37 f	0.56 k	0.68 g	5.95 f	6.00 g	2.35 I	2.30 f	71 h	60 I
	irradiation	Soil application	48 f	48 e	0.65 I	0.77 f	6.25 bc	6.30 bc	2.80abc	2.75 ab	85 ef	74 g
		Water extract	44 fg	42 f	0.62 j	0.72 fg	6.10 cdef	6.15 def	2.65 cdef	2.60 bcd	80 fg	68 h
Poultry manure	Non-irradiation	Soil application	70 c	68 b	0.98 c	0.99 b	6.05 def	6.10efg	2.60 defg	2.55 cde	100 c	95 bc
		Water extract	68 c	62 cd	0.95 d	0.97 bc	6.00 ef	6.03 fg	2.45 ghi	2.40 ef	98 c	90 cd
	irradiation	Soil application	85 a	82 a	1.05 a	1.07 a	6.43 a	6.50 a	2.90 a	2.80 a	142 a	107 a
		Water extract	77 b	80 a	1.00 b	1.02 ab	6.20 bcd	6.25 cd	2.75 abcd	2.65 abc	120 b	99 b
Sheep manure	Non-irradiation	Soil application	60 de	58 d	0.71 g	0.86 e	6.05 def	6.10efg	2.55 efgh	2.50 cde	90 de	82 ef
		Water extract	58 e	52 e	0.68 h	0.85 e	5.96 f	6.00 g	2.40 hi	2.45 def	88 de	77 fg
	irradiation	Soil application	66 cd	67 bc	0.81 e	0.92 cd	6.35 ab	6.40 ab	2.85 ab	2.75 ab	100 c	89 d
		Water extract	64 cde	62 cd	0.78 f	0.89 de	6.18 bcde	6.20 cde	2.70 bcde	2.65 abc	92 d	85 de

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

arised from cattle manured ones in both seasons. On the other hand, sheep manured seedlings had intermediate values in this respect.

Moreover, irradiating organic manure surpassed non-irradiating organic manure to exert a distinctive positive effect on stem diameter in both seasons.

Furthermore, soil application of organic manure succeeded to induce a pronounced positive effect on stem diameter as compared with water extract of organic manure.

In addition, **Table (83)** illustrates that the interaction between organic manure source and irradiating organic manure, shows that irradiating poultry manure produced the highest stem diameter in both seasons whereas non-irradiating or irradiating cattle manure induced the lowest positive effect in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, indicates that poultry manure applied particularly as soil application or secondly as water extract exerted the highest positive effect on stem diameter of Volkamer lemon seedlings in both seasons, **(Table, 84).**

Furthermore, irradiating organic manure and applied as soil application exerted the highest enhancing effect on stem diameter, followed descendingly by those applied as water extract. On the contrary, non-irradiating organic manure applied as soil application or water extract induced the lowest positive effect on stem diameter in both seasons **(Table, 85).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other combinations (cattle and sheep) in enhancing stem diameter with the superiority of irradiating poultry manure on the expense of non-irradiating poultry manure and applied as soil application on the expense of water extract application of organic manure. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 86).**

4.2.2.1.3. leaf chlorophyll (a & b)

Table (82) shows that leaves of poultry manured seedlings had the highest values of chlorophyll (a) followed descendingly by those of sheep manured ones and finally of cattle manured seedlings in both seasons. Besides, leaves of poultry manured seedlings had the highest values of chlorophyll (b) followed descendingly by these of sheep manured ones and finally of cattle manured seedlings in the first season **(2000).**

Moreover, irradiating organic manure surpassed non-irradiating organic manure in enhancing leaf chlorophyll (a & b) in both seasons

Furthermore, soil application of organic manure succeeded to induce a pronounced effect on chlorophyll (a & b) as compared water extract application of organic manure.

In addition, **Table (83)** illustrates that the interaction between organic manure source and irradiation of organic manure, demonstrates that irradiating poultry manure

significantly enhanced chlorophyll (a & b) in both seasons whereas non-irradiation or irradiating cattle manure showed the lowest positive effect in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, illustrates that poultry manure applied as soil application or water extract exerted the highest positive effect on chlorophyll (a & b) of Volkamer lemon seedlings, in both seasons, **(Table, 84).**

Furthermore, irradiating organic manure and manuring as soil application exerted the highest stimulative effect on chlorophyll (a & b) , followed descendingly by those applied as water extract. On the contrary, non-irradiation of organic manure and applied as soil application or as water extract had the lowest positive effect on chlorophyll (a & b) in both seasons **(Table, 85).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other combination (cattle and sheep) in enhancing chlorophyll a& b with the superiority of irradiating poultry manure on the expense of non-irradiating poultry manure and applied as soil application on the expense of water extract of organic manure application. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 86).**

4.2.2.1.4. No. of leaves/seedling

It is clear from **Table (82)** that poultry manured seedlings produced higher No. of leaves/seedling as compared with those arised from cattle manured ones in both seasons. On the contrary, cattle manured seedlings had the lowest values in this respect.

Moreover, irradiating organic manure surpassed nonirradiating organic manure in exerting a distinctive effect on No. of leaves/seedling in both seasons.

Furthermore, Soil application of organic manure succeeded to induce a distinctive effect on No. of leaves/seedling as compared with water extract of organic manure in this respect.

In addition, **Table (83)** illustrates that the interaction between organic manure source and irradiating organic manure , reveals that irradiating poultry manure induced more No. of leaves/seedling in both seasons followed descendingly by non-irradiating and / or irradiating cattle manure had the lowest distinctive effect in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, reveals that poultry manure applied in soil application and/or water extract exerted the highest positive effect on no. of leaves/seedling of Volkamer lemon seedlings followed descendingly by sheep manure applied in soil application and / or water extract, in both seasons, **(Table, 84).**

Furthermore, irradiating organic manure and applied in soil application exerted the highest stimulative effect on no. of leaves/seedling, followed descendingly by those applied in water

extract. On the contrary, non-irradiating organic manure and applied in soil application and / or water extract had the lowest positive effect on no. of leaves/seedling in both seasons **(Table, 85).**

Finally, the interaction between the three studied factors indicates that the interaction of poultry manure surpassed the other combination (cattle and sheep) in enhancing no. of leaves/seedling with the superiority of irradiating poultry manure on the expense of non-irradiating poultry manure and applied in soil application on the expense of water extract of organic manure. Besides, sheep manure combination surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 86).**

4.2.2.1.5. Root length

It is clear from **Table (87)** that poultry manured seedlings produced longer roots length as compared with those arised from cattle manured ones in both seasons. Besides, sheep manured seedlings had intermediate values in this respect.

Moreover, irradiating organic manure surpassed non-irradiating organic manure in produced longer roots in both seasons.

Furthermore, soil application of organic manure succeeded to exert significantly positive effect on root length as compared with water extract application of organic manure.

In addition, **Table (88)** illustrates that the interaction between organic manure source and irradiation of organic manure, indicates that irradiating poultry manure enhanced root

Table (87): Specific effects of organic manure source, irradiation and application method on leaf area, root length and No. of roots/seedling of Volkamer lemon seedlings (2000 and 2001 seasons).

Factor	Leaf area (cm^2)		No. of roots/seeding		Root length (cm)	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source						
Cattle manure	15.9 a	16.1 a	2.56 a	2.66 a	17.9 c	18.4 c
Poultry manure	16.1 a	16.2 a	2.66 a	2.76 a	18.8 a	19.1 a
Sheep manure	16.0 a	16.2 a	2.62 a	6.71 a	18.4 b	18.7 b
b. Effect of irradiation						
Non-irradiation	15.7 b	15.8 b	2.54 b	2.63 b	17.2 b	17.5 b
Irradiation	16.3 a	16.5 a	2.69 a	2.79 a	19.5 a	19.8 a
c. Effect of application method						
Soil application	16.2 a	16.3 a	2.66 a	2.76 a	18.9 a	19.3 a
Water extract	15.8 b	16.0 b	2.56 b	2.66 b	17.8 b	18.1 b

Means within each column, followed by the same letter(s) are not significantly different at 5% level

Table (88): Effect of interaction between organic manure source and irradiation on leaf area, root length and No. of roots/seedling of Volkamer lemon seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Leaf area (cm^2)		No. of roots/seeding		Root length (cm)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Non-irradiation	15.7 c	15.9 b	2.50 c	2.60 d	16.9 c	17.3 d
	Irradiation	16.1 b	16.3 a	2.62 abc	2.72 bc	19.0 b	19.4 b
Poultry manure	Non-irradiation	15.6 c	15.8 b	2.55 bc	2.65 cd	17.5 c	17.8 c
	Irradiation	16.5 a	16.6 a	2.77 a	2.87 a	20.0 a	20.3 a
Sheep manure	Non-irradiation	15.6 c	15.8 b	2.57 bc	2.65 cd	17.3 c	17.5 cd
	Irradiation	16.3 ab	16.5 a	2.67 ab	2.77 b	19.6 ab	19.8 b

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

length in both seasons whereas non-irradiation and/ or irradiating cattle manure had the lowest stimulstive effect in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, shows that poultry manure applied as soil application or water extract induced the highest positive effect on root length of Volkamer lemon seedlings, in both seasons, **(Table, 89).**

Furthermore, irradiating organic manure and application as soil application exerted the highest stimulative effect on root length, followed descendingly by those applied as water extract. On the contrary, non-irradiation of organic manure and applied as soil application or water extract had the lowest positive effect on root length in both seasons **(Table, 90).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other combinations (cattle and sheep) in enhancing root length with the superiority to irradiating poultry manure on the expense of nonirradiating poultry manure and applied in soil application on the expense of water extract of organic manure. Besides, sheep manure combination surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 91).**

4.2.2.1.6. No. of roots / seedling

It is clear from **Table (87)** that organic manure source failed to induce a distinctive effect on No. of roots/seedling in both seasons.

Table (89): Effect of interaction between organic manure source and application method on leaf area, root length and No. of roots/seedling of Volkamer lemon seedlings (2000 and 2001 seasons).

Organic manure source	Application method	Leaf area (cm^2)		No. of roots/seeding		Root length (cm)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Soil application	16.1 ab	16.3 a	2.60 bc	2.70 bc	18.5 bc	18.9 ab
	Water extract	15.7 b	15.9 a	2.52 c	2.62 c	17.4 d	17.8 b
Poultry manure	Soil application	16.2 a	16.3 a	2.72 a	2.82 a	19.4 a	19.7 a
	Water extract	15.9 ab	16.1 a	2.60 bc	2.70 bc	18.1 cd	18.4 ab
Sheep manure	Soil application	16.1 ab	16.3 a	2.67 ab	2.75 ab	19.0 ab	19.3 ab
	Water extract	15.8 ab	16.0 a	2.57 bc	2.67 bc	17.8 cd	18.1 b

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

Table (90): Effect of interaction between irradiation and application method of organic manure on leaf area, root length and No. of roots/seedling of Volkamer lemon seedlings (2000 and 2001 seasons).

Irradiation	Application method	Leaf area (cm^2)		No. of roots/seeding		Root length (cm)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Non-irradiation	Soil application	15.7 c	15.9 bc	2.55 b	2.63 b	17.7 c	18.1 bc
	Water extract	15.6 c	15.8 c	2.53 b	2.63 b	16.7 d	17.0 e
Irradiation	Soil application	16.6 a	16.7 a	2.78 a	2.88 a	20.2 a	20.5 a
	Water extract	16.1 b	16.2 b	2.60 b	2.70 b	18.8 b	19.2 b

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

Table (91): Effect of interaction between organic manure source, irradiation and application method on leaf area, root length and No. of roots/seedling of Volkamer lemon seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Application method	Leaf area (cm^2)		No. of roots/seeding		Root length (cm)	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Non-irradiation	Soil application	15.8 d	16.0 bc	2.50 d	2.60 d	17.5 efgh	17.9 cdef
		Water extract	15.6 d	15.8 c	2.50 d	2.60 d	16.4 h	16.7 f
	Irradiation	Soil application	16.4 abc	16.6 ab	2.70 bc	2.80 bc	19.5 bc	20.0 abc
		Water extract	15.9 cd	16.1 bc	2.55 cd	2.65 cd	18.5 cde	18.9 abcdef
Poultry manure	Non-irradiation	Soil application	15.7 d	15.9 c	2.55 cd	2.65 cd	18.0 def	18.3 bcdef
		Water extract	15.6 d	15.8 c	2.55 cd	2.65 cd	17.1 fgh	17.4 def
	Irradiation	Soil application	16.8 a	16.8 a	2.90 a	3.00 a	20.9 a	21.2 a
		Water extract	16.2 bcd	16.4 abc	2.65 bcd	2.75 bcd	19.2 bc	19.5 abcd
Sheep manure	Non-irradiation	Soil application	15.7 d	15.9 c	2.60 bcd	2.66 cd	17.7 efg	18.1 cdef
		Water extract	15.6 d	15.8 c	2.55 cd	2.65 cd	16.8 gh	17.0 ef
	Irradiation	Soil application	16.6 ab	16.8 a	2.75 ab	2.85 ab	20.3 ab	20.5 ab
		Water extract	16.1 bcd	16.3 abc	2.60 bcd	2.70 bcd	18.9 cd	19.2 abcde

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

Moreover, irradiating organic manure surpassed nonirradiating organic manure in exerting a distinctive effect on no. of roots / seedling in both seasons.

Furthermore, soil application of organic manure succeeded to induce a distinctive effect on No. of roots / seedling as compared water extract. In addition, **Table (88)** illustrates that the interaction between organic manure source and irradiation of organic manure, demonstrates that irradiating poultry manure induced higher No. of roots / seedling in both seasons. On the contrary, non-irradiating or irradiating cattle manure induced the lowest enhancing effects in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, indicates that poultry manure applied as soil application or water extract exerted the highest positive effect on No. of roots / seedling of Volkamer lemon seedlings, in both seasons, **(Table, 89).**

Furthermore, irradiating organic manure and applied as soil application exerted the highest stimulative effect on No. of roots / seedling, followed descendingly by those applied as water extract. On the contrary, non-irradiating organic manure, applied as soil application or water extract had the lowest positive effects on No. of roots / seedling in both seasons **(Table, 90).**

Finally, the interaction between the three studied factors indicates that the interaction of poultry manure surpassed the other combinations (cattle and sheep) in enhancing on No. of roots / seedling with the superiority of irradiating poultry manure on the expense of non-irradiating poultry manure, applied as soil application on the expense of water extract application. Besides, sheep manure combinations surpassed cattle manure interactions

in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 91).**

4.2.2.1.7. Leaf area

It is clear from **Table (87)** that organic manure source failed to induce any significant effect on leaf area in both seasons.

Moreover, irradiating organic manure surpassed non-irradiating organic manure to exert a distinctive effect on leaf area in both seasons.

Furthermore, Soil application of organic manure succeeded to induce a positive effect on leaf area as compared with water extract.

In addition, **Table (88)** illustrates that the interaction between organic manure source and irradiating organic manure, shows that irradiating poultry manure produced more expanded leaves in both seasons. On the contrary, non-irradiating or irradiating cattle manure shows the lowest enhancing effect in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, demonstrates that poultry manure applied as soil application or water extract caused the highest positive effect on leaf area of Volkamer lemon seedlings, in the first season, **(Table, 89).**

Furthermore, irradiating organic manure applied as soil application exerted the highest stimulative effect on leaf area, followed descendingly by those applied as water extract. On the contrary, non-irradiation of organic manure applied as soil

application or water extract gave the lowest positive effect on leaf area in both seasons **(Table, 90).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other combination (cattle and sheep) in enhancing leaf area with the superiority of irradiating poultry manure on the expense of non-irradiation of poultry manure and applied as soil application on the expense of water extract of organic manure. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 91).**

4.2.2.1.8 Stem dry weight

It is clear from **Table (92)** that poultry manured seedlings had the heaviest stem dry weight as compared with those arised from cattle manured ones in both seasons. Besides, sheep manured seedlings had the between values in this respect.

Moreover, irradiating organic manure surpassed non-irradiating organic manure in enhancing on stem dry weight in both seasons.

Furthermore, Soil application of organic manure succeeded to induce an enhancing effect on stem dry weight as compared with water extract.

In addition, **Table (93)** illustrates that the interaction between organic manure source and irradiation of organic manure , shows that irradiating poultry manure gave the heaviest stem dry weight in both seasons. On the contrary, non-

Table (92): Specific effect of organic manure source, irradiation and application method on plant dry weight parameters of Volkamer lemon seedlings (2000 and 2001 seasons).

Factor	Stem dry Weight (g)		Leaves dry weight (g)		Root dry Weight (g)		Total seedling dry weight (g)		Top :root Ratio	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source										
Cattle manure	3.35 c	3.44 c	2.85 c	3.56 c	2.88 c	2.88 c	9.01 c	9.90 c	2.11 a	2.45 a
Poultry manure	4.37 a	4.59 a	4.95 a	4.85 a	4.73 a	4.87 a	14.06 a	14.32 a	2.04 a	1.93 b
Sheep manure	4.13 b	4.42 b	4.41 b	4.58 b	4.08 b	4.28 b	12.67 b	13.27 b	2.10 a	2.09 b
b. Effect of Irradiation										
Non-irradiation	3.68 b	3.85 b	3.80 b	4.14 b	3.74 b	3.92 b	11.17 b	11.90 b	2.05 a	2.05 b
Irradiation	4.22 a	4.45 a	4.34 a	4.52 a	4.05 a	4.11 a	12.65 a	13.09 a	2.12 a	2.26 a
c. Effect of application method										
Soil application	4.11 a	4.34 a	4.15 a	4.52 a	3.97 a	4.03 a	12.27 a	12.90 a	2.09 a	2.29 a
Water extract	3.79 b	3.45 b	3.99 b	4.14 b	3.82 b	3.99 a	11.56 b	12.10 b	2.07 a	2.03 b

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

Table (93): Effect of interaction between organic manure source and irradiation on plant dry weight parameters of Volkamer lemon seedlings (2000 and 2001 seasons).

Organic manure source	irradiation	Stem dry Weight (g)		Leaves dry weight (g)		Root dry Weight (g)		Total seedling dry weight (g)		Top :root Ratio	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Non-irradiation	3.04 e	3.10 e	2.81 e	3.23 d	2.74 f	2.90 e	8.43 e	9.23 e	2.06 a	2.16 b
	Irradiation	3.67 d	3.78 d	2.89 e	3.90 c	3.03 e	2.96 e	9.59 d	10.57 d	2.16 a	2.74 a
Poultry	Non-irradiation	4.08 bc	4.37 b	4.60 c	4.69 b	4.58 b	4.75 b	13.26 b	13.82 b	2.05 a	1.90 b
	Irradiation	4.67 a	4.81 a	5.30 a	5.01 a	4.88 a	5.00 a	14.85 a	14.82 a	2.03 a	1.96 b
Sheep	Non-irradiation	3.93 c	4.07 c	3.98 d	4.52 b	3.90 d	4.10 d	11.82 c	12.66 c	2.03 a	2.09 b
	Irradiation	4.32 b	4.76 a	4.84 b	4.65 b	4.25 c	4.47 c	13.32 b	13.89 b	2.17 a	2.10 b

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

irradiation or irradiating cattle manure had the lowest stimulative effect in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, demonstrates that poultry manure applied as soil application or water extract induced the highest positive effect on stem dry weight of Volkamer lemon seedlings in both seasons, **(Table, 94).**

Furthermore, irradiating organic manure applied as soil application exerted the highest stimulative effects on stem dry weight, followed descendingly by those applied as water extract. On the contrary, non-irradiation of organic manure applied as soil application or water extract had the lowest positive effect on stem dry weight in both seasons **(Table, 95).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other combination (cattle and sheep) in enhancing stem dry weight with the superiority to irradiating poultry manure on the expense of non-irradiating poultry manure applied in soil application on the expense of water extract of organic manure. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 96).**

4.2.2.1.9 Leaf dry weight

It is clear from **Table(92)** that poultry manured seedlings had the highest leaf dry weight as compared with those arised

Table (94): Effect of interaction between organic manure source and application method on plant dry weight parameters of Volkamer lemon seedlings (2000 and 2001 seasons).

Organic manure source	Application method	Stem dry Weight (g)		Leaves dry weight (g)		Root dry Weight (g)		Total seedling dry weight (g)		Top :root Ratio	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Soil application	3.60 c	3.75 e	3.76 d	3.77 c	2.95 e	2.79 c	9.31 e	10.31 d	2.15 a	2.75 a
	Water extract	3.10 d	3.12 f	2.94 d	3.36 d	2.81 f	2.98 c	8.71 f	9.49 e	2.07 a	2.16 b
Poultry	Soil application	4.54 a	4.77 a	5.20 a	4.96 a	4.80 a	4.95 a	14.54 a	14.69 a	2.02 a	1.96 bc
	Water extract	4.21 b	4.41 c	4.70 b	4.74 a	4.66 b	4.80 a	13.58 b	13.95 b	2.06 a	1.90 c
Sheep	Soil application	4.20 b	4.51 b	4.49 bc	4.84 a	4.15 c	4.36 b	12.94 c	13.72 b	2.11 a	2.14 bc
	Water extract	4.06 b	4.32 d	4.33 c	4.33 b	4.00 d	4.21 b	12.40 d	12.84 c	2.09 a	2.05 bc

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

Table (95): Effect of interaction between irradiation and application method of organic manure on plant dry weight parameters of Volkamer lemon seedlings (2000 and 2001 seasons).

Irradiation	Application method	Stem dry Weight (g)		Leaves dry weight (g)		Root dry Weight (g)		Total seedling dry weight (g)		Top :root Ratio	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Non-irradiation	**Soil application**	3.88 ab	4.11 c	3.91 b	4.39 b	3.82 c	4.00 ab	11.63 c	12.51 c	2.06 a	2.15 b
	Water extract	3.48 b	3.58 d	3.68 c	3.90 c	3.65 d	3.83 b	10.72 d	11.30 d	2.03 a	1.95 c
Irradiation	**Soil application**	4.34 a	4.58 a	4.39 a	4.65 a	4.11 a	4.06 a	12.91a	13.30 a	2.12 a	2.41 a
	Water extract	4.09 ab	4.32 b	4.30 a	4.38 b	3.99 b	4.15 a	12.40 b	12.89 b	2.12 a	2.12 bc

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

Table (96): Effect of interaction between organic manure source, irradiation and application method on plant dry weight parameters of Volkamer lemon seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Application method	Stem dry Weight (g)		Leaves dry weight (g)		Root dry Weight (g)		Total seedling dry weight (g)		Top :root Ratio	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Non-irradiation	Soil application	3.44 f	3.65 h	2.89 ef	3.56 g	2.81 k	3.00 gh	9.14 h	10.21 f	2.24 a	2.40 b
		Water extract	2.63 g	2.55 l	2.74 f	2.91 h	2.67 L	2.81 hi	7.72 l	8.25 g	1.88 b	1.93 d
	Irradiation	Soil application	3.76 ef	3.86 g	2.63 f	3.98 ef	3.10 l	2.58 l	9.49 gh	10.40 e	2.05 ab	3.11 a
		Water extract	3.58 ef	3.70 h	3.15 e	3.82 fg	2.96 j	3.15 g	9.69 g	10.74 e	2.27 a	2.38 bc
Poultry manure	Non-irradiation	Soil application	4.20bcd	4.55 d	4.74 b	4.77 b	4.67 c	4.81 abc	13.63 c	14.13 b	1.91 ab	1.93 d
		Water extract	3.96 de	4.20 e	4.44 c	4.61 bc	4.50 d	4.70 bcd	12.90 d	13.51 c	2.19 ab	1.87 d
	Irradiation	Soil application	4.88 a	5.00 a	5.64 a	5.15 a	4.93 a	5.10 a	15.45 a	15.25 a	2.12 ab	1.98 d
		Water extract	4.46 b	4.62 c	4.96 b	4.88 ab	4.83 b	4.90 ab	14.26 b	14.40 b	1.94 ab	1.93 d
Sheep manure	Non-irradiation	Soil application	4.00cde	4.15 e	4.10 d	4.84 b	4.00 g	4.20 ef	12.11 e	13.19 c	2.03 ab	2.13 bcd
		Water extract	3.87 de	4.00 f	3.87 d	4.20 de	3.80 h	4.00 f	11.54 f	12.14 d	2.03 ab	2.04 cd
	Irradiation	Soil application	4.40 bc	4.88 b	4.89 b	4.84 b	4.31 e	4.52 cde	13.78 c	14.24 b	2.19 ab	2.14 bcd
		Water extract	4.25bcd	4.65 c	4.80 b	4.46 cd	4.20 f	4.42 de	13.25 d	13.53 c	2.15 ab	2.05 bcd

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

from cattle manured ones in both seasons. On the other hand. sheep manured seedlings had intermediate values in this respect.

Moreover, irradiating organic manure surpassed non-irradiating organic manure to exert a distinctive effect on leaves dry weight in both seasons.

Furthermore, soil application of organic manure succeeded to induce a positive effect on leaf dry weight as compared with water extract.

In addition, **Table (93)** illustrates that the interaction between organic manure source and irradiating organic manure , reveals that irradiating poultry manure had the highest leaves dry weight in both seasons whereas non-irradiating or irradiating cattle manure had the lowest distinctive effect in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, inducates that poultry manure applied particularly in soil application or secondly + water extract exerted the highest positive effect on leaf dry weight of Volkamer lemon seedlings, in both seasons, **(Table, 94).**

Furthermore, application of irradiated organic manure as soil application exerted the highest stimulative effects on leaves dry weight, followed descendingly by those applied as water extract. On the contrary, non-irradiating organic manure applied as soil application or water extract had the lowest positive effect on leaves dry weight in both seasons **(Table, 95).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other combinations of cattle and sheep in enhancing leaf dry weight with the superiority to irradiating poultry manure on the

expense of non-irradiating poultry manure applied as soil application on the expense of water extract of organic manure. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 96).**

4.2.2.1.10 Root dry weight

It is clear from **Table (92)** that poultry manured seedlings had the highest root dry weight as compared with that arised from cattle manured ones in both seasons. Besides, sheep manured seedlings had inbetween values in this respect.

Moreover, irradiating organic manure surpassed non-irradiating organic manure in increasing root dry weight in both seasons.

Furthermore, soil application of organic manure succeeded to induce a positive effect on root dry weight as compared with water extract of organic manure in this respect.

In addition, **Table (93)** illustrates that the interaction between organic manure source and irradiating organic manure, demonstrates that irradiating poultry manure induced heavier root dry weight in both seasons. On the contrary, non-irradiating or irradiating cattle manure had the lowest enhancing effects in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, shows that poultry applying manure as soil application or water extract exerted the highest positive effect on root dry weight of Volkamer lemon seedlings, in both seasons, **(Table, 94).**

Furthermore, applying irradiating organic manure as soil application exerted the highest stimulative effects on root dry weight, followed descendingly by those applied as water extract. On the contrary, non-irradiating organic manure applied as soil application or water extract had the lowest positive effect on root dry weight in both seasons **(Table, 95).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other tested combinations in enhancing root dry weight with the superiority to irradiating poultry manure on the expense of non-irradiating poultry manure applied as soil application on the expense of water extract. Besides, sheep manure combination surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 96).**

4.2.2.1.11. Total seedling dry weight

It is clear from **Table (92)** that poultry manured seedlings produced higher total seedling dry weight as compared with those arised from cattle manured ones in both seasons. Besides, sheep manured seedlings came inbetween in this respect.

Moreover, irradiating organic manure surpassed non-irradiating organic manure in increasing total seedling dry weight in both seasons.

Furthermore, soil application of organic manure succeeded to induce a positive effect on total seedling dry weight as compared with water extract.

In addition, **Table (93)** illustrates that the interaction between organic manure source and irradiating organic manure, indicates that irradiating poultry manure induced higher total seedling dry weight in both seasons. Besides, non-irradiating or irradiating cattle manure had the lowest pronounced effect in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, declares that poultry manure applied as soil application or water extract induced the highest positive effect on total seedling dry weight of Volkamer lemon seedlings, in both seasons, **(Table, 94).**

Furthermore, applying irradiating organic manure as soil application exerted the highest enhancing effect on total seedling dry weight, followed descendingly by those applied as water extract. On the contrary, non-irradiating organic manure and applied as soil application or water extract had the lowest positive effect on total seedling dry weight in both seasons **(Table, 95).**

Finally, the interaction between the three studied factors indicates that the interactions of poultry manure surpassed the other tested combinations in increasing total seedling dry weight with the superiority of irradiating poultry manure on the expense to non-irradiating treatment and applied as soil application on the expense of water extract application. Besides, sheep manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons**, (Table, 96).**

4.2.2.1.12. Top : root ratio

It is clear from **Table (92)** that cattle manured seedlings produced higher top : root ratio as compared with those given by cattle manured ones in second season. On the contrary, poultry and sheep manured seedlings gave the lowest values in this respect.

Moreover, irradiating organic manure surpassed non-irradiating in exerting a distinctive positive effects on top : root ratio in the second season, only.

Furthermore, soil application of organic manure succeeded to induce a positive effect on top : root ratio as compared with water extract application in the second season **(2001).**

In addition, **Table (93)** illustrates that the interaction between organic manure source and irradiating organic manure, declares that irradiating cattle manure induced higher top : root ratio in the second, only season **(2001).** Besides, non-irradiating or irradiating poultry and sheep manure produced the lowest positive effect in this respect.

On the other hand, the interaction between organic manure and method of organic manure application, shows that cattle manure applied as soil application or water extract induced the highest positive effect on top:root ratio of Volkamer lemon seedlings in both seasons, **(Table, 94).**

Furthermore, applying irradiated organic manure as soil application produced the highest stimulative effects on top : root ratio, followed descendingly by those applied as water extract. On the contrary, non-irradiating organic manure applied as soil

application or water extract induced the lowest positive effect on top : root ratio in the second season **(Table, 95).**

Finally, the interaction between the three studied factors indicates that the interaction of cattle manure surpassed the other combination (sheep and poultry) in enhancing top : root ratio with the superiority of irradiating cattle manure on the expense of non-irradiating cattle manure and applied in soil application on the expense of water extract of organic manure. Besides, sheep manure combination surpassed poultry manure interactions in this respect and took the same pattern of cattle manure combinations in both seasons, **(Table, 96).**

4.2.2.2. Leaf mineral content

Leaf mineral content (N, P, K, Ca, Mg, Fe, Zn and Mn) of Volkamer lemon seedlings during 2000 and 2001 seasons in response to organic manure source (cattle, poultry and sheep), irradiation and/or non-irradiation of dry organic manure and method of organic manure application (soil application and soil application of water extract) as well as their interactions is reported in **Tables (97 -106).**

4.2.2.2.1. Nitrogen

It is clear from **Table (97)** that leaves of poultry manured seedlings had higher values of nitrogen content (2.64 & 2.62%) as compared with those manured with cattle (2.43 & 2.42%) in the first and second seasons, respectively. Besides, leaves of sheep manured seedlings scored inbetween values of nitrogen content (2.55 & 2.53%) in 2000 and 2001 seasons, respectively.

Table (97): Specific effect of organic manure source, irradiation and application method on leaf N, P, K, Ca and Mg content of Volkamer lemon seedlings (2000 and 2001 seasons).

Factor	Elements concentration in dried leaves (%)									
	Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source										
Cattle manure	2.43 c	2.42 c	0.122 b	0.125 b	0.745 c	0.745 c	3.2 c	3.5 c	0.36 c	0.33 b
Poultry manure	2.64 a	2.62 a	0.145 a	0.145 a	0.963 a	0.963 a	4.3 a	4.5 a	0.53 a	0.53 a
Sheep manure	2.55 b	2.53 b	0.130 b	0.132 b	0.902 b	0.895 b	3.8 b	4.2 b	0.45 b	0.40 b
b. Effect of Irradiation										
Non-irradiation	2.51 b	2.49 b	0.128 b	0.130 b	0.830 b	0.822 b	3.5 b	3.9 b	0.43 b	0.40 a
Irradiation	2.58 a	2.56 a	0.137 a	0.138 a	0.910 a	0.913 a	4.1 a	4.3 a	0.46 a	0.44 a
c. Effect of application method										
Soil application	2.56 a	2.54 a	0.137 a	0.138 a	0.897 a	0.888 a	3.9 a	4.2 a	0.44 a	0.42 a
Water extract	2.52 b	2.50 b	0.128 b	0.130 b	0.843 b	0.847 b	36 b	3.9 b	0.44 a	0.41 a

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

Anyhow, the differences between the three studied organic manure sources in this regard were pronounced to be significant.

Furthermore, irradiation of dry organic manures enhanced leaf nitrogen content rather than non-irradiation treatment.

In addition, the application of organic manure as soil application induced higher positive effect on leaf nitrogen content rather than water extract application method **(Table,98).**

Furthermore, the interaction between organic manure source and irradiation of dry organic manure reveals that leaf nitrogen content showed more response to organic manure source rather than to irradiation of dry organic manuers, hence, irradiated poultry manure, non-irradiated poultry manure and irradiated sheep manure recorded the highest values of leaf nitrogen content.

Moreover, the interaction between organic manure source and method of organic manure application demonstrates that leaf nitrogen content showed more response to organic manure source rather than to method of organic manure application, hence poultry manure applied as soil application as water extract induced the highest positive effects on leaf nitrogen content, followed descendingly by the combinations of sheep manure and lastly by the interactions of cattle manure **(Table, 99).**

Moreover, **Table (100)** reveals that the interactions between irradiation of organic manure source and method of organic manure application shows that interactions of irradiation

Table (98): Effect of interaction between organic manure source and irradiation on leaf N, P, K, Ca and Mg content Volkamer lemon seedlings (2000 and 2001 seasons).

Organic manure Source	Irradiation	Elements concentration in dried leaves (%)									
		Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Non-irradiation	2.42 e	2.41 c	0.125 b	0.125 b	0.735 e	0.725 e	3.1 b	3.4 e	0.33 e	0.32 d
	Irradiation	2.45 d	2.43 c	0.120 b	0.125 b	0.755 e	0.765 e	3.3 b	3.7 d	0.38 d	0.35 cd
Poultry	Non-irradiation	2.58 b	2.56 b	0.135 b	0.135 b	0.910 c	0.910 c	4.2 a	4.3 b	0.52 a	0.52 ab
	Irradiation	2.71 a	2.68 a	0.155 a	0.155 a	1.015 a	1.015 a	4.5 a	4.6 a	0.53 a	0.54 a
Sheep	Non-irradiation	2.52 c	2.50 b	0.125 b	0.130 b	0.845 d	0.830 d	3.3 b	4.0 c	0.43 c	0.36 cd
	Irradiation	2.58 b	2.57 b	0.135 b	0.135 b	0.960 b	0.960 b	4.3 a	4.4 ab	0.46 b	0.44 bc

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

Table (99): Effect of interaction between organic manure source and application method on leaf N, P, K, Ca and Mg content of Volkamer lemon seedlings (2000 and 2001 seasons).

Organic manure source	Application method	Elements concentration in dried leaves (%)									
		Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle	Soil application	2.45 d	2.43 d	0.125 cd	0.130 bc	0.765 d	0.760 d	3.3 d	3.7 d	0.35 e	0.36 c
	Water extract	2.42 d	2.41 d	0.120 d	0.120 c	0.725 e	0.730 d	3.2 d	3.4 e	0.37 d	0.31 c
Poultry	Soil application	2.68 a	2.65 a	0.150 a	0.150 a	0.995 a	0.995 a	4.6 a	4.6 a	0.54 a	0.55 a
	Water extract	2.61 b	2.59 b	0.140 ab	0.140 ab	0.930 b	0.930 b	4.2 b	4.3 b	0.52 b	0.51 ab
Sheep	Soil application	2.57 c	2.55 c	0.135 bc	0.135 b	0.930 b	0.910 bc	4.1 b	4.4 b	0.45 c	0.37 c
	Water extract	2.54 c	2.52 c	0.125 cd	0.130 bc	0.875 c	0.880 c	3.6 c	4.0 c	0.44 c	0.42 bc

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

Table (100): Effect of interaction between irradiation and application method of organic manure on leaf N, P, K, Ca and Mg content of Volkamer lemon seedlings (2000 and 2001 seasons).

Irradiation	Application method	Elements concentration in dried leaves (%)									
		Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Non-irradiation	Soil application	2.52 bc	2.50 c	0.133 ab	0.133 ab	0.847 b	0.833 c	3.7 b	4.1 b	0.42 c	0.39 a
	Water extract	2.50 c	2.48 c	0.123 b	0.127 b	0.813 c	0.810 c	3.4 c	3.7 c	0.43 c	0.41 a
Irradiation	Soil application	2.61 a	2.59 a	0.140 a	0.143 a	0.947 a	0.943 a	4.3 a	4.4 a	0.47 a	0.46 a
	Water extract	2.55 b	2.53 b	0.133 ab	0.133 ab	0.873 b	0.883 b	3.8 b	4.1 b	0.45 b	0.42 a

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

of organic manure and soil application method enhanced leaf nitrogen content followed descendingly by irradiation of organic manure and water extract application.

Finally, the interaction between organic manure source, irradiation of organic manure and method of organic manure application shows that the interactions of poultry manure, particularly when poultry manure irradiated and applied as soil application induced the highest positive effect on leaf nitrogen content. On the contrary, the combinations of cattle manure exerted the least positive effect on leaf nitrogen content **(Table, 101)**.

4.2.2.2.2. Phosphorus

It is clear from **Table (97)** that leaves of poultry manured seedlings had higher values of phosphorus content (0.145 & 0.145%) as compared with those manured with cattle (0.122 & 0.125%) in the first and second seasons, respectively. Besides, leaves of sheep manured seedlings scored inbetween values of phosphorus content (0.130 & 0.132%) in 2000 and 2001 seasons, respectively. Anyhow, the differences between the three studied organic manure sources in this regard were obvious to be significant.

Furthermore, irradiation of dry organic manures enhanced leaf phosphorus content rather than non-irradiation treatment.

In addition, the application of organic manure source as soil application enhanced leaf phosphorus content rather than soil application water extract application method **(Table,97).**

Table (101): Effect of interaction between organic manure source, irradiation and application method on leaf N, P, K, Ca and Mg content of Volkamer lemon seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Application method	Elements concentration in dried leaves (%)									
			Nitrogen		Phosphorus		Potassium		Calcium		Magnesium	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Non-irradiation	Soil application	2.43 f	2.42 g	0.130 cd	0.130 c	0.150 g	0.740 fg	3.2 fg	3.6 f	0.31 g	0.35 cd
		Water extract	2.41 f	2.40 g	0.120 d	0.120 c	0.720 g	0.710 g	3.0 g	3.2 g	0.36 f	0.30 d
	Irradiation	Soil application	2.47 ef	2.45 fg	0.120 d	0.130 c	0.780 fg	0.780 ef	3.4 ef	3.8 ef	0.39 e	0.37 bcd
		Water extrac.	2.44 f	2.42 g	0.120 d	0.120 c	0.73 g	0.750 fg	3.3 ef	3.7 ef	0.38 e	0.33 d
Poultry manure	Non-irradiation	Soil application	2.60 bc	2.57 cd	0.140 bc	0.140 bc	0.920 cd	0.920 bc	4.4 bc	4.4 bcd	0.53 b	0.53 ab
		Water extract	2.57 cd	2.55 cde	0.130 cd	0.130 c	0.900 cd	0.900 c	4.1 d	4.2 d	0.52 b	0.51 abc
	Irradiation	Soil application	2.77 a	2.73 a	0.160 a	0.160 a	1.070 a	1.070 a	4.8 a	4.8 a	0.55 a	0.57 a
		Water extract	2.65 b	2.640 b	0.150 ab	0.150 ab	0.960 bc	0.960 bc	4.2 cd	4.5 bc	0.52 b	0.51 abc
Sheep manure	Non-irradiation	Soil application	2.53 d	2.51 de	0.130 cd	0.130 c	0.870 de	0.840 d	3.5 e	4.2 d	0.44 d	0.297 d
		Water extract	2.52 de	2.50 ef	0.120 d	0.130 c	0.820 ef	0.820 de	3.2 fg	3.8 e	0.43 d	0.423 abcd
	Irradiation	Soil application	2.61 bc	2.60 bc	0.140 bc	0.140 bc	0.990 b	0.980 b	4.6 ab	4.6 ab	0.47 c	0.45 abcd
		Water extract	2.56 cd	2.54 cde	0.130 cd	0.130 c	0.930 cd	0.940 bc	4.0 d	4.3 cd	0.46 c	0.43 abcd

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

Furthermore, **Table (98)** indicates that the interaction between organic manure source and irradiation of dry organic manure source exerted that leaf phosphorus content showed more response to organic manure source rather than to irradiation of dry organic manuers, hence, irradiated poultry manure, non-irradiated poultry manure and irradiated sheep manure scored the highest values of leaf phosphorus content in descending order.

Moreover, the interaction between organic manure source and method of organic manure application demonstrates that leaf phosphorus content showed more response to organic manure source rather than to method of organic manure application, hence poultry manure applied as soil application or as water extract induced the highest positive effect on leaf phosphorus content, followed descendingly by the combinations of sheep manure and lastly by the interactions of cattle manure **(Table, 99).**

Moreover, **Table (100)** reveals that the interactions between irradiation of organic manure source and method of organic manure application shows that interactions of irradiation of organic manure and soil application method enhanced leaf phosphorus content followed descendingly by irradiation of organic manure and in soil application of water extract application method.

Finally, the interaction between organic manure source, irradiation of organic manure and method of organic manure application shows that the interactions of poultry manure, particularly when poultry manure irradiated and applied as soil application induced the highest positive effect on leaf

phosphorus content. Besides, the combinations of cattle manure exerted the least positive effect on leaf nitrogen content. **(Table, 101)**.

4.2.2.2.3. Potassium

It is clear from **Table (97)** that fertilizing Volkamer lemon seedlings with poultry manure enriched leaf potassium content (0.963 & 0.963%) as compared with those manured with sheep (0.902 & 0.895%) and cattle manured seedlings (0.745 & 0.745%) in 2000 and 2001 seasons, respectively. Anyhow, the differences between the three organic manure sources in this respect were obvious to be significant.

Furthermore, irradiation of dry organic manures enhanced leaf potassium content rather than non-irradiation treatment.

In addition, the application of organic manure source as soil application enhanced leaf potassium content rather than water extract application method **(Table,97).**

Moreover, **Table (98)** indicates that the interaction between organic manure source and irradiation of dry organic manner source exerted that leaf potassium content showed more response to organic manure source rather than to irradiation of dry organic manuers, hence, irradiated poultry manure followed secondly by irradiated sheep manure induced the highest positive effect in this respect.

Furthermore, the interaction between organic manure source and method of organic manure application demonstrates that leaf potassium content showed more response to organic manure source rather than to method of organic manure

application, hence poultry manure applied firstly in soil application and/or secondly soil application of water extract induced the highest positive effect on leaf potassium content, followed descendingly by the combinations of sheep manure and lastly by the interactions of cattle manure **(Table, 99).**

Moreover, **Table (100)** reveals that the interactions between irradiation of organic manure and method of organic manure application shows that interactions of irradiation of organic manure and soil application enhanced leaf potassium content followed descendingly by irradiation of organic manure source and water extract application method.

Finally, the interaction between organic manure source, irradiation of organic manure and method of organic manure application shows that the interactions of poultry manure, particularly when poultry manure irradiated and applied as soil application induced the highest positive effect on leaf potassium content. followed descendingly by irradiated sheep manure applied as soil application. On the contrary, the combinations of cattle manure exerted the least positive effects on leaf potassium content. **(Table, 101).**

4.2.2.2.4. Calcium

It is clear that fertilizing Volkamer lemon seedlings with poultry manure enriched leaf calcium content (4.3 & 4.5%) as compared with those manured with sheep (3.8 & 4.2%) and cattle manured seedlings (3.2 & 3.5%) in 2000 and 2001 seasons, respectively. Anyhow, the differences between the three

organic manure sources in this respect were obvious to be significant.

Furthermore, irradiation of organic manures enhanced leaf calcium content rather than non-irradiation treatment.

In addition, the application of organic manure source as soil application enhanced leaf calcium content rather than water extract application **(Table,97).**

Moreover, **Table (98)** indicates that the interaction between organic manure source and irradiation of dry organic manure demonstrated that leaf calcium content showed more response to organic manure source rather than to irradiation of dry organic manuers, hence, poultry manure whether irradiated or non-irradiated showed the highest values of leaf calcium content.

Furthermore, the interaction between organic manure source and method of organic manure application demonstrates that leaf calcium content showed more response to organic manure source rather than to method of organic manure application, hence poultry manure applied as soil application or as water extract induced the highest positive effect on leaf calcium content, followed descendingly by the combinations of sheep manure and lastly by the interactions of cattle manure **(Table, 99).**

Moreover, **Table (100)** reveals that the interactions between irradiation of organic manure source and method of organic manure application shows that interactions of irradiation of organic manure source and method of organic manure application as soil application enhanced leaf calcium content

followed descendingly by irradiation of organic manure source and water extract application method.

Finally, the interaction between organic manure source, irradiation of organic manure and method of organic manure application shows that the interactions of poultry manure, particularly when poultry manure irradiated and applied as soil application induced the highest positive effect on leaf calcium content. followed descendingly by sheep manure irradiated and applied as soil application. On the contrary, the combinations of cattle manure exerted the least positive effect on leaf calcium content **(Table, 101)**.

4.2.2.2.5. Magnesium

It is clear from **Table (97)** that leaves of poultry manured Volkamer lemon seedlings had higher values of magnesium content (0.53 & 0.53%) as compared with those manured with cattle (0.36 & 0.33%) in the first and second seasons, respectively. Besides, leaves of sheep manured seedlings scored inbetween values of magnesium content (0.45 & 0.40%) in 2000 and 2001 seasons, respectively. Anyhow, the differences between the three studied organic manure sources in this regard were obvious to be significant.

Furthermore, irradiation of dry organic manures enhanced leaf magnesium content rather than non-irradiation of dry organic manures.

In addition, the tested application methods of organic manure failed to induce any positive effect on leaf magnesium content in both seasons **(Table,97).**

Furthermore, the interaction between organic manure source and irradiation of dry organic manures demonstrated that leaf magnesium content showed more response to organic manure source rather than to irradiation of dry organic manuers, hence, poultry manure whether irradiated or non-irradiated gave the highest values of leaf magnesium content.

Moreover, the interaction between organic manure source and method of organic manure application demonstrates that leaf magnesium content showed more response to organic manure source rather than to method of organic manure application, hence poultry manure applied as soil application or as water extract induced the highest positive effect on leaf magnesium content, followed descendingly by the combinations of sheep manure and lastly by the interactions of cattle manure **(Table, 99).**

Moreover, **Table (100)** demonstrates that the interaction between irradiation of organic manure and method of organic manure application shows that interactions of irradiation of organic manure and soil application enhanced leaf magnesium content followed descendingly by irradiation of organic manure and method of organic manure application as water extract application.

Finally, the interaction between organic manure source, irradiation of organic manure and method of organic manure application shows that the interactions of poultry manure, particularly when poultry manure irradiated and applied as soil application induced the highest positive effect on leaf magnesium content. On the contrary, the combinations of cattle manure exerted the least positive effects on leaf magnesium

content. Besides, the combinations of sheep manure occupied inbetween positions in this respect **(Table, 101)**.

4.2.2.2.6. Iron, Manganese and Zinc

It is obvious from **Table (102)** that leaves of poultry manured seedlings had the highest values of leaf Fe, Mn and Zn content, followed descendingly by those of sheep manured ones and lastly those fertilized with cattle manure. However, the differences between the three tested organic manure sources in this concern were remarkable to be significant.

Moreover, irradiation of the three organic manure sources enhanced leaf Fe, Mn and Zn content rather than non-irradiation treatment.

Furthermore, the application of organic manure as soil application enhancd leaf Fe, Mn and Zn content rather than water extract application.

Additionally, **Table (103)** reveals that the application of irradiated poultry manure in particular or non-irradiated exerted the highest stimulative effects on leaf Fe, Mn and Zn content. On the contrary, the application of cattle manure either irradiated or non-irradiated scored the lowest values in this respect. The interactions of sheep manure occupied an intermediate position in this sphere.

Table (104) shows that the application of poultry manure particularly as soil application or as water extract exerted the highest stimulative effect on leaf Fe, Mn and Zn content. On the contrary, the application of cattle manure either as soil application or water extract induced the lowest positive effect in

Table (102): Specific effect of organic manure source, irradiation and application method on leaf Fe, Mn and Zn content of Volkamer lemon seedlings (2000 and 2001 seasons).

Factor	Elements concentration in dried leaves (ppm)					
	Iron		Manganese		Zinc	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source						
Cattle manure	70 c	72 c	49 c	52 c	44 c	45 c
Poultry manure	92 a	94 a	75 a	77 a	73 a	72 a
Sheep manure	79 b	81 b	66 b	67 b	57 b	61 b
b. Effect of irradiation						
Non-irradiation	78 b	80 b	60 b	61 b	55 b	57 b
Irradiation	82 a	85 a	67 a	69 a	60 a	62 a
c. Effect of application method						
Soil application	82 a	84 a	66 a	68 a	61 a	62 a
Water extract	79 a	81 b	61 b	62 b	55 b	57 b

Means within each column, followed by the same letter(s) are not significantly different at 5% level

Table (103): Effect of interaction between organic manure source and irradiation on leaf leaf Fe, Mn and Zn content of Volkamer lemon seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Elements concentration in dried leaves (ppm)					
		Iron		Manganese		Zinc	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Non-irradiation	68 d	70 f	46 f	47 d	39 d	42 f
	Irradiation	72 d	74 e	53 e	57 c	49 c	49 e
Poultry manure	Non-irradiation	89 b	90 b	72 b	70 b	71 a	70 b
	Irradiation	96 a	98 a	79 a	84 a	74 a	75 a
Sheep manure	Non-irradiation	79 c	79 d	64 d	67 b	56 b	59 d
	Irradiation	80 c	83 c	69 c	67 b	58 b	63 c

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

Table (104): Effect of interaction between organic manure source and application method on leaf leaf Fe, Mn and Zn content of Volkamer lemon seedlings (2000 and 2001 seasons).

Organic manure source	Application method	Elements concentration in dried leaves (ppm)					
		Iron		Manganese		Zinc	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Soil application	72 c	75 d	52 e	54 e	48 d	49 e
	Water extract	67 d	69 e	47 f	49 f	40 e	42 f
Poultry manure	Soil application	92 a	95 a	78 a	79 a	74 a	74 a
	Water extract	92 a	93 b	72 b	74 b	72 a	70 b
Sheep manure	Soil application	81 b	82 c	68 c	70 c	61 b	63 c
	Water extract	78 b	80 c	64 d	64 d	54 c	59 d

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

this respect. The interactions of sheep manure occupied an intermediate position in this sphere.

Table (105) shows that leaves of irradiated of organic manured seedlings manured superficially or as water extract were the richest ones in their content of Fe, Mn and Zn as compared with those of produced by non-irradiated organic manure.

Lastly, the interaction between organic manure source, irradiation of organic manure and method of organic manure application, **(Table, 106)** declares that irradiated poultry manured seedlings as soil application or water extract followed descendingly by the corresponding ones non-irradiated and manured as soil application and or water extract showed the highest values of leaf Fe, Mn and Zn content. Besides, the combinations of sheep manure proved to be more efficient in enhancing leaf Fe, Mn and Zn content than the analogous ones of cattle manure.

Briefly, the results of leaf mineral content due to organic manure source are in accordance with the findings of **Sekiya et al. (1993)** on Satsuma mandarin, **Kalu-Singh et al. (1984)** on mango. **Noack (1984)** on apple, **Darfeld and Lenz (1985)** on pear, **Umemiya and Sekiya (1985)** on persimmon, **Villasurda and Baluyut (1990)** on guava, **Ben-Ya-Acov et al. (1992)** on avocado, **Awad et al. (1993)** on olive, **Alvarez etal. (1993)** on pinapple, **Smith (1994)** on banana, **Abu-Sayed Ahmed (1997)** on Balady mandarin **El-Kobbia (1999)** on Balady mandarin and **Moustafa (2002)** on Washington navel orange. They reported that organic manure, particularly, poultry manure improved leaf mineral content.

Table (105): Effect of interaction between irradiation and application method of organic manure on leaf Fe, Mn and Zn content of Volkamer lemon seedlings (2000 and 2001 seasons).

Irradiation	Application method	Elements concentration in dried leaves (ppm)					
		Iron		Manganese		Zinc	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Non-irradiation	Soil application	79 b	81 c	62 b	62 bc	57 b	58 b
	Water extract	77 b	78 d	58 c	60 c	54 c	55 c
Irradiation	Soil application	84 a	87 a	70 a	73 a	65 a	66 a
	Water extract	81 ab	83 b	64 b	65 b	56 bc	59 b

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

Table (106): Effect of interaction between organic manure source, irradiation and application method on leaf leaf Fe, Mn and Zn content of Volkamer lemon seedlings (2000 and 2001 seasons).

Organic manure source	Irradiation	Application method	Elements concentration in dried leaves (PPM)					
			Iron		Manganese		Zinc	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Non-irradiation	Soil application	70 efg	72 f	48 hi	50 gh	41 de	44 g
		Water extract	66 g	68 g	44 l	44 h	37 e	40 g
	Irradiation	Soil application	75 def	78 e	57 g	59 ef	56 c	55 f
		Water extract	69 fg	71 fg	50 h	55 fg	43 d	44 g
Poultry manure	Non-irradiation	Soil application	88 bc	92 b	74 bc	70 cd	72 a	72 bc
		Water extract	90 ab	89 b	70 cde	70 cd	71 a	68 cd
	Irradiation	Soil application	97 a	99 a	82 a	89 a	76 a	77 a
		Water extract	95 ab	97 a	75 b	79 b	73 a	73 ab
Sheep manure	Non-irradiation	Soil application	81 cd	80 de	66 ef	68 cd	59 bc	60 e
		Water extract	77 de	79 de	62 f	66 cd	54 c	58 ef
	Irradiation	Soil application	81 cd	84 c	71 bcd	72 c	63 b	66 d
		Water extract	80 d	82 cd	67 de	63 de	54 c	61 e

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

Besides, the obtained results of leaf mineral content attributed to the effect of method of organic manure application are in line with the findings of **Thachuk (1983)** on apple, **Bhangoo et al. (1988)** on grape and **Goede (1993)** on mango. Moreover, the results of biofertilizer regarding leaf mineral content are in agreement with the findings of **Pmares et al. (1983)** on oranges, **Chokha et al. (1993)** on orange, **Haggag and Azzazy (1996)** on mango, **Ahmed et al. (1997)** on grape, **Awashi et al. (1998)** on peach, **Fernandez et al. (1998)** on banana, **Mansour (1998)** on Anna apple, **Mahmoud and Mahmoud (1999)** on peach **Tiwary et al. (1999)** on banana and **Moustafa (2002)** on Washington navel orange. They mentioned that Rhizobacterien enhanced most leaf mineral content.