RESULTS AND DISCUSSION

4- RESULTS and DISCUSSION

4.1. Tree growth

The effect of organic manure sources, namely cattle, poultry and rabbit, method of organic manure application *i.e.* surface and trench and biofertilizers namely Rhizobacterien and Nitrobien as well as their combination on tree growth of Washington navel orange 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 cycles and some leaf parameters *i.e.* surface area, leaf shape index, leaf chlorophyll (*a*) & (*b*) and leaf dry weight is presented in **Tables (3-25)**.

4.1.1. Growth cycles duration

Data reported in **Tables (3 & 4)** show the effect of organic manure source, method of organic manure application and biofertilizers as well as their interactions on the growth cycles of Washington navel orange trees during 2000 and 2001 seasons.

Generally, under conditions of Kalubia Governorate, growth of Washington navel orange trees commenced on January, 27th and January, 26th 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 one in autumn. The spring growth cycle of poultry manured trees fertilized in trenches and inoculated with Rhizobacterien started on January, 27th and January, 26th and continued till April, 2nd and April, 3rd in the first and second seasons, respectively (about 65 and 67 days duration). On the contrary, cattle manured trees, fertilized superficially and inoculated with Rhizobacterien commenced spring growth cycle on February, 1st and January, 31st and continued till April, 1st and April, 2nd in 2000 and 2001 seasons, respectively (about 60 and 62 days duration). Shortly, all tested combinations of tested three factors *i.e.* organic manure source, method of organic manure application and biofertilizers exerted considerably similar effect on spring growth cycle duration except for the combinations of cattle manure applied superficially or in trenches and fertilized with Rhizobacterien or Nitrobien which showed comparatively shorter spring growth cycle duration (59 – 63 days).

On the other hand, the new growth of the first summer growth cycle of poultry manured trees, fertilized in trenches and inoculated with Rhizobacterien peeped out on April, 19th and April, 20th and ceased on May, 27th and May, 27th in the first and second seasons, respectively (about 38 and 37 days). Other tested interactions recorded about 31- 36 days duration for the first spring growth cycle. Moreover, the growth of the second summer cycle began on June, 18th and June, 17th for those trees fertilized with poultry manure applied in trenches and inoculated with Rhizobacterien and ceased on August, 19th and August, 20th with duration of about 62 and 64 days for the first and second seasons, respectively. On the contrary, cattle manured trees, fertilized superficially and inoculated with Nitrobien recorded the shortest duration for the second summer growth cycle (55 and 57 days) in 2000 and 2001 seasons, respectively. Other studied interactions scored intermediate values for the second summer growth cycle.

In summary, poultry manure applied in trenches and supported with Rhizobacterien prolonged the annual growth cycle (228 and 233 days), followed descendingly by poultry manured trees, fertilized in trenches and inoculated with Nitrobien (220 and 225 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 (207 days) in both seasons. The other studied combinations scored intermediate values of annual growth cycle (208 – 223 days). The growth of autumn cycle of poultry manured trees, fertilized in trenches and inoculated with Rhizobacterien began on August, 24th and August, 22nd and ceased on October, 25th and October, 26th with duration of about 63 and 65 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 55 and 57 days) in the first and second seasons, respectively. Other tested interactions showed comparatively inbetween values regarding autumn growth cycle duration (58 – 63 days).

The obtained results of growth cycles of Washington navel orange trees in the present study go in line with the findings of **Helail and Awad (1993).** 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 biofertilizers as well as their interactions on growth intensity (No. of shoots/branch) of growth cycles of Washington navel orange trees during 2000 and 2001 seasons is reported in **Tables (5-9).**

It is quite clear from **Table (5)** that fertilizing Washington navel orange with poultry manure significantly increased growth intensity of spring growth cycle (39.13 shoots/branch), first summer growth cycle (19.75 shoots/branch). second summer growth cycle (17.42 shoots/branch) and autumn growth cycle (10.25 shoots/branch) with grand average (21.7 shoots/branch) against (34.80, 15.75, 13.20 and 8.10 shoots per branch for spring, first and second summer and autumn growth cycles of cattle manured trees, respectively, with grand average (17.90 shoots/branc). On the other hand, rabbit manured trees scored 37.28, 17.75, 15.43 and 8.80 shoots/branch for spring, first and second summer growth cycles and autumn growth cycle, respectively with grand average (19.83 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 spring, first and second summer and autumn growth cycles during 2000 and 2001 seasons **(Table, 5)**.

In addition, it is obvious from **Table (5)** that biofertilizing Washington navel orange trees with Rhizobacterien significantly enhanced growth intensity of different growth cycles (spring, first, second summer and autumn) as compared with the analogous ones inoculated with Nitrobien.

On the other hand, **Table (6)** demonstrates that fertilizing Washington navel orange 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 autumn growth cycles. On the contrary, cattle manured trees particularly those fertilized superficially exerted the lowest positive effect in this concern. Besides, rabbit manured trees with the superiority to those trenches fertilized in 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 (7)** indicates that in both seasons, the application of Nitrobien and the trench application method proved to be the most effective combinations in enhancing growth intensity of different growth cycles. Besides, the addition of Nitrobien and surface application of organic manure exerted similar effect to that of interaction between Rhizobacterien and trench application. On the contrary, biofertilizing with Rhizobacterien when interacted with surface method of organic manure application gave comparatively the lowest values of growth intensity of growth cycles. However, significant differences were obvious between the different studied combinations.

Additionally, the interaction between organic manure source and biofertilizers 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 Nitrobien), (poultry manure x Rhizobacterien), (rabbit manure x Nitrobien), (rabbit manure x Rhizobacterien), (cattle manure x Nitrobien) and (cattle manure x Rhizobacterien) **(Table, 8)**.

Furthermore, the interaction between organic manure source, method of organic manure application and biofertilizers 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 rabbit 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, 9).**

Table (3): Effect of organic manure source, method of application and biofertilizer on growth cycles of Washington navel orange 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	1/2	1/4	60 cd	23/4	26/5	33 cd	22/6	18/8	57 bcd	27/8	24/10	58 bc	208 bc
		Rhizobacterien	1/2	31/3	59 d	24/4	25/5	31 d	23/6	17/8	55 d	28/8	23/10	56 c	207 c
	Trench	Nitrobien	31/1	1/4	61 bcd	23/4	26/5	33 cd	22/6	18/8	57 bcd	27/8	24/10	58 bc	209 bc
		Rhizobacterien	31/1	31/3	60 cd	23/4	25/5	32 cd	22/6	17/8	56 cd	27/8	23/10	61 ab	209 bc
Poultry manure	Surface	Nitrobien	28/1	1/4	63 ab	20/4	26/5	36 ab	19/6	18/8	60 ab	27/8	24/10	61 ab	220 ab
		Rhizobacterien	29/1	31/3	61 bcd	21/4	25/5	34 bc	20/6	17/8	58 bcd	25/8	23/10	59 bc	212 bc
	Trench	Nitrobien	27/1	2/4	65 a	19/4	27/5	38 a	18/6	19/8	62 a	24/8	25/10	63 a	228 a
		Rhizobacterien	28/1	1/4	63 ab	20/4	26/5	38 a	19/6	18/8	60 ab	26/8	24/10	61 ab	220 ab
Rabbit manure	Surface	Nitrobien	30/1	1/4	61 bcd	22/4	26/5	34 bc	21/6	18/8	58 bcd	26/8	24/10	59 bc	212 bc
		Rhizobacterien	30/1	1/4	61 bcd	22/4	26/5	34 bc	21/6	18/8	58 bcd	26/8	24/10	59 bc	212 bc
	Trench	Nitrobien	31/1	2/4	62 bc	23/4	27/5	34 bc	22/6	19/8	58 bcd	27/8	25/10	59 bc	213 bc
		Rhizobacterien	31/1	1/4	60 cd	23/4	26/5	33 bc	22/6	18/8	59 abc	27/8	24/10	58 bc	210 bc

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

Table (4): Effect of organic manure source, method of application and biofertilizer on growth cycles of Washington navel orange 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	31/1	2/4	60 cd	24/4	26/5	32 c	21/6	19/8	59 bcd	26/8	25/10	62 b	215 bcd
		Rhizobacterien	31/1	1/4	61 d	25/4	26/5	31 c	22/6	18/8	57 cd	27/8	24/10	58 c	207 d
	Trench	Nitrobien	30/1	2/4	63 bcd	24/4	26/5	31 c	21/6	19/8	58 bcd	26/8	25/10	62 b	214 bcd
		Rhizobacterien	30/1	1/4	62 cd	24/4	25/5	31 c	21/6	18/8	58 bcd	26/8	24/10	61 b	212 cd
Poultry manure	Surface	Nitrobien	29/1	2/4	64 bc	21/4	26/5	35 b	19/6	19/8	61 abc	23/8	25/10	63 ab	223 abc
		Rhizobacterien	30/1	1/4	62 cd	22/4	25/5	33 bc	19/6	18/8	60 abcd	23/8	24/10	61 b	216 bcd
	Trench	Nitrobien	26/1	3/4	67 a	20/4	27/5	37 a	17/6	20/8	64 a	22/8	26/10	65 a	233 a
		Rhizobacterien	27/1	2/4	65 ab	21/4	26/5	35 b	18/6	19/8	62 ab	23/8	25/10	63 ab	225 ab
Rabbit manure	Surface	Nitrobien	29/1	2/4	64 bc	23/4	26/5	33 bc	20/6	19/8	60 abcd	25/8	25/10	61 b	216 bcd
		Rhizobacterien	29/1	2/4	64 bc	23/4	26/5	33 bc	20/6	19/8	60 abcd	25/8	25/10	61 b	218 bcd
	Trench	Nitrobien	30/1	3/4	64 bc	24/4	27/5	33 bc	21/6	20/8	60 abcd	26/8	26/10	63 ab	220 bc
		Rhizobacterien	30/1	2/4	63 bcd	24/4	26/5	33 bc	21/6	19/8	60 abcd	26/8	25/10	62 b	206 d

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

Table (5): Specific effect of organic manure source, application method and biofertilizer on number of shoots per branch of Washington navel orange trees (2000 and 2001 seasons).

Factor	No. of Shoots per branch												
	Spring growth cycie			Summer growth cycle						Autumn growth cycle			Grand Average
				1^{st} cycle			2^{nd} cycle						
	(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	(2000)	(2001)	Average	
a. Effect of organic manure source													
Cattle manure	34.25 c	35.35 c	34.80 c	15.35 c	16.17 c	15.75 c	12.15 c	13.88 c	13.20 c	7.90 c	8.23 c	8.10 b	17.90 c
Poultry manure	38.53 a	39.63 a	39.13 a	19.35 a	20.15 a	19.75 a	16.52 a	18.33 a	17.42 a	10.07 a	10.21 a	10.25 a	21.71 a
Rabbit manure	36.58 b	37.92 b	37.28 b	17.35 b	18.15 b	17.75 b	14.48 b	16.27 b	15.43 b	8.63 b	8.90 b	8.80 b	19.83 b
b. Effect of application method													
Surface	35.88 b	37.17 b	36.55 b	16.90 b	17.70 b	17.30 b	13.80 b	15.58 b	14.68 b	8.37 b	8.68 b	8.55 b	19.28 b
Trench	37.02 a	38.10 a	37.58 a	17.80 a	18.62 a	18.20 a	14.97 a	16.75 a	15.90 a	9.37 a	9.54 a	9.55 a	20.34 a
c. Effect of biofertilizer													
Nitrobien	35.93 b	37.17 b	36.57 b	16.97 b	17.78 b	17.37 b	13.85 b	15.63 b	14.75 b	8.63 b	8.88 b	8.83 b	19.41 b
Rhizobacterien	36.97 a	38.10 a	37.57 a	17.73 a	18.53 a	18.13 a	14.92 a	16.70 a	15.83 a	8.10 b	9.34 a	9.27 a	20.22 a

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

Table (6): Effect of interaction between organic manure source and application method on number of shoots per branch of Washington navel orange trees (2000 and 2001 seasons).

Organic manure	Application method	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	
Cattle	Surface	33.75 f	34.85 e	34.30 f	14.85 f	15.65 f	15.25 e	11.85 f	13.35 f	12.05 f	7.45 b	7.80 d	7.65 d	17.40 e
	Trench	34.75 e	35.85 d	35.30 e	15.85 e	16.70 e	16.25 d	12.65 e	14.90 e	13.55 e	8.35 b	8.65 c	8.55 c	18.40 d
Poultry	Surface	37.85 b	38.95 b	38.45 b	18.95 b	19.75 b	19.35 a	15.85 b	17.65 b	16.75 b	9.80 a	10.10 ab	9.95 ab	21.32 b
	Trench	39.20 a	40.30 a	39.80 a	19.75 a	20.55 a	20.15 a	17.20 a	19.00 a	18.10 a	10.35 a	10.32 a	10.55 a	22.10 a
Rabbit	Surface	36.05 d	37.70 c	36.90 d	16.90 d	17.70 d	17.30 c	13.90 d	15.70 d	14.80 d	7.85 b	8.15 d	8.05 cd	19.50 c
	Trench	37.10 c	38.15 c	37.65 c	17.80 c	18.60 c	18.20 b	15.05 c	16.85 c	16.05 c	9.40 a	9.65 b	9.55 b	20.15 c

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

Table (7): Effect of interaction between application method and biofertilizer on number of shoots per branch of Washington navel orange 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	35.37 c	36.83 c	36.10 c	16.53 c	17.33 c	16.93 c	13.30 c	15.10 c	14.20 c	8.17 c	8.47 c	8.37 c	18.90 c
Surface	Rhizobacterien	36.40 b	37.50 b	37.00 b	17.27 b	18.07 b	17.67 b	14.30 b	16.03 b	15.17 b	8.57 c	8.90 bc	8.73 c	19.67 b
Trench	Nitrobien	36.50 b	37.50 b	37.03 b	17.40 b	18.23 b	17.80 b	14.40 b	16.17 b	15.30 b	9.10 b	9.29 ab	9.30 b	19.91 b
Trench	Rhizobacterien	37.53 a	38.70 a	38.13 a	18.20 a	19.00 a	18.60 a	15.53 a	17.67 a	16.50 e	9.63 a	9.79 a	9.80 a	20.77 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 biofertilizer on number of shoots per branch of Washington navel orange 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	33.75 f	34.80 e	34.25 e	14.90 f	15.75 f	15.30 d	11.60 f	13.35 f	12.50 f	7.45 c	7.75 c	7.65 c	17.40 f
	Rhizobacterien	34.75 e	35.90 d	35.35 d	15.80 e	16.60 e	16.20 c	12.70 e	14.90 e	13.55 e	8.35 b	8.70 b	8.55 b	18.40 e
Poultry	Nitrobien	37.90 b	39.00 b	38.50 b	19.00 b	19.80 b	19.40 a	15.90 b	17.70 b	16.80 b	9.95 a	10.08 a	10.15 a	21.15 b
	Rhizobacterien	39.15 a	40.25 a	39.75 a	19.70 a	20.50 a	20.10 a	17.15 a	18.95 a	18.05 a	10.20 a	10.33 a	10.35 a	22.27 a
Rabbit	Nitrobien	36.15 d	37.70 c	36.95 c	17.00 d	17.80 d	17.40 b	14.05 d	15.85 d	14.95 d	8.50 b	8.80 b	8.70 b	19.30 d
	Rhizobacterien	37.00 c	38.15 c	37.60 c	17.70 c	18.50 c	18.10 b	14.90 c	16.70 c	15.90 c	8.75 b	9.00 b	8.90 b	20.35 c

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

Table (9): Effect of interaction between organic manure source, application method and biofertilizer on number of shoots per branch of Washington navel orange trees (2000 and 2001 season).

Organic Manure source	Application method	Biofertilizer N-fixing bacteria	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 manure	Surface	Nitrobien	33.2 h	34.3 h	33.7 g	14.4 f	15.2 f	14.8 e	11.1 h	12.9 h	12.0 g	7.0 e	7.3 d	7.2 f	16.9 g
		Rhizobacterien	34.3 g	35.4 g	34.9 f	15.3 e	16.1 e	15.7 de	12.2 g	13.8 h	13.0 f	7.9 de	8.3 cd	8.1 ef	17.9 f
	Trench	Nitrobien	34.3 g	35.3 g	34.8 f	15.4 e	16.3 e	15.8 de	12.1 g	13.8 h	13.0 f	7.9 de	8.2 cd	8.1 ef	17.9 f
		Rhizobacterien	35.2 f	36.4 f	35.8 ef	16.3 d	17.1 d	16.7 cd	13.2 f	15.0 g	14.1 e	8.8 cd	9.1 bc	9.0 de	18.9 e
Poultry manure	Surface	Nitrobien	37.3 cd	38.4 cd	37.9 c	18.4 b	19.2 b	18.8 b	15.3 cd	17.1 cde	16.2 c	9.7 abc	10.0 ab	9.9 abcd	20.7 cd
		Rhizobacterien	38.4 b	39.5 b	39.0 b	19.5 a	20.3 a	19.9 a	16.4 b	18.2 bc	17.3 b	9.9 ab	10.2 a	10.0 abc	21.6 bc
	Trench	Nitrobien	38.5 b	39.6 b	39.1 b	19.6 a	20.4 a	20.0 a	16.5 b	18.3 b	17.4 b	10.2 a	10.5 a	10.4 ab	21.7 ab
		Rhizobacterien	39.9 a	41.0 a	40.5 a	19.9 a	20.7 a	20.3 a	17.9 a	19.7 a	18.8 a	10.5 a	10.8 a	10.7 a	22.6 a
Rabbit manure	Surface	Nitrobien	35.6 f	37.8 de	36.7 de	16.8 cd	17.6 cd	17.2 c	13.5 f	15.3 fg	14.4 e	7.8 e	8.1 cd	8.0 f	19.1 e
		Rhizobacterien	36.5 e	37.6 e	37.1 cd	17.0 cd	17.8 c	17.4 c	14.3 e	16.1 efg	15.2 d	7.9 e	8.2 cd	8.1 f	19.5 e
	Trench	Nitrobien	36.7 de	37.6 e	37.2 cd	17.2 c	18.0 c	17.6 c	14.6 de	16.4 def	15.5 d	9.2 bc	9.5 ab	9.4 ed	19.9 de
		Rhizobacterien	37.5 c	38.7 c	38.1 bc	18.4 b	19.2 b	18.8 b	15.5 c	17.3 bcd	16.6 c	9.6 abc	9.8 ab	9.7 bcd	20.8 cd

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

4.1.3. Shoot length increase

Tables (10-14) show the effect of organic manure source (cattle, poultry and rabbit), method organic manure application (surface and trench) and biofertilizers (Rhizobacterien and Nitrobien) as well as their combinations on shoot length increase of spring, summer and autumn growth cycles of Washington navel orange 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 rabbit manured trees. In other words, the shortest shoots of the different studied growth cycles were shown on cattle manured. Besides, shoots of rabbit manured trees scored intermediate values of length 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, 10).**

It is obvious from **Table (10)** that the application of organic manure in trenches exerted higher positive effect on shoot length increase of different growth cycles than surface application method. The differences in shoot length increase of the different growth cycles between the two organic manure application methods sources were obvious to reach significant 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 (11) 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 Washington navel orange 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, rabbit manure when applied in trenches produced longer shoots than surface application.

Additionally, the interaction between organic manure source and biofertilizers 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, rabbit manure provided with Rhizobacterien or Nitrobien induced similarly intermediate positive effect on shoot length of different growth cycles, **(Table, 12)**.

As for the interaction between method of organic manure application and biofertilizers, **Table (13)** 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 Washington navel orange trees.

Finally, the interaction between the three studied factors *i.e.* organic manure source, method of organic manure application and biofertilizers, **Table (14)** 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 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 rabbit 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 Washington navel orange 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 Washington navel orange trees during 2000 and 2001 seasons is reported in **Tables (15-19).**

It is obvious from **Table (15)** that shoots of poultry manured trees had significantly higher number of leaves of spring (5.20 & 5.05), summer (6.70 & 6.97) and autumn (3.30 & 3.42), whereas, those of rabbit manured trees recorded (4.97 & 4.76) for spring, (6.20 & 6.50) for summer and (2.95 & 3.10) 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 (4.70 & 4.45), summer (5.62 & 5.92) and autumn (2.65 & 2.87) 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 and autumn growth cycles. Meanwhile, trench application of organic manure surpassed surface application in enhancing number of produced leaves per shoot of summer growth cycle.

Table (10): Specific effect of organic manure source, application method and biofertilizer on shoot length increase of Washington navel orange trees (2000 and 2001 seasons).

Factor	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	
a. Effect of organic manure source													
Cattle manure	9.23 c	9.43 c	9.30 c	7.50 c	7.33 c	7.43 c	12.15 c	13.90 c	13.02 c	2.80 c	2.55 c	2.70 c	6.80 b
Poultry manure	11.65 a	11.83 a	11.75 a	9.15 a	9.05 a	9.10 a	16.52 a	18.33 a	17.42 a	4.20 a	3.92 a	4.05 a	7.87 a
Rabbit manure	10.20 b	10.46 b	10.35 b	8.50 b	8.33 b	8.43 b	14.39 b	16.28 b	15.43 b	3.50 b	3.22 b	3.37 b	7.62 a
b. Effect of application method													
Surface	10.23 b	10.42 b	10.35 b	8.33 a	8.22 a	8.30 a	13.74 b	15.58 b	14.68 b	3.48 a	3.23 a	3.36 a	7.60 a
Trench	10.48 a	10.72 a	10.58 a	8.43 a	8.25 a	8.33 a	14.97 a	16.75 a	15.90 a	3.51 a	3.23 a	3.38 a	7.26 a
c. Effect of biofertilizer													
Rhizobacterien	10.52 a	10.74 a	10.63 a	8.50 a	8.40 a	8.50 a	13.85 b	15.63 b	14.75 b	3.68 a	3.43 a	3.56 a	7.80 a
Nitrobien	10.20 b	10.40 b	10.30 b	8.20 b	8.08 b	8.15 b	14.86 a	16.70 a	15.83 a	3.31 b	3.03 b	3.18 b	7.06 b

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

Table (11): Effect of interaction between organic manure source and application methods on shoot length increase of Washington navel orange 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	9.20 e	9.35 e	9.30 d	7.45 d	7.30 c	7.40 c	11.65 f	13.40 f	12.50 f	2.80 c	2.55 c	2.70 c	6.80 c
	Trench	9.25 e	9.50 e	9.30 d	7.55 d	7.35 c	7.50 c	12.65 e	14.40 e	13.55 e	2.80 c	2.55 c	2.70 c	6.80 c
Poultry	Surface	11.45 b	11.60 b	11.55 b	9.10 ab	9.05 a	9.10 a	15.85 b	17.65 b	16.75 b	4.15 a	3.95 a	4.05 a	7.30 b
	Trench	11.85 a	12.05 a	11.95 a	9.20 a	9.05 a	9.10 a	17.20 a	19.00 a	18.10 a	4.25 a	3.90 a	4.05 a	8.45 a
Rabbit	Surface	10.05 d	10.30 d	10.20 c	8.45 c	8.30 b	8.40 b	13.73 d	15.70 d	14.80 d	3.50 b	3.20 b	3.35 a	7.55 b
	Trench	10.35 c	10.62 c	10.50 c	8.55 bc	8.35 b	8.50 b	15.05 c	16.85 c	16.05 c	3.50 b	3.25 b	3.40 b	7.70 b

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

Table (12): Effect of interaction between organic manure source and biofertilizer on shoot length increase of Washington navel orange 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	Rhizobacterien	9.35 d	9.55 d	9.45 d	7.70 e	7.50 d	7.60 de	11.60 f	13.35 f	12.50 f	2.95 e	2.75 e	2.85 e	6.95 cd
	Nitrobien	9.10 e	9.30 d	9.15 e	7.30 f	7.15 e	7.23 ef	12.70 e	14.45 e	13.55 e	2.65 f	2.35 f	2.55 f	6.65 d
Poultry	Rhizobacterien	11.90 a	12.10 a	12.00 a	9.30 a	9.15 a	9.23 a	15.90 b	17.70 b	16.80 b	4.40 a	4.15 a	4.30 a	8.70 a
	Nitrobien	11.40 b	11.55 b	11.50 b	9.00 b	8.05 a	8.53 a	17.15 a	18.95 a	18.05 a	4.00 b	3.70 b	3.80 b	7.05 cd
Rabbit	Rhizobacterien	10.30 c	10.57 c	10.45 c	8.70 c	8.50 b	8.60 bc	14.05 a	15.85 d	14.95 d	3.70 c	3.40 c	3.55 c	7.75 b
	Nitrobien	10.10 c	10.35 c	10.25 c	8.30 d	8.15 c	8.23 cd	14.73 c	16.70 c	15.90 c	3.30 d	3.05 d	3.20 d	7.50 bc

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

Table (13): Effect of interaction between application method and biofertilizer on shoot length increase of Washington navel orange 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	Rhizobacterien	10.33 b	10.53 b	10.43 b	8.47 b	8.30 ab	8.39 b	13.30 c	15.10 c	14.20 c	3.60 a	3.40 a	3.50 a	7.70 a
	Nitrobien	10.13 b	10.30 b	10.27 b	8.20 c	8.13 b	8.17 c	14.19 b	16.07 b	15.17 b	3.36 b	3.06 b	3.23 b	7.50 a
Trench	Rhizobacterien	10.70 a	10.94 a	10.83 a	8.67 a	8.47 a	8.57 a	14.40 b	16.17 b	15.30 b	3.76 a	3.46 a	3.63 a	7.90 a
	Nitrobien	10.27 b	10.50 b	10.33 b	8.20 c	8.03 b	8.12 c	15.53 a	17.33 a	16.50 a	3.26 b	3.00 b	3.13 b	6.63 b

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

Table (14): Effect of interaction between organic manure source, application method and biofertilizer on number of shoot length increase Washington navel orange trees (2000 and 2001 season).

Organic Manure source	Application method	Biofertilizer N-fixing bacteria	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 manure	Surface	Rhizobacterien	9.2 fg	9.4 e	9.3 fg	7.6 fg	7.4 d	7.5 fg	8.0 f	8.2 d	8.1 e	2.9 ghi	2.7 fg	2.8 def	6.9 def
		Nitrobien	9.2 fg	9.3 e	9.3 fg	7.3 g	7.2 d	7.3 g	7.5 g	7.5 f	7.5 f	2.7 hi	2.4 gh	2.6 ef	6.7 ef
	Trench	Rhizobacterien	9.5 f	9.7 e	9.6 f	7.8 f	7.6 d	7.7 f	8.0 f	8.1 e	8.0 e	3.0 gh	2.8 ef	2.9 de	7.0 def
		Nitrobien	9.0 g	9.3 e	9.0 g	7.3 e	7.1 d	7.2 g	7.5 g	7.6 f	7.5 f	2.6 I	2.3 h	2.5 f	6.6 f
Poultry manure	Surface	Rhizobacterien	11.7 b	11.9 a	11.8 b	9.2 ab	9.1 ab	9.2 ab	9.3 b	9.5 a	9.4 a	4.3 ab	4.2 a	4.3 a	8.6 ab
		Nitrobien	11.2 c	11.3 b	11.3 c	9.0 bc	9.0 ab	9.0 abc	9.0 c	9.1 b	9.0 b	4.0 bc	3.7 b	3.8 b	8.3 abc
	Trench	Rhizobacterien	12.1 a	12.3 a	12.2 a	9.4 a	9.2 a	9.3 a	9.6 a	9.5 a	9.5 a	4.5 a	4.1 a	4.3 a	8.8 a
		Nitrobien	11.6 b	11.8 a	11.7 b	9.0 bc	8.9 ab	8.9 bc	9.1 c	9.0 b	9.0 b	4.0 bc	3.7 b	3.8 b	8.4 ab
Rabbit manure	Surface	Rhizobacterien	10.1 e	10.3 cd	10.2 e	8.6 de	8.4 c	8.5 de	8.6 de	8.5 c	8.5 cd	3.6 de	3.3 cd	3.4 c	7.6 cd
		Nitrobien	10.0 e	10.3 cd	10.2 e	8.3 e	8.2 c	8.3 e	8.5 e	8.3 d	8.4 d	3.4 ef	3.1 de	3.3 c	7.5 cde
	Trench	Rhizobacterien	10.5 d	10.8 bc	10.7 d	8.8 cd	8.6 bc	8.7 cd	8.7 d	8.6 c	8.6 c	3.8 cd	3.5 bc	3.7 b	7.9 bc
		Nitrobien	10.2 de	10.4 cd	10.3 e	8.3 e	8.1 c	8.2 e	8.4 e	8.3 d	8.4 d	3.2 fg	3.0 def	3.1 cd	7.5 cde

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

Moreover, the biofertilizers effect took the same trend of application method, regarding number of leaves per shoots of different growth cycles. Where, Rhizobacterien induced more positive effect on number of developed leaves per shoot of summer growth cycle, only than did Nitrobien (**Table, 15**).

Regarding the interaction between organic manure source and method of application **Table (16)** 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 rabbit and finally by the corresponding ones of cattle manure.

In addition, **Table (17)** reveals that the interaction between organic manure source and biofertilizers 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 by the combinations of rabbit manure and lastly by the interactions of cattle manure.

Table (18) demonstrates that the interaction between method of organic manure application and biofertilizers failed to induce a distinctive effect on number of developed leaves per shoot of most studied growth cycles of Washington navel orange trees in 2000 and 2001 seasons.

As for the interaction between the three studied factors namely organic manure source, method of organic manure application and biofertilizers, **Table (19)** 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 rabbit manure and finally by the corresponding ones of cattle manure.

Table (15): Specific effect of organic manure source, application method and biofertilizer on number of leaves per shoot of Washington navel orange 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	4.70 c	4.45 c	5.62 c	5.92 c	2.65 c	2.87 c
Poultry manure	5.20 a	5.05 a	6.70 a	6.97 a	3.30 a	3.42 a
Rabbit manure	4.97 b	4.76 b	6.20 b	6.50 b	2.95 b	3.10 b
b. Effect of application method						
Surface	4.91 a	4.71 a	6.05 b	6.35 b	2.85 b	3.01 a
Trench	5.00 a	4.79 a	6.30 a	6.58 a	3.08 a	3.25 a
c. Effect of biofertilizer						
Rhizobacterien	5.00 a	4.79 a	6.25 a	6.56 a	3.03 a	3.20 a
Nitrobien	4.91 a	4.71 a	6.10 b	6.36 b	2.90 b	3.06 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 and application method on number of leaves per shoot of Washington navel orange 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	4.65 d	4.40 d	5.45 d	5.80 e	2.55 e	2.80 c
	Trench	4.75 cd	4.50 cd	5.80 c	6.05 de	2.75 de	2.95 bc
Poultry	Surface	5.15 ab	5.00 ab	6.60 a	6.85 ab	3.15 b	3.30 ab
	Trench	5.25 a	5.10 a	6.80 a	7.10 a	3.45 a	3.55 a
Rabbit	Surface	4.95 bc	4.75 bc	6.10 b	6.40 cd	2.85 cd	2.95 bc
	Trench	5.00 b	4.78 b	6.30 b	6.60 bc	3.05 bc	3.25 ab

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

Table (17): Effect of interaction between organic manure source and biofertilizer on number of leaves per shoot of Washington navel orange 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 →	Rhizobacterien	4.75 cd	4.50 c	5.65 c	6.00 d	2.70 de	2.90 cd
	Nitrobien	4.65 cd	4.40 c	5.60 c	5.85 d	2.60 e	2.85 d
Poultry →	Rhizobacterien	5.25 a	5.10 a	6.80 a	7.10 a	3.40 a	3.55 a
	Nitrobien	5.15 ab	5.00 a	6.60 a	6.85 ab	3.20 ab	3.30 ab
Rabbit →	Rhizobacterien	5.00 abc	4.78 b	6.30 b	6.60 bc	3.00 bc	3.15 bc
	Nitrobien	4.95 bc	4.75 b	6.10 b	6.40 c	2.90 cd	3.05 bcd

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

Table (18): Effect of interaction between application method and biofertilizer on number of leaves per shoot of Washington navel orange 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 →	Rhizobacterien	4.95 a	4.73 a	6.13 bc	6.46 a	2.93 bc	3.06 b
	Nitrobien	4.86 a	4.70 a	5.96 c	6.23 b	2.76 c	2.96 b
Trench →	Rhizobacterien	5.03 a	4.85 a	6.36 a	6.66 a	3.13 a	3.33 a
	Nitrobien	4.96 a	4.73 a	6.23 ab	6.50 a	3.03 ab	3.16 ab

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, application method and biofertilizer on number of leaves/ shoot of Washington navel orange trees (2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer N-fixing bacteria	No. of leaves/shoot					
			Spring growth cycle		Mean of summer growth cycles		Autumn growth cycles	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	Rhizobacterein	4.7 de	4.4 d	5.5 fg	5.9 ef	2.6 fg	2.8 d
		Nitrobein	4.6 e	4.4 d	5.4 g	5.7 f	2.5 g	2.8 d
	Trench	Rhizobacterein	4.8 cde	4.6 cd	5.8 ef	6.1 de	2.8 defg	3.0 bcd
		Nitrobein	4.7 de	4.4 d	5.7 ef	6.0 def	2.7 efg	2.9 cd
Poultry Manure	Surface	Rhizobacterein	5.2 ab	5.0 ab	6.7 ab	7.0 ab	3.3 abc	3.4 ab
		Nitrobein	5.1 abc	5.0 ab	6.5 bc	6.7 bc	3.0 cde	3.2 bcd
	Trench	Rhizobacterein	5.3 a	5.2 a	6.9 a	7.2 a	3.5 a	3.7 a
		Nitrobein	5.2 ab	5.0 ab	6.7 ab	7.0 ab	3.4 ab	3.4 ab
Rabbit manure	Surface	Rhizobacterein	5.0 abcd	4.8 bc	6.2 cd	6.5 c	2.9 def	3.0 bcd
		Nitrobein	4.9 bcde	4.7 bcd	6.0 de	6.3 cd	2.8 defg	2.9 cd
	Trench	Rhizobacterein	5.0 abcd	4.8 bc	6.4 bc	6.7 bc	3.1 bcd	3.3 abc
		Nitrobein	5.0 abcd	4.8 bc	6.2 cd	6.5 c	3.0 cde	3.2 bcd

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

4.1.5. Leaf parameters

Tables (20 – 25) show the response of some leaf parameters, *i.e.* leaf surface area, leaf shape index, leaf chlorophyll (*a* & *b*) and leaf dry weight to organic manure source, method of organic manure application and biofertilizers as well as their interactions during 2000 and 2001 seasons.

4.1.5.1. Leaf surface area

It is clear from **Table (20)** that poultry manured trees produced more expanded leaves as compared with those arised from cattle or rabbit manured ones. However, the differences between cattle and rabbit 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.

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 method reveals that poultry manure applied particularly in trenches or secondly + superficially exerted the highest positive effect on leaf surface area of Washington navel orange trees in both seasons, **(Table, 21).** Other studied interactions gave nearly more or less similar values in this respect.

In addition, **Table (22)** illustrates that the interaction between organic manure source and biofertilizer 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 cattie and rabbit manure induced statistically similar effect in this respect, except for cattle manure applied superficially which showed the lowest leaf surface area values from 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, 23).** 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 interaction of poultry manure surpassed the other combination (cattle and rabbit) 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, rabbit manure combinations surpassed cattle manure interactions in this respect and took the same pattern of poultry manure combinations in both seasons, **(Table, 24).**

4.1.5.2. Leaf shape index

It is clear from **Tables (20 – 24)** that neither the three tested factors (organic manure sources, method of organic manure application and biofertilizer) levelly nor in their different combinations succeeded in exerting a distinctive effect on leaf shape index of Washington navel orange trees.

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

Table (20) shows that leaves of poultry manured trees had the highest values of chlorophyll *a* & *b*, followed descendingly by those of rabbit 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, trenchly-manured trees produced leaves richer in their content of chlorophyll *a* & *b* than superficially manured ones.

Additionally, Rhizobacterien inoculation trees gave leaves richer in their content of chlorophyll *a* & *b* than did those inoculated with Nitrobien.

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, 23)**.

Finally, the interaction between the three studied factors **(Table, 24)** demonstrates that the combinations of poultry manure gave the highest values of leaf chlorophyll *a* & *b* with the superiority in side trench application and Rhizobacterien inoculation. Besides, the interactions of rabbit manure surpassed the corresponding ones of cattle manure with the superiority to trench and Rhizobacterien inoculation.

On the other hand, **Table (21)** 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 rabbit manure surpassed cattle manure in enhancing leaf chlorophyll *a* & *b* with the superiority to trench application.

Furthermore, **Table (22)** 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, rabbit manure combinations surpassed cattle manure combination with the superiority to Rhizobacterien inoculation.

4.1.5.4. Leaf dry weight

It is cleat that leaves of poultry and rabbit manured trees had similarly higher values of dry weight than those produced by cattle manured trees **(Table, 20)**.

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

As for the interaction between organic manure source and method of organic manure application, **Table (21)** reveals that the combination of poultry and rabbit exerted statistically similar and higher positive effect on leaf dry weight as compared with those arised from cattle combinations.

Furthermore, the interaction between organic manure source and biofertilizer illustrates that all studied interactions produced statistically similar and higher values of leaf dry weight as compared with cattle manure x Rhizobacterien combination in both seasons of study, **(Table, 22).**

Additionally, **Table (23)** reveals that when the method of organic manure application interacted with biofertilizer, it failed to add an additional remarkable effect on leaf dry weight of Washington navel orange trees.

Finally, the interaction between the three studied factors (organic manure source. method of organic manure application and biofertilizer) 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, 24)**.

Conclusively, poultry manure proved to be the most efficicnt organic manure source in enhancing tree growth of Washington navel orange trees expressed as the longest growth cycles durations, the highest growth cycles intensity, the longest shoot 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 content and the heaviest leaf dry weight. Cattle manure induced the least positive effect, whereas rabbit manure exerted intermediate effect in this concern.

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

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 due to: (1) its physical effects on soil condition, (2) the nutrients it supplies and (3) the way it supplies them. 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).** Besides, **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 biofertilizers 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 Washington navel orange and **Grassi *et al.* (1999)** on Rangpur lime seedlings. 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.

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 Azzazy (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, and **Mahmoud and Mahmoud (1999)** on peach. They showed that biofertilizers, *i.e.* Rhizobacterien and Nitrobien caused material improvement in shoot length, leaf-area and cane thickness.

Table (20): Specific effect of organic manure source, application method and biofertilizer on some leaf parameters of Washington navel orange 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	14.30 b	14.57 b	2.32 a	2.33 a	5.77 c	6.10 b	2.29 c	2.48 c	0.97 b	1.08 b
Poultry manure	15.85 a	16.06 a	2.32 a	2.34 a	6.32 a	6.51 a	2.94 a	3.13 a	1.20 a	1.23 a
Rabbit manure	14.80 b	15.00 b	2.33 a	2.33 a	6.00 b	6.10 b	2.64 b	2.91 b	1.14 a	1.18 a
b. Effect of application method										
Surface	14.72 b	14.91 b	2.32 a	2.34 a	5.94 b	6.10 b	2.54 b	2.79 b	1.08 a	1.14 a
Trench	15.25 a	15.52 a	2.32 a	2.33 a	6.12 a	6.40 a	2.70 a	2.89 a	1.13 a	1.19 a
c. Effect of biofertilizer										
Rhizobacterien	15.13 a	15.36 a	2.31 a	2.34 a	6.10 a	6.39 a	2.60 a	2.90 a	1.12 a	1.16 a
Nitrobien	14.83 b	15.07 b	2.33 a	2.33 a	5.96 b	6.15 b	2.50 b	2.78 b	1.09 a	1.17 a

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

Table (21): Effect of interaction between organic manure source and application method on some leaf parameters of Washington navel orange 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	14.10 d	14.35 d	2.32 a	2.34 a	5.68 f	5.88 d	2.21 f	2.41 c	0.92 b	1.06 c
	Trench	14.50 cd	14.80 cd	2.33 a	2.33 a	5.85 e	6.33 bc	2.37 e	2.55 c	1.01 b	1.11 bc
Poultry	Surface	15.35 b	15.52 b	2.33 a	2.35 a	6.20 b	6.38 b	2.86 b	3.05 ab	1.19 a	1.21 a
	Trench	16.35 a	16.60 a	2.31 a	2.33 a	6.45 a	6.64 a	3.01 a	3.21 a	1.22 a	1.25 a
Rabbit	Surface	14.70 c	14.85 cd	2.33 a	2.33 a	5.95 d	6.14 c	2.56 d	2.91 b	1.13 a	1.20 a
	Trench	14.90 bc	15.15 bc	2.33 a	2.33 a	6.06 c	6.25 bc	2.72 c	2.92 b	1.16 a	1.22 a

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

Table (22): Effect of interaction between organic manure source and biofertilizer on some leaf parameters of Washington navel orange 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	Rhizobacterien	14.40 de	14.70 de	2.32 a	2.33 a	5.81 d	6.30 bc	2.32 c	2.52 c	0.99 b	1.01 b
	Nitrobien	14.20 e	14.45 e	2.32 a	2.33 a	5.73 d	5.91 e	2.26 c	2.44 c	1.15 a	1.16 a
Poultry	Rhizobacterien	16.10 a	16.27 a	2.31 a	2.33 a	6.42 a	6.61 a	2.96 a	3.15 a	1.22 a	1.25 a
	Nitrobien	15.60 b	15.85 b	2.32 a	2.35 a	6.22 b	6.42 b	2.91 a	3.11 a	1.19 a	1.27 a
Rabbit	Rhizobacterien	14.90 c	15.10 c	2.31 a	2.33 a	6.06 c	6.25 cd	2.69 b	2.90 b	1.16 a	1.22 a
	Nitrobien	14.70 cd	14.90 cd	2.34 a	2.33 a	5.95 c	6.20 d	2.60 b	2.79 b	1.19 a	1.19 a

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

Table (23): Effect of interaction between application method of organic manure and biofertilizer on some leaf parameters of Washington navel orange 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	Rhizobacterien	14.83 bc	15.04 c	2.32 a	2.33 a	5.99 bc	6.19 bc	2.59 b	2.90 a	1.10 a	1.12 a
	Nitrobien	14.60 c	14.77 d	2.33 a	2.34 a	5.90 c	6.08 c	2.50 c	2.68 b	1.09 a	1.16 a
Trench	Rhizobacterien	15.43 a	15.67 a	2.31 a	2.33 a	6.20 a	6.59 a	2.72 a	2.91 a	1.15 a	1.20 a
	Nitrobien	15.07 b	15.37 b	2.33 a	2.33 a	6.03 b	6.23 b	2.68 ab	2.88 a	1.11 a	1.18 a

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, application method and biofertilizer on some leaf parameters of Washington navel orange 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)		Leaf chlorophyll (mg/L) (b)		Leaf dry weight (g)	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	Rhizobacterein	14.2 gh	14.5 gh	2.34 a	2.35 a	5.72 ef	5.93 gh	2.25 gh	2.46 de	0.95 cd	0.97 c
		Nitrobein	14.0 h	14.2 h	2.30 a	2.33 a	5.65 f	5.84 h	2.17 h	2.36 e	1.15 ab	1.16 ab
	Trench	Rhizobacterein	14.6 efg	14.9 efg	2.31 a	2.32 a	5.90 de	6.68 ab	2.40 fg	2.58 de	1.15 ab	1.06 bc
		Nitrobein	14.4 fgh	14.7 fg	2.35 a	2.34 a	5.81 ef	5.98 fgh	2.35 fg	2.53 de	1.14 ab	1.13 ab
Poultry Manure	Surface	Rhizobacterein	15.5 bc	15.5 c	2.31 a	2.33 a	6.25 b	6.44 c	2.90 ab	3.09 ab	1.20 ab	1.22 ab
		Nitrobein	15.2 cd	15.4 cd	2.35 a	2.33 a	6.15 bc	6.33 cd	2.83 bc	3.01 ab	1.18 ab	1.20 ab
	Trench	Rhizobacterein	16.7 a	16.9 a	2.32 a	2.34 a	6.60 a	6.78 a	3.03 a	3.21 ab	1.25 a	1.28 a
		Nitrobein	16.0 b	16.3 b	2.30 a	2.33 a	6.30 b	6.51 bc	3.00 a	3.21 ab	1.20 ab	1.22 ab
Rabbit manure	Surface	Rhizobacterein	14.8 def	15.0 def	2.31 a	2.33 a	6.01 cd	6.20 def	2.63 de	2.15 ab	1.15 ab	1.17 ab
		Nitrobein	14.6 efg	14.7 fg	2.35 a	2.34 a	5.90 de	6.08 efg	2.50 ef	2.68 cd	1.12 b	1.13 ab
	Trench	Rhizobacterein	15.0 cde	15.2 cde	2.32 a	2.34 a	6.12 bc	6.31 cde	2.75 bcd	2.94 abc	1.17 ab	1.28 a
		Nitrobein	14.8 def	15.1 def	2.34 a	2.33 a	6.00 cd	6.20 def	2.70 cd	2.90 bc	1.15 ab	1.16 ab

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

Table (25): Specific effect of organic manure source, application method and biofertilizer on leaf N, P, K, Ca and Mg content of Washington navel orange 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	2.42 c	2.44 c	0.127 a	0.132 a	0.76 c	0.74 c	3.07 c	3.30 c	0.35 c	0.37 c
Poultry manure	2.67 a	2.70 a	0.142 a	0.152 a	1.04 a	0.93 a	4.02 a	4.43 a	0.53 a	0.55 a
Rabbit manure	2.55 b	2.57 b	0.137 a	0.147 a	0.90 b	0.89 b	3.37 b	3.68 b	0.44 b	0.46 b
b. Effect of application method										
Surface	2.53 a	2.55 a	0.133 a	0.142 a	0.88 a	0.87 a	3.40 b	3.68 b	0.42 b	0.45 b
Trench	2.55 a	2.59 a	0.138 a	0.147 a	0.92 a	0.90 a	3.58 a	3.92 a	0.46 a	0.47 a
c. Effect of biofertilizer										
Rhizobacterien	2.57 a	2.60 a	0.148 a	0.146 a	0.92 a	0.91 a	3.62 a	3.93 a	0.46 a	0.47 a
Nitrobien	2.51 b	2.54 b	0.140 a	0.141 a	0.88 b	0.86 b	3.36 b	3.67 b	0.42 b	0.45 b

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

4.2. Leaf mineral content

Leaf mineral content (N, P, K, Ca, Mg, Fe, Zn, Mn and Cu) of Washington navel orange trees during 2000 and 2001 seasons in response to organic manure source (cattle, poultry and rabbit), method of organic manure application (surface and trench) and biofertilizers (Rhizobacterien and Nitrobien) as well as their interactions is reported in **Tables (25 -35).**

4.2.1. Nitrogen

It is clear from **Table (25)** that leaves of poultry manured trees had higher values of nitrogen content (2.67 & 2.70%) as compared with those manured with cattle (2.42 & 2.44%) in the first and second seasons, respectively. Besides, leaves of rabbit manured trees scored inbetween values of nitrogen content (2.55 & 2.57%) 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, the method of organic manure application failed to induce a distinctive effect on leaf nitrogen content from the statistical standpoint.

In addition, fertilizing Washington navel orange 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

Additionally, **Table (27)** indicates that leaf nitrogen content responded largely to organic manure source rather than biofertilizers, where poultry manured trees supported firstly by Rhizobacterien or secondly by Nitrobien scored the highest values of leaf nitrogen content, followed descendingly by those of rabbit manure and lastly by the combinations of cattle manure.

Moreover, **Table (28)** reveals that the application of organic manure in trench and Rhizobacterien fertilization proved to be most efficient interaction in enhancing leaf nitrogen content of Washington navel orange 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 biofertilizers 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 rabbit manure occupied inbetween positions in this respect **(Table, 29)**.

4.2.2. Phosphorus

Table (25-29) demonstrates that the three studied factors *i.e.* organic manure source (cattle, poultry and rabbit), method of organic manure application (surface and trench) and biofertilizers alone or in different combinations failed to show any distinctive effect on leaf phosphorus content of Washington navel orange trees during 2000 and 2001 seasons.

4.2.3. Potassium

It is clear that fertilizing Washington navel orange trees with poultry manure enriched leaf potassium content (1.04 & 0.93%) as compared with those manured with rabbit (0.90 & 0.89%) and cattle manured trees (0.76 & 0.74%) in 2000 and 2001 seasons, respectively. Anyhow, the differences between the three organic manure sources in this respect were obvious to be significant.

Furthermore, the application of organic manure in trenches or superficially exerted similar effect on leaf potassium content of Washington navel orange from the statistical standpoint.

Moreover, **Table (25)** reveals that fertilizing Washington navel orange trees with Rhizobacterien improved leaf potassium content rather than Nitrobien fertilization.

Furthermore, **Table (26)** 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 rabbit manure and lastly by the corresponding ones of cattle manure in both seasons of study.

In addition, the interaction between organic manure source and biofertilizers demonstrates that the upper hand for the effect on leaf potassium content was organic manure source rather than biofertilizers. 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 rabbit manure and lastly the interactions of cattle manure **(Table, 27).**

On the other side, **Table (28)** reveals that out of interaction between method of organic manure application and biofertilizers, trench application x Rhizobacterien scored statistically higher leaf potassium content. Other tested combinations produced similar effect on leaf potassium content from the statistical 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 biofertilizers demonstrates that the interactions of poultry manure exerted similarly higher positive effect on leaf potassium content of Washington navel orange trees, followed descendingly by those of rabbit manure, and lastly, the interaction of cattle manure in the first and second seasons **(Table, 29)**.

4.2.4. Calcium

It is obvious from **Table (25)** that leaves of poultry manured trees had higher values of calcium (4.02 & 4.43%), followed by those manured with rabbit (3.37 & 3.68%) and lastly by those of cattle manured trees (3.07 & 3.30%) in 1999 and 2000 seasons, respectively. The differences between the three studied organic manure sources, regarding leaf calcium content were remarkable to be significantly at 5% level.

In addition, the application of three studied organic manure sources in trenches induced higher positive effect on leaf calcium content rather than superficial application **(Table, 25)**.

Moreover, inoculating Washington navel orange trees with Rhizobacterien enhanced leaf calcium content rather than Nitrobien fertilization.

As for the interaction between organic manure source and application method of organic manure, **Table (26)** reveals that poultry manure applied firstly in trenches and secondly superficially showed to be the most efficient combinations in enhancing leaf calcium content. Besides, the interactions of rabbit manure surpassed the corresponding ones of cattle manure in improving leaf calcium content of Washington navel orange trees in both seasons.

Regarding the interaction between organic manure source and biofertilizers, **Table (27)** demonstrates that Rhizobacterien combinations surpassed Nitrobien interactions in enhancing leaf calcium content. Thereupon, the highest values of leaf calcium content were noticed with poultry manured trees supported with Rhizobacterien followed descendingly by those manured with the same organic manure source and provided with Nitrobien. Besides, the combinations of rabbit manure took not only the same trend, but also surpassed the analogous ones of cattle manure.

Furthermore, **Table (28)** 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 surpassed surface application provided with the same biofertilization in enhancing leaf calcium content.

Finally, **Table (29)** illustrates the interaction between the three studied factors *i.e.* organic manure source, application method of organic manure and biofertilizers 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 rabbit manure surpassed the corresponding ones of cattle manure in improving leaf calcium content of Washington navel orange trees.

4.2.5. Magnesium

Table (25 – 29) shows that, the specific effect of organic manure source, application method of organic manure and biofertilizer **(Table, 25),** the interaction effect between organic manure source and application method **(Table, 26),** the interaction effect between organic manure source and biofertilizer **(Table, 27),** the interaction effect between method of organic manure application and biofertilizer **(Table, 28)** and the interaction effect between the three studied factors, *i.e.* organic manure source, method of application and biofertilizer, **(Table, 29)** took nearly similar trend to that of leaf calcium content of Washington navel orange trees in 2000 and 2001 seasons.

4.2.6. Iron, Manganese and Zinc

It is obvious from **Table (30)** that leaves of poultry manured trees had the highest values of leaf Fe, Mn and Zn content, followed descendingly by those of rabbit 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.

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

Moreover, inoculation Washington navel orange trees with Rhizobacterien exerted more positive effect on leaf Fe, Mn and Zn rather than Nitrobien inoculation.

Additionally, **Table (31)** reveals that the application of poultry manure firstly in trenches and secondly superficial exerted the highest stimulative effect on leaf Fe, Mn and Zn content. On the contrary, the applications of cattle manure either in trenches or superficially induced the lowest values in this respect. The interactions of rabbit manure occupied an intermediate position in this sphere.

Table (32) shows that the interaction between organic manure source and biofertilizers 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 trench in particular or superficially were the richest ones in their content of Fe, Mn and Zn. Besides, the combinations of rabbit 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 (33)** that the application of organic manure in trenches, provided with Rhizobacterien 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 Rhizobacterien 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 biofertilizer, **(Table, 34)** reveals that poultry manured trees, inoculated with Rhizobacterien 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 rabbit manure proved to be more efficient in enhancing leaf Fe, Mn and Zn content than the analogous ones of cattle manure.

4.2.7. Copper

It is clear from **Tables (30 – 34)** that the three studied factors, *i.e.* organic manure source, method of organic manure application and biofertilizer whether concerned lonely or in their different studied combinations failed to induce a distinctive effect on leaf copper content of Washington navel orange 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 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 induces positive effect on physical condition of the soil; creates favourable conditions for root growth and nutrients absorption; it supplies much nutrients, and it facilities the tree of fixed nutrients to be absorbed. Besides, poultry manure contains twice as much nitrogen as farmyard manure, they are much richer in phosphorus and contain as much 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 incorpation 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.* (1983)** 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 *et al.* (1993)** on pineapple, **Smith (1994)** on banana, **Abou-Sayed Ahmed (1997)** on Balady mandarin and **El-Kobbia (1999)** 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 **Tkachuk (1983)** on apple, **Bhangoo *et al.* (1988)** on grape and **Goede (1993)** on mange. Moreover, the results of biofertilizer regarding leaf mineral content are in agreement with the findings of **Pomares *et al.* (1983)** on oranges, **Chokha *et al.* (1993)** on orange, **Haggag and Azzazy (1996)** on mango, **Ahmed *et al.* (1997)** on grape, **Awasthi *et al.* (1998)** on peach, **Fernandez *et al.* (1998)** on banana, **Mansour (1998)** on Anna apple, **Mahmoud and Mahmoud (1999)** on peach and **Tiwary *et al.* (1999)** on banana. They mentioned that Rhizobacterien enhanced most leaf mineral content.

Table (26): Effect of interaction between organic manure source and application method on leaf N, P, K, Ca and Mg content of Washington navel orange 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	2.41 d	2.43 d	0.125 a	0.130 a	0.74 c	0.72 c	3.05 d	3.20 e	0.33 c	0.36 c
	Trench	2.42 d	2.45 d	0.130 a	0.135 a	0.78 c	0.76 c	3.10 d	3.40 d	0.37 c	0.37 c
Poultry	Surface	2.64 ab	2.67 b	0.140 a	0.150 a	1.03 a	1.02 a	3.80 b	4.20 b	0.52 a	0.52 a
	Trench	2.69 a	2.73 a	0.145 a	0.155 a	1.05 a	1.04 a	4.25 a	4.65 a	0.55 a	0.56 a
Rabbit	Surface	2.53 c	2.56 c	0.135 a	0.145 a	0.88 b	0.87 b	3.35 c	3.65 c	0.43 b	0.45 b
	Trench	2.56 bc	2.59 c	0.140 a	0.150 a	0.93 b	0.90 b	3.40 c	3.70 c	0.45 b	0.47 b

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

Table (27): Effect of interaction between organic manure source and biofertilizer on leaf N, P, K, Ca and Mg content of Washington navel orange 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	Rhizobacterien	2.43 d	2.45 d	0.130 a	0.140 a	0.78 c	0.76 c	3.15 e	3.40 e	0.37 d	0.38 d
	Nitrobien	2.40 d	2.42 d	0.125 a	0.125 a	0.73 c	0.72 c	3.00 f	3.20 f	0.33 e	0.36 d
Poultry	Rhizobacterien	2.71 a	2.74 a	0.145 a	0.155 a	1.07 a	1.05 a	4.25 a	4.65 a	0.56 a	0.56 a
	Nitrobien	2.62 b	2.65 b	0.140 a	0.150 a	1.02 a	1.00 a	3.80 b	4.20 b	0.51 b	0.53 b
Rabbit	Rhizobacterien	2.57 bc	2.60 bc	0.140 a	0.150 a	0.92 b	0.89 b	3.45 c	3.75 c	0.45 c	0.47 c
	Nitrobien	2.52 c	2.55 c	0.135 a	0.145 a	0.89 b	0.87 b	3.30 d	3.60 d	0.43 c	0.45 c

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

Table (28): Effect of interaction between application method of organic manure and biofertilizer on leaf N, P, K, Ca and Mg content of Washington navel orange 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	Rhizobacterien	2.55 ab	2.57 ab	0.136 a	0.146 a	0.90 b	0.87 b	3.50 b	3.80 b	0.44 b	0.46 ab
	Nitrobien	2.51 b	2.53 b	0.130 a	0.136 a	0.87 b	0.85 b	3.30 d	3.57 c	0.41 b	0.43 b
Trench	Rhizobacterien	2.59 a	2.62 a	0.140 a	0.150 a	0.94 a	0.93 a	3.73 a	4.07 a	0.47 a	0.48 a
	Nitrobien	2.52 b	2.55 b	0.136 a	0.143 a	0.89 b	0.86 b	3.43 c	3.77 b	0.43 b	0.46 ab

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, application method and biofertilizer on leaf (N, P, K, Ca and Mg) content of Washington navel orange 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	Rhizobacterein	2.42 ef	2.44 fg	0.13 a	0.14 a	0.76 ef	0.74 ef	3.1 h	3.3 fg	0.35 fg	0.37 f
		Nitrobein	2.41 ef	2.42 g	0.12 a	0.12 a	0.71 f	0.70 f	3.0 i	3.1 g	0.30 g	0.31 f
	Trench	Rhizobacterein	2.45 def	2.47 efg	0.13 a	0.14 a	0.80 de	0.79 de	3.2 g	3.5 ef	0.38 ef	0.39 ef
		Nitrobein	2.40 f	2.43 g	0.13 a	0.13 a	0.75 ef	0.73 ef	3.0 i	3.3 fg	0.35 fg	0.38 f
Poultry Manure	Surface	Rhizobacterein	2.67 ab	2.70 ab	0.14 a	0.15 a	1.05 a	1.03 a	4.0 b	4.4 b	0.53 ab	0.55 ab
		Nitrobein	2.61 bc	2.64 bcd	0.14 a	0.15 a	1.01 ab	1.00 ab	3.6 c	4.0 c	0.50 bc	0.52 bc
	Trench	Rhizobacterein	2.75 a	2.79 a	0.15 a	0.16 a	1.08 a	1.08 a	4.5 a	4.9 a	0.58 a	0.58 a
		Nitrobein	2.63 bc	2.67 bc	0.14 a	0.15 a	1.02 ab	1.00 ab	4.0 b	4.4 b	0.52 b	0.54 ab
Rabbit manure	Surface	Rhizobacterein	2.56 bcd	2.59 bcde	0.14 a	0.15 a	0.88 cd	0.86 cd	3.4 e	3.7 de	0.44 de	0.46 cd
		Nitrobein	2.51 cdef	2.54 cdef	0.13 a	0.14 a	0.88 cd	0.87 cd	3.3 f	3.6 de	0.42 de	0.44 de
	Trench	Rhizobacterein	2.59 bc	2.62 bcd	0.14 a	0.15 a	0.95 bc	0.93 bc	3.5 d	3.8 cd	0.46 cd	0.48 cd
		Nitrobein	253. cde	2.56 cdef	0.14 a	0.15 a	0.90 c	0.88 cd	3.3 f	3.6 de	0.44 cde	0.46 cd

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

Table (30): Specific effect of organic manure source, application method and biofertilizer on leaf Fe, Mn, Zn, and Cu content of Washington navel orange 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	67 c	70 c	46 c	50 c	45 c	44 c	6 a	7 a
Poultry manure	89 a	92 a	72 a	77 a	72 a	70 a	6 a	7 a
Rabbit manure	76 b	81 b	61 b	66 b	59 b	57 b	6 a	6 a
b. Effect of application method								
Surface	76 b	79 b	57 b	61 b	56 b	55 b	6 a	7 a
Trench	80 a	83 a	62 a	67 a	61 a	61 a	6 a	6 a
c. Effect of biofertilizer								
Rhizobacterien	80 a	83 a	62 a	68 a	61 a	60 a	6 a	7 a
Nitrobien	76 b	79 b	57 b	60 b	57 b	55 b	6 a	7 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 and application method on leaf Fe, Mn, Zn, and Cu content of Washington navel orange 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	65 d	68 d	43 f	46 e	42 c	41 d	6 a	7 a
	Trench	68 d	71 d	48 e	52 d	48 c	47 c	6 a	6 a
Poultry manure	Surface	86 b	90 b	70 b	73 b	70 a	69 a	6 a	7 a
	Trench	92 a	95 a	74 a	80 a	74 a	73 a	6 a	7 a
Rabbit manure	Surface	77 c	80 c	58 d	65 c	58 b	56 b	6 a	6 a
	Trench	79 c	82 c	64 c	67 c	62 b	62 b	6 a	7 a

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

Table (32): Effect of interaction between organic manure source and biofertilizer on leaf Fe, Mn, Zn, and Cu content of Washington navel orange 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	Rhizobacterien	69 d	73 d	49 e	54 e	48 c	47 c	6 a	7 a
	Nitrobien	64 e	67 e	42 f	45 f	42 d	41 d	5 a	7 a
Poultry manure	Rhizobacterien	91 a	95 a	74 a	81 a	74 a	73 a	6 a	7 a
	Nitrobien	87 b	90 b	70 b	72 b	70 a	67 a	5 a	7 a
Rabbit manure	Rhizobacterien	79 c	82 c	63 c	68 c	60 b	51 b	5 a	7 a
	Nitrobien	77 c	80 c	59 d	63 d	59 b	57 b	6 a	6 a

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

Table (33): Effect of interaction between organic manure application method and biofertilizer on leaf Fe, Mn, Zn, and Cu content of Washington navel orange 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 →	Rhizobacterien	77 b	81 b	59 b	64 b	59 b	57 b	6 a	7 a
	Nitrobien	74 c	77 c	55 c	58 c	55 c	53 c	6 a	7 a
Trench →	Rhizobacterien	82 a	85 a	65 a	71 a	64 a	63 a	6 a	6 a
	Nitrobien	78 b	81 b	60 b	63 b	59 b	58 b	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, application method and biofertilizer on leaf (Fe, Mn, Zn, and Cu) content of Washington navel orange 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	Rhizobacterein	68 gh	72 gh	46 h	51 f	44 ef	42 e	6 a	7 a
		Nitrobein	63 i	65 i	40 i	42 g	40 f	39 e	5 a	7 a
	Trench	Rhizobacterein	71 g	74 g	52 g	57 e	52 de	52 d	6 a	6 a
		Nitrobein	66 hi	69 hi	44 h	48 f	44 ef	42 e	5 a	6 a
Poultry Manure	Surface	Rhizobacterein	88 bc	92 bc	71 b	76 b	72 a	71 ab	6 a	7 a
		Nitrobein	85 cd	88 cd	66 bc	70 c	68 ab	66 cd	5 a	7 a
	Trench	Rhizobacterein	95 a	98 a	81 a	87 a	77 a	75 a	6 a	6 a
		Nitrobein	90 b	93 b	71 b	74 b	72 a	71 ab	5 a	7 a
Rabbit manure	Surface	Rhizobacterein	78 ef	81 ef	62 ef	66 d	60 bcd	58 cd	5 a	6 a
		Nitrobein	76 f	79 f	58 fg	63 d	56 cd	54 d	6 a	6 a
	Trench	Rhizobacterein	81 de	84 de	66 cd	70 c	65 bcd	63 bc	5 a	7 a
		Nitrobein	78 ef	81 ef	62 de	64 d	62 bc	60 cd	6 a	6 a

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

4.3. Tree fruiting

Data presented in **Tables (35 – 45)** show the effect of organic manure source, *i.e.* cattle, poultry and rabbit, method of organic manure application (surface and trench) and biofertilizers (Rhizobacterien and Nitrobien) as well as their interactions on tree fruiting parameters *i.e.*, fruit set, fruit drop percentages, number of fruits per tree and yield (kg/tree) of Washington navel orange trees during 2000 and 2001 seasons.

4.3.1. Fruit set percentages

It is quite evident from **Table (35)** that poultry manured-navel orange trees set higher percentages of fruits (16.92 & 17.33), followed descendingly by rabbit manured trees (16.46 & 16.81) and finally cattle manured ones (16.15 & 16.40) 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 rabbit manure and both poultry and cattle manure in this concern were so small to reach the significance level.

Furthermore, the application of organic manures either superficially or in trenches failed to induce any significant effect on fruit set of Washington navel orange trees in both seasons of study **(Table, 35).**

In addition, inoculation of Washington navel orange trees with Rhizobacterien exerted more positive effect on fruit set percentages (17.08 & 17.43) as compared with the analogous ones inoculated with Nitrobien (16.93 & 16.28) in the first and second seasons, respectively.

As for the effect of interaction between organic manure source and method of application on fruit set percentages of Washington navel orange trees, **Table (36)** demonstrates that in both seasons of study, the combinations of organic manure sources *i.e.* cattle, poultry and rabbit and the methods of application namely surface and trench failed to induce a pronounced effect on fruit set from the statistical standpoint.

Concerning the effect of interaction between organic manure source and biofertilizers, **Table (37)** demonstrates that flowers of Washington navel orange trees fertilized with poultry manure and inoculated with Rhizobacterien set comparatively higher percentages of fruits. On the contrary, flowers of Washington navel orange trees manured with cattle and inoculated with Nitrobien set comparatively lower percentages of fruits. Generally, all combinations of Rhizobacterien induced relatively similar and higher positive effect on fruit set of Washington navel orange trees than the corresponding one of Nitrobien.

Regarding the effect of interaction between method of organic manure application and biofertilizers, it is clear from **Table (38)** that in 2000 and 2001 seasons, the application of organic manure in trenches and fertilizing the trees with Rhizobacterien exerted higher percentage of fruit set. Besides, the combinations of Nitrobien and the two methods of organic manure application (surface and trench) produced statistically similar and lesser positive effect on fruit set percentages than the interaction between Rhizobacterien and the application of organic manure superficially in both seasons of study.

Regarding the interaction between organic manure source, method of organic manure application and biofertilizers, **Table (39)** indicates that nearly all the studied combinations of the three tested factors recorded statistically similar values of fruit set percentages of Washington navel orange trees except for the combinations of cattle manure applied superficially and Nitrobien which gave comparatively lower values of fruit set percentages of navel orange trees.

4.3.2. Fruit drop percentages

Table (35) reveals that in both seasons cattle manured trees recorded higher percentages of fruit dropping during April, 15th – May, 3rd, May, 4th – May, 24th and May, 25th – June, 21st as compared with those fertilized with poultry or rabbit manure. Besides, poultry manured trees shed lesser percentages of fruits during April, 15th – May, 3rd and May, 4th – May, 24th as compared with those fertilized with rabbit manure in both seasons. The reverse was true during the period of May, 25th – June, 21st.

Furthermore, the application of organic manures in trenches succeeded in reducing fruit shedding during the three studied periods of fruit dropping, *i.e.* April, 15th – May, 3rd, May, 4th – May, 24th and May, 25th – June, 21st as compared with surface application in both seasons.

Additionally, biofertilization in the form of Rhizobacterien surpassed Nitrobien in reducing fruit shedding during the studied periods of fruit dropping in 2000 and 2001 seasons **(Table, 35).**

Concerning the effect of interaction between organic manure source and method of application, **Table (36)** demonstrates that in general, the application of poultry and rabbit manure either superficially or in trenches induced nearly similar and negative effect on fruit dropping during April, 15th – June, 21st as compared with cattle manure when applied superficially in both seasons.

As for the effect of interaction between organic manure source and biofertilizers, it is clear from **Table (37)** 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 April, 15th – June, 21st. On the other hand, other tested interactions induced relatively similar effect in this respect during most studied periods.

Table (38) shows that the interaction between method of organic manure application and biofertilizers failed to induce an obvious trend regarding their effect on fruit drop percentage during April, 15^{th} – June, 21^{st} in both seasons of study.

Additionally, the interaction between organic manure source, method of organic manure application and biofertilizers 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.* April, 15^{th} – May, 3^{rd}, May, 4^{th} – May, 24^{th} and May, 25^{th} – June, 21^{st}. Besides, other tested combinations namely, poultry and rabbit manure whether applied superficially or in trenches and supported with Rhizobacterien or Nitrobien exerted nearly similar effect on fruit shedding during the periods of April, 15^{th} - June, 21^{st}.

4.3.3. No. of fruit/tree

Table (40) indicates that in both seasons, the three studied organic manure sources *i.e.* cattle, poultry and rabbit exerted statistically similar effect on number of produced fruits per tree. Besides, neither the application method (surface and trench) nor the biofertilizers (Rhizobacterien and Nitrobien) significantly affect number of produced fruits per tree in 2000 and 2001 seasons.

Furthermore, **Table (41)** shows that out of all interactions between organic manure source and method of organic manure application, pouitry manure applied in trenches gave the highest remarkable positive effect on number of produced fruit/tree. Other tested interactions failed to induce a distinctive trend in this respect.

In addition, **Table (42)** reveals that the interaction between organic manure source and biofertilizers took similar trend to that of interaction between organic manure source and method of application, hence, out of all interactions, poultry manure and rabbit manure supported with Rhizobacterien induced higher distinctive effect on number of developed fruits/tree. Other tested interactions failed to show a distinctive trend in this concern.

4.3.4. Yield (kg)/tree

It is quite evident from **Table (40)** that poultry manure and rabbit manure significantly increased tree yield as compared with those manured with cattle manure in 2000 and 2001 seasons. However, the differences between poultry and rabbit manure in this respect were lacking from statistical standpoint.

Furthermore, trench application of organic manure significantly increased number of fruits/trees as compared with superficial application **(Table, 40).**

Moreover, the two tested methods of organic manure application *i.e.* surface and trench exerted similar effect on tree yield in both seasons of study.

Furthermore, 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 application 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 particularly in the second season (2001). The combinations of rabbit manure showed inbetween values in this respect **(Table, 41).**

Table (42) demonstrates that the interaction between organic manure source and biofertilizers exerted that poultry manure provided with Rhizobacterien proved to be the most effective combination in enhancing tree productivity of Washington navel orange. On the contrary, cattle manure interactions showed to be the lowest effective combinations in this concern. Besides, other studied interactions produced intermediate effect on tree yield in both seasons of study.

It is obvious from **Table (43)** that out of all interactions between method of organic manure application and biofertilizers, trench application of manure when interacted with Rhizobacterien showed distinctive and higher positive effect on tree yield in both seasons. Other tested combinations gave similar values of tree yield from the statistical standpoint.

Moreover, **Table (43)** demonstrates that the interaction between method of organic manure application and biofertilizers gave in most cases similar effect on number of produced fruits per tree in both seasons.

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

Concerning the interaction between the three studied factors *i.e.* organic manure source, method of organic manure application and biofertilizers, **(Table, 44)** poultry manure applied in trenches and supported with Rhizobacterien or Nitrobien exerted the highest positive distinctive effect in enhancing tree productivity [yield (kg)/tree]. Other tested interactions scored comparatively similar values of tree yield (kg) from the statistical standpoint.

Abstractly, poultry manure proved to be the most efficient organic manure source in enhancing tree fruiting of Washington navel orange trees, hence it increased fruit set percentage reduced 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 nutrient elements with much higher with poultry manure, (4) it releases much more of 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 biofertilizers may be due to the production of growth regulator 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 **Bacha 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), Davitadze (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 combined treatments on yield were poultry manure and cattle manure at 3.5 and 12 t/fed, respectively. Recently, **El-Kobbia (1999)** on Washington navel orange, realized the highest yield was produced by cattle manure.

The obtained results regarding the effect of organic manure application 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.* (1983)** on orange, **Akl *et al.* (1997), Fernandez *et al.* (1998)** and **Mansour (1998)** on apple.

Table (35): Specific effect of organic manure source, application method and biofertilizer on fruit set and fruit drop percentages of Washington navel orange trees (2000 and 2001 seasons).

Factor	Fruit set (%)		Fruit Shedding (%)					
			April, 15th – May, 3rd		May, 4th – May, 24th		May. 25th –June, 21st	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source								
Cattle manure	16.15 b	16.40 b	65.20 a	66.42 a	9.80 a	9.66 a	4.70 a	4.47 a
Poultry manure	16.92 a	17.33 a	63.00 b	64.17 c	9.41 b	9.27 b	4.31 b	4.10 b
Rabbit manure	16.46 ab	16.81 ab	63.80 b	65.02 b	9.80 a	9.69 a	4.20 c	3.10 c
b. Effect of application method								
Surface	16.23 a	16.51 a	64.31 a	65.53 a	9.74 a	9.62 a	4.50 a	4.26 a
Trench	16.80 a	17.19 a	63.66 b	64.87 a	9.60 a	9.46 b	4.32 b	4.11 b
c. Effect of biofertilizer								
Rhizobacterien	17.08 a	17.43 a	62.80 b	64.00 b	9.63 a	9.53 a	4.40 a	4.19 a
Nitrobien	16.93 b	16.28 b	65.20 a	66.41 a	9.70 a	9.55 a	4.41 a	4.18 a

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

Table (36): Effect of interaction between organic manure source and application method on fruit set and fruit drop percentages of Washington navel orange trees (2000 and 2001 seasons).

Organic manure source	Application method	Fruit set (%)		Fruit Shedding (%)					
				April, 15th – May, 3rd		May, 4th – May, 24th		May. 25th –June, 21st	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	15.90 a	16.07 b	65.70 a	66.90 a	9.90 a	9.78 a	4.80 a	4.55 a
	Trench	16.40 a	16.74 ab	64.73 b	65.90 ab	9.70 ab	9.55 bc	4.62 ab	4.40 b
Poultry manure	Surface	16.40 a	16.74 ab	63.60 c	64.81 bc	9.53 ab	9.42 c	4.50 b	4.28 b
	Trench	16.77 a	17.95 a	62.32 d	63.54 c	9.30 b	9.13 d	4.12 c	3.93 c
Rabbit manure	Surface	16.40 a	16.75 ab	63.70 c	64.90 b	9.80 ab	9.68 ab	4.16 c	3.95 c
	Trench	16.51 a	16.89 ab	63.92 bc	65.14 b	9.81 ab	9.70 ab	4.22 c	4.01 c

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

Table (37): Effect of interaction between organic manure source and biofertilizer on fruit set and fruit drop percentages of Washington navel orange trees (2000 and 2001 seasons).

Organic manure source	Biofertilizer	Fruit set (%)		Fruit Shedding (%)					
				April, 15th – May, 3rd		May, 4th – May, 24th		May. 25th –June, 21st	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Rhizobacterien	16.70 ab	16.93 abc	63.70 b	64.91 bc	9.80 a	9.65 a	4.73 a	4.51 a
	Nitrobien	15.60 c	15.88 c	66.70 a	67.93 a	9.80 a	9.65 a	4.70 a	4.44 a
Poultry manure	Rhizobacterien	17.60 a	17.98 a	61.60 c	62.81 d	9.35 a	9.24 b	4.30 b	4.10 b
	Nitrobien	16.30 bc	16.71 bc	64.32 b	65.54 b	9.50 a	9.31 b	4.34 b	4.10 b
Rabbit manure	Rhizobacterien	16.96 ab	17.37 ab	63.06 b	64.23 c	9.80 a	9.67 a	4.20 b	3.95 c
	Nitrobien	15.95 bc	16.27 bc	64.53 b	65.76 b	9.82 a	9.71 a	4.23 b	4.02 bc

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 biofertilizer on fruit set and fruit drop percentages of Washington navel orange trees (2000 and 2001 seasons).

Application method	Biofertilizer	Fruit set (%)		Fruit Shedding (%)					
				April, 15th – May, 3rd		May, 4th – May, 24th		May. 25th –June, 21st	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Surface	Rhizobacterien	16.71 ab	17.06 ab	63.50 b	64.70 b	9.72 a	9.61 a	4.50 a	4.25 a
	Nitrobien	15.70 c	15.97 bc	65.16 a	66.40 a	9.50 a	9.64 a	4.50 a	4.26 a
Trench	Rhizobacterien	17.40 a	17.79 a	62.10 c	63.32 c	9.60 a	9.45 a	4.30 b	4.12 b
	Nitrobien	16.20 bc	16.59 bc	65.22 a	66.44 a	9.61 a	9.47 a	4.34 ab	4.11 b

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, application method and biofertilizer on fruit set and fruit drop percentages of Washington navel orange trees (2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer N-fixing bacteria	Fruit set (%)		Fruit drop percentage					
					April, 15th – May, 3rd		May, 4th – May, 24th		May. 25th – June, 21st	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	Rhizobacterein	16.50 ab	16.58 bc	64.13 bc	65.35 cd	9.82 a	9.71 ab	4.81 a	4.59 a
		Nitrobein	15.28 b	15.56 c	67.20 a	68.42 a	9.95 a	9.84 a	4.72 ab	4.50 ab
	Trench	Rhizobacterein	16.90 ab	17.28 abc	63.25 c	64.47 cd	9.76 a	9.65 ab	4.65 ab	4.43 abc
		Nitrobein	15.90 ab	16.20 bc	66.21 ab	67.43 ab	9.55 a	9.45 bc	4.59 ab	4.37 bc
Poultry Manure	Surface	Rhizobacterein	17.00 ab	17.40 abc	63.05 c	64.27 d	9.57 a	9.46 bc	4.49 bcd	4.27 c
		Nitrobein	15.80 ab	16.08 bc	64.12 bc	65.34 cd	9.48 a	9.37 bc	4.50 bc	4.28 c
	Trench	Rhizobacterein	18.15 a	18.56 a	60.12 d	61.34 e	9.12 a	9.02 d	4.05 e	3.93 d
		Nitrobein	16.72 ab	17.00 abc	64.52 bc	65.74 cd	9.35 a	9.27 cd	4.18 e	3.92 d
Poultry Manure	Surface	Rhizobacterein	17.00 ab	17.40 abc	63.05 c	64.27 d	9.57 a	9.46 bc	4.49 bcd	4.27 c
		Nitrobein	15.80 ab	16.08 bc	64.12 bc	65.34 cd	9.48 a	9.37 bc	4.50 bc	4.28 c
	Trench	Rhizobacterein	18.15 a	18.56 a	60.12 d	61.34 e	9.12 a	9.02 d	4.05 e	3.93 d
		Nitrobein	16.72 ab	17.00 abc	64.52 bc	65.74 cd	9.35 a	9.27 cd	4.18 e	3.92 d

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

Table (40): Specific effect of organic manure source, application method and biofertilizer on fruiting of Washington navel orange 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	216 b	203 a	42.34 b	40.30 b
Poultry manure	227 a	213 a	46.79 a	44.87 a
Rabbit manure	223 a	214 a	45.68 a	44.24 a
b. Effect of application method				
Surface	219 a	207 b	44.69 a	41.99 b
Trench	225 a	213 a	45.78 a	44.24 a
c. Effect of biofertilizer				
Rhizobacterien	227 a	213 a	45.92 a	44.00 a
Nitrobien	217 a	207 a	43.95 a	42.22 a

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 and application method on some fruiting parameters of Washington navel orange trees (2000 and 2001 seasons).

Organic manure source	Application method	No. of fruits/ tree		Yield (kg)/ tree	
		(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	217 b	205 cd	42.31 b	40.40 c
	Trench	215 b	201 d	42.36 b	40.20 c
Poultry manure	Surface	220 b	204 cd	45.10 ab	42.22 bc
	Trench	235 a	223 a	48.47 a	47.40 a
Rabbit manure	Surface	222 b	212 bc	44.84 ab	43.40 b
	Trench	225 a	216 ab	46.51 ab	45.13 ab

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

Table (42): Effect of interaction between organic manure source and biofertilizer on some fruiting parameters of Washington navel orange trees (2000 and 2001 seasons).

Organic manure source	Biofertilizer	No. of fruits/ tree		Yield (kg)/ tree	
		(2000)	(2001)	(2000)	(2001)
Cattle manure	Rhizobacterien	221 abc	206 cd	43.53 bc	41.30 bc
	Nitrobien	211 c	200 c	41.14 c	39.30 c
Poultry manure	Rhizobacterien	232 b	214 ab	47.62 a	45.40 a
	Nitrobien	222 abc	213 ab	45.97 ab	44.22 ab
Rabbit manure	Rhizobacterien	228 ab	219 a	46.61 ab	45.33 a
	Nitrobien	218 bc	209 abc	44.74 ab	43.15 ab

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

Table (43): Effect of interaction between application method of organic manure and biofertilizer on some fruiting parameters of Washington navel orange trees (2000 and 2001 seasons).

Application method	Biofertilizer	No. of fruits/ tree		Yield (kg)/ tree	
		(2000)	(2001)	(2000)	(2001)
Surface	Rhizobacterien	224 ab	210 ab	45.24 ab	42.90 ab
	Nitrobien	214 b	204 b	42.94 b	41.10 b
Trench	Rhizobacterien	230 a	216 a	46.61 a	45.12 a
	Nitrobien	220 ab	210 ab	44.96 ab	43.40 ab

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, application method and biofertilizer on fruiting of Washington navel orange trees (2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer N-fixing bacteria	No. of fruit/ tree		Yield (kg)/tree	
			(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	Rhizobacterein	222 abc	210 abcd	43.51 bc	41.79 bcd
		Nitrobein	212 bc	200 d	41.12 c	39.00 d
	Trench	Rhizobacterein	220 bc	203 cd	43.56 bc	40.80 cd
		Nitrobein	210 c	200 d	41.16 c	39.60 cd
Poultry Manure	Surface	Rhizobacterein	225 abc	203 cd	46.35 abc	42.42 bcd
		Nitrobein	215 bc	205 bcd	43.86 abc	42.02 bcd
	Trench	Rhizobacterein	240 a	225 a	50.88 a	48.37 a
		Nitrobein	230 ab	221 ab	48.07 ab	46.63 ab
Rabbit manure	Surface	Rhizobacterein	227 abc	217 abc	45.85 abc	44.48 abc
		Nitrobein	217 bc	208 bcd	43.83 abc	42.22 bcd
	Trench	Rhizobacterein	230 ab	221 ab	47.38 ab	46.18 ab
		Nitrobein	220 bc	211 abcd	45.32 abc	44.09 abc

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

4.4. Fruit quality

4.4.1. Fruit physical properties

The effect of organic manure source, method of organic manure application and biofertilizers as well as their interactions on fruit physical properties expressed as fruit weight, length, diameter, juice weight and peel thickness of Washington navel orange trees during 2000 and 2001 seasons is reported in **Tables (45 – 49).**

4.4.2. Fruit weight

It is clear from **Table (45)** that poultry manured trees produced heavier fruits (207.8 & 209.5 g) than those produced by rabbit manured ones (203.8 & 205.3 g) and finally those produced by cattle manured trees (196.0 & 198.3 g) in 2000 and 2001 seasons, respectively. The differences between the three studied organic manure sources were obvious to be significant.

Furthermore, trench application of organic manure significantly increased fruit weight as compared with superficial application.

In addition, fertilizing Washington navel orange 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 Washington navel orange trees. On the contrary, cattle manure whether applied superficially or in trenches proved to be the least effective interactions in enhancing fruit weight. Other combinations induced intermediate effect in this concern **(Table, 46)**.

Moreover, the interaction between method of organic manure application and biofertilizers 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, 47).**

In addition, **Table (48)** demonstrates that out of all interactions between organic manure source and biofertilizers, 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 rabbit manure exerted intermediate effect in this respect.

As for the interaction between the three studied factors namely organic manure source, method of organic manure application and biofertilizer reveals that out of all interactions poultry manure applied in trenches and provided with Rhizobacterien proved to be the most effective interactions 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 intermediate effect in this respect **(Table, 49).**

4.4.1.2. Fruit length

It is clear that organic manure source, *i.e.* cattle, poultry and rabbit failed to exert a distinctive effect on fruit length of Washington navel orange trees **(Table, 45).**

Furthermore, the applications of organic manure in trenches or superficially showed similar effect on fruit length of Washington navel orange during the two seasons of study.

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

On the other hand, the interaction between organic manure source, *i.e.* cattle manure, poultry manure and rabbit and organic manure application method (surface and trench) exerted similar effect on fruit length of Washington navel orange from the statistical standpoint **(Table, 46)**.

Additionally, the interaction between method of organic manure application and biofertilizer shows that Washington navel orange trees manured in trenches or superficially and inoculated with Rhizobacterien produced the longest fruits. On the contrary, fruits of Washington navel orange trees manured superficially and inoculated with Nitrobien had the lowest values of fruit length. Other combination reduced intermediate values of fruit length, **(Table, 47).**

Furthermore, **Table (48)** illustrates that neither the interaction between organic manure source, *i.e.* cattle, poultry and rabbit manure, nor the biofertilizer type namely Rhizobacterien and Nitrobien induced a distinctive effect on fruit length of Washington navel orange trees.

Finally, **Table (49)** reveals that the interaction between the three studied factors, *i.e.* organic manure source, method of organic manure application and biofertilizers failed to exert a distinctive and pronounced effect on fruit weight of Washington navel orange trees during the two seasons of study.

4.4.1.3. Fruit diameter

Table (45) shows that cattle manured trees, poultry manured trees and rabbit manured ones produced fruits similar in their diameter from the statistical standpoint.

On the other hand, the application of organic manure in trenches enhanced fruit diameter rather than the application of organic manure superficially.

Furthermore, Rhizobacterien-inoculated trees produced fruits similar in their diameter to those produced by Nitrobien-inoculated ones from the statistical standpoint.

In addition, the interaction between organic manure source, *i.e.* cattle, poultry and rabbit manure and method of organic manure application namely surface and trench failed to induce a distinctive effect on fruit diameter of Washington navel orange trees **(Table, 46).**

On the other hand, the combination of method of organic manure application and biofertilizer failed to add a pronounced effect on fruit diameter of Washington navel orange trees, **(Table, 47).**

Concerning the effect of interaction between organic manure source and biofertilizer, **Table (48)** demonstrates that all the studied combination exerted statistically similar effect on fruit diameter of Washington navel orange trees in both seasons of study.

Finally, **Table (49)** indicates that when the three studied factors, *i.e.* organic manure source, method of organic manure application and biofertilizer interacted together failed to induce a remarkable effect on fruit diameter of Washington navel orange trees from the statistical standpoint.

4.4.1.4. Peel thickness

Table (45) reveals that Washington navel orange trees whether manured with cattle, poultry or rabbit produced fruits similar in their rind thickness from the statistical standpoint.

Moreover, Washington navel orange trees manured in trenches produced fruits thicker in their peel rather than those manured superficially.

In addition, fruits of Rhizobacterien-inoculated trees had thicker rinds as compared with those produced by Nitrobien-inoculated ones in both seasons of study.

Furthermore, **Table (46)** demonstrates that rind thickness showed insignificant response to the interaction between organic manure source, *i.e.* cattle, poultry and rabbit and method of organic manure application in both seasons of study.

On the other side, the interaction between application method of organic manure and biofertilizer, **(Table, 47)** reveals that all studied combination showed statistically similar effect on peel thickness except for surface application of organic manure associated with Nitrobien inoculation which recorded statistically the lowest values of peel thickness in both seasons.

In addition, supporting organic manure source (cattle, poultry and rabbit) with biofertilizer (Rhizobacterien or Nitrobien) failed to exert an additional effect on peel thickness from statistical standpoint **(Table, 48)**.

Lastly, the studied combinations of the three studied factors, *i.e.* organic manure source, application method of organic manure and biofertilizer exerted statistically similar effect on peel thickness in both seasons, **(Table, 49)**.

4.4.1.5. Juice weight

It is clear from **Table (45)** that Washington navel orange trees whether manured with cattle, poultry and rabbit produced fruits similar in their juice content from the statistical standpoint.

Furthermore, the application of organic manure in trenches enhanced fruit juice content rather than the application of organic manure superficially.

Moreover, Rhizobacterien-inoculated trees produced juicy fruits as compared with the analogous ones inoculated with Nitrobien.

As for the interaction between organic manure source and method of organic manure application, **Table (46)** shows that there was no distinctive trend could be attributed to the studied interactions in both seasons of study.

On the other hand, **Table (47)** demonstrates that when method of organic manure application interacted with biofertilizer, the biofertilizer type showed to be the responsible for the final result of the interaction, hence Rhizobacterien inoculation, whether supported with surface or trench application of organic manure recorded the highest values of fruit juice content. On the contrary, surface application of organic manure provided with Nitrobien scored the lowest values of fruit juice content.

Furthermore, **Table (48)** demonstrates that organic manure source was responsible on the final result of interaction between organic manure source and biofertilizer. Briefly, fruits of poultry manured trees, inoculated with Rhizobacterien were the richest ones in juice content. Besides, Rhizobacterien combinations of the other two studied organic manure source produced statistically similar and higher positive effect on fruit juice content as compared with the interactions of Nitrobien.

Finally, the interaction between the three studied factors, *i.e.* organic manure source, method of organic manure application and biofertilizer reveals that out of these studied combinations poultry manure x trench application x Rhizobacterien induced the most pronounced distinctive effect on fruit juice content of Washington navel orange in both seasons of study **(Table, 49)**.

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

4.4.2. Fruit chemical properties

Tables (50-54) show the effect of organic manure source (cattle, poultry and rabbit), method of organic manure application (surface and trench) and biofertilizers (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 Washington navel orange trees during 2000 and 2001 seasons.

4.4.2.1. Total soluble solids (T.S.S)

It is quite evident that poultry manured trees produced fruits richer in their total soluble solids content (10.60 & 10.13%) as compared with those produced by rabbit manured trees (10.15 & 9.65%) and cattle manured ones (9.70 & 9.20%) in 2000 and 2001 seasons, respectively. However, the differences between the three organic manure sources in this respect were obvious to be significant **(Table, 50)**.

Furthermore, the application of organic manure in trenches succeeded in enhancing fruit content of total soluble solids than the application of organic manure superficially **(Table, 50)**.

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 (51)** 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 rabbit manure whether applied superficially or in trenches. Lastly, cattle manure applied in trenches or superficially induced similarly the lowest positive effect on fruit total soluble solids content of Washington navel orange trees.

On the other side,. **Table (52)** 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 rabbit manure either supported with Rhizobacterien or Nitrobien and lastly cattle manure whether enriched with Rhizobacterien or Nitrobien.

On the other hand, the interaction between of organic manure application method and biofertilizers 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, surface application of organic manure and fertilizing with Nitrobien took the other way around. Other studied interactions tock an intermediate positions between the previously two mentioned categories **(Table, 53)**.

On the other hand, the interaction between organic manure source, method of organic manure application and biofertilizers exerted that the application of poultry manure in trenches or superficially and provided with Rhizobacterien, followed descendingly by the analogous ones fertilized with poultry manure whether in superficially or in trenches and inoculated with Nitrobien gave comparatively 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 rabbit manure showed inbetween values in this respect.

4.4.2.2. Total acidity

Table (50) reveals that in 2000 and 2001 seasons, the studied organic manure sources (cattle, poultry and rabbit), method of organic manure application (surface and trench) and biofertilizers (Rhizobacterien and Nitrobien) induced statistically similar effect on fruit total acidity content.

Furthermore, interaction between organic manure source (cattle, poultry and rabbit) and method of organic manure application (surface and trench) produced similar effect on fruit total acidity content from the statistical standpoint **(Table, 51)**.

Table (52) demonstrates that the interaction between organic manure source i.e. cattle, poultry and rabbit and biofertilizers namely Rhizobacterien and Nitrobien failed to induce an additive effect on fruit total acidity content of Washington navel orange during the two seasons of study.

Additionally, **Table (53)** shows that in both seasons, the interaction between the method of organic manure application (surface and trench) and biofertilizers (Rhizobacterien and Nitrobien) failed to add any complementary effect on fruit total acidity content of Washington navel orange trees.

Finally, the interaction between the three studied factors *i.e.* organic manure source, method of organic manure application and biofertilizers failed to show any additive effect on fruit total acidity content of Washington navel orange trees **(Table, 54)**.

4.4.2.3 TSS/acid ratio

It is obvious from **Table (50)** that fruits produced by poultry manured trees had higher TSS/acid ratio (13.77 & 13.47) followed descendingly by the corresponding ones resulted from rabbit manured trees (13.06 & 12.58) and lastly those produced by cattle manured ones (12.61 & 12.27) 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 (50)** demonstrates that in both seasons Rhizobacterien surpassed Nitrobien in enhancing fruit TSS/acid ratio of Washington navel orange trees.

On the other side, **Table (51)** shows that the effect of organic manure source dominate 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 rabbit manure applied either superficially or in trenches and lastly cattle manure applied in trenches or superficially.

Furthermore, **Table (52)** reveals that in both seasons, the effect of organic manure source predominates the effect of biofertilizers, where poultry manure whether provided with Rhizobacterien or Nitrobien produced nearly similar and higher positive effect on fruit TSS/acid ratio, followed descendingly by rabbit 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 biofertilizers indicates that fruit TSS/acid ratio responded mainly to biofertilizer type rather than the method of organic manure application, hence fertilizing Washington navel orange 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 **(Table, 53)**.

As for the interaction between organic manure source, method of organic manure application and biofertilizer, **Table (54)** 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 rabbit manure gave nearly more or less similar effect in this respect.

4.4.2.4. Ascorbic acid

It is quite evident from **Table (50)** that in both seasons, poultry manured trees produced fruits richer in their ascorbic acid content (55.50 & 59.41 mg/100 ml juice) as compared with those resulted from rabbit manure (52.25 & 56.25 mg/100 ml juice) and cattle manured trees (50.00 & 54.25 mg/100 ml juice) in 2000 and 2001 seasons, respectively. The differences between cattle and rabbit manure in this respect were lacking from the statistical standpoint.

On the other hand, the method of organic manure application failed to induce a reasonable effect on fruit ascorbic acid content of Washington navel orange trees.

Furthermore, **Table (50)** indicates that fruit ascorbic acid content did not show a pronounced response whether the trees were inoculated with Rhizobacterien or Nitrobien in both seasons of study.

Additionally, the interaction between organic manure source and method of organic manure application reveals that the positive effect on fruit ascorbic content was attributed to organic manure source rather than the method of organic manure application, hence poultry manure whether applied superficially or in trenches produced similarly higher positive effect on fruit ascorbic acid content, followed descendingly by rabbit manure applied either superficially or in trenches and finally, cattle manure applied in trenches or superficially.

On the other side, **Table (52)** shows that the values of fruit ascorbic acid content resulted from interaction between organic manure source and biofertilizers were attributed mainly to the predominating effect of organic manure source rather than biofertilizers. Thereupon, poultry manure supported with Rhizobacterien or Nitrobien scored the highest values of fruit ascorbic acid content, followed descendingly by the combinations of rabbit manure and lastly by those of cattle manure.

In addition, it is clear from **Table (53)** 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 Washington navel orange trees in 2000 and 2001 seasons.

In summary, the interactions between organic manure source, method of organic manure application and biofertilizers show that all combinations of poultry manure *i.e.* poultry manure x (surface and trench) x (Rhizobacterien and Nitrobien) induced similar higher positive effect on fruit ascorbic acid content of Washington navel orange trees in both seasons of study. Other studied combinations of rabbit and cattle manure showed more or less similar effect in this respect, **(Table, 54)**.

Shortly, poultry manure proved to be the superior organic manure source in enhancing the studied fruit chemical characteristics, *i.e.*, T.S.S, total acidity and T.S.S./acid ratio. Besides, the application of organic manure in trenches exerted high positive effect on the previously mentioned fruit chemical characteristics rather than surface application. Moreover, Rhizobacterien inoculation induce stimulative effect on T.S.S/acid ratio, only as compared with Nitrobien inoculation.

Fruit quality results due to organic manure source are in agreement with the findings of **Sermann *et al.* (1975)** on pomes, stones and vines, **Bacha and Abo-Hassan (1983)** on date palm, **Sekiya *et al.* (1983)** on Satsuma mandarin, **Gasanov (1984)** on persimmon, **Kalu-Singh *et al.* (1984)** on mango, **Darfeld and Lenz (1985)** on pear, Lenartowicz (1985) on raspberry, **Umemiya and Sekiya (1985)** on persimmon, **Bussi and Defrance (1987)** on peach, **Piatkowski *et al.* (1990)** on apple, **Davitadve (1991)** on lemon, **Wang *et al.* (1991)** on grape, **Gouda *et al.* (1992)** on grape, **Hussein *et al.*** (1992) on date palm, **Alvarez *et al.* (1993)** on pineapple, **Li *et al.*** (1993) on pummelo, **Li *et al.* (1997)** on pear, **Mansour and Ahmed (1998)** on banana, **Silva (1998)** on mango, **El-Kobbia (1999)** on Washington navel orange and **Songe *et al.* (1999)** on apple. In this respect, **Rabeh *et al.*** (1993) (on Balady mandarin) and **Huang *et al.* (1995)** (on Satsuma mandarin) mentioned that poultry manure and farmyard manure enhanced fruit quality and gave better than pig manure.

Furthermore, the results of organic manure application method go in line with the findings of **Bhangoo *et al.* (1988)** on grapevines, **Fisun and Kodzokov (1991)** on plum and **Goede (1993)** on mango. In addition, fruit quality results attributed to biofertilizers are in accordance with those reported by **Pomares *et al.* (1983)** on mango, **Das *et al.* (1996)** on mulberry and **Mansour (1998)** on Anna apple. In this concern, **Akl *et al.* (1997)** mentioned that Rhizobacterien and Nitrobien added positive improvement on chemical and physical properties of grape berries.

Table (45): Specific effect of organic manure source, application method and biofertilizer on fruit physical properties of Washington navel orange trees (2000 and 2001 seasons).

Factor	Fruit characteristics									
	Weight (g)		Length (cm)		Diameter (cm)		Juice weight (g)		Peel thickness (mm)	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source										
Cattle manure	196.0 c	198.3 c	7.23 a	7.55 a	7.23 a	7.08 a	91.7 a	92.5 a	6.1 a	6.2 a
Poultry manure	207.8 a	209.5 a	7.78 a	7.60 a	7.25 a	7.10 a	93.0 a	94.0 a	6.2 a	6.3 a
Rabbit manure	203.8 b	205.3 b	7.73 a	7.55 a	7.33 a	7.15 a	91.7 a	92.2 a	6.0 a	6.2 a
b. Effect of application method										
Surface	200.7 b	202.3 b	7.70 a	7.70 a	7.26 a	7.07 a	91.3 b	92.1 b	6.0 b	6.1 b
Trench	204.4 a	206.3 a	7.78 a	7.63 a	7.28 a	7.15 a	93.0 a	93.6 a	6.2 a	6.3 a
c. Effect of biofertilizer										
Rhizobacterien	203.9 a	206.0 a	7.82 a	7.73 a	7.34 a	7.22 a	94.1 a	94.5 a	6.2 a	6.3 a
Nitrobien	201.2 b	202.6 b	7.67 b	7.47 b	7.23 a	7.10 a	90.0 b	91.3 b	6.0 b	6.1 b

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 and application method on fruit physical properties of Washington navel orange trees (2000 and 2001 seasons).

Organic manure source	Application method	Fruit characteristics									
		Weight (g)		Length (cm)		Diameter (cm)		Juice weight (g)		Peel thickness (mm)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	195.0 d	197.0 c	7.70 a	7.50 a	7.22 a	7.05 a	91.0 a	91.5 a	6.0 a	6.1 a
	Trench	197.0 d	199.5 c	7.75 a	7.60 a	7.25 a	7.10 a	92.5 a	93.5 a	6.1 a	6.2 a
Poultry manure	Surface	205.0 b	206.0 b	7.70 a	7.50 a	7.20 a	7.05 a	91.5 a	92.5 a	6.0 a	6.1 a
	Trench	210.5 a	213.0 a	7.85 a	7.70 a	7.30 a	7.15 a	94.5 a	95.5 a	6.3 a	6.3 a
Rabbit manure	Surface	202.0 c	204.0 b	7.70 a	7.50 a	7.37 a	7.10 a	91.5 a	92.5 a	6.0 a	6.1 a
	Trench	205.7 b	206.5 b	7.75 a	7.60 a	7.30 a	7.20 a	92.0 a	92.0 a	6.1 a	6.2 a

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

Table (47): Effect of interaction between application method and biofertilizer on fruit physical properties of Washington navel orange trees (2000 and 2001 seasons).

Application method	Biofertilizer	Fruit characteristics									
		Weight (g)		Length (cm)		Diameter (cm)		Juice weight (g)		Peel thickness (mm)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Surface →	Rhizobacterien	201.3 b	203.7 b	7.80 a	7.70 a	7.30 a	7.20 a	93.6 a	94.0 a	6.1 a	6.2 a
	Nitrobien	200.0 b	201.0 b	7.60 b	7.30 c	7.22 a	6.93 c	89.0 c	90.3 c	5.9 b	6.0 b
Trench →	Rhizobacterien	206.4 a	208.3 a	7.83 a	7.77 a	7.33 a	7.23 a	94.6 a	95.0 a	6.2 a	6.3 a
	Nitrobien	202.3 b	204.3 ab	7.73 ab	7.50 b	7.23 a	7.07 a	91.3 b	92.3 b	6.1 a	6.2 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, application method and biofertilizer on fruit physical properties of Washington navel orange trees (2000 and 2001 seasons).

Organic manure source	Biofertilizer	Fruit characteristics									
		Weight (g)		Length (cm)		Diameter (cm)		Juice weight (g)		Peel thickness (mm)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Rhizobacterien	197.0 c	200.0 cd	7.80 a	7.70 a	7.30 a	7.20 a	93.5 b	93.5 b	6.2 a	6.3 a
	Nitrobien	195.0 c	196.5 b	7.65 a	7.60 a	7.17 a	7.19 a	90.0 c	91.5 c	6.0 a	6.1 a
Poultry manure	Rhizobacterien	209.0 a	211.0 a	7.85 a	7.80 a	7.35 a	7.25 a	95.5 a	96.5 a	6.3 a	6.3 a
	Nitrobien	206.5 a	208.0 ab	7.70 a	7.60 a	7.15 a	7.10 a	90.5 c	91.5 c	6.1 a	6.2 a
Rabbit manure	Rhizobacterien	205.7 a	207.0 ab	7.30 a	7.70 a	7.30 a	7.20 a	93.5 b	93.5 b	6.1 a	6.2 a
	Nitrobien	202.0 b	203.5 bc	7.65 a	7.70 a	7.37 a	7.10 a	90.0 c	91.0 c	6.0 a	6.1 a

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

Table (49): Effect of interaction between organic manure source, application method and biofertilizer on fruit physical of Washington navel orange trees (2000 and 2001 seasons).

Organic manure source	Application method	Biofertilizer N-fixing bacteria	Fruit characteristics									
			Weight (g)		Length (cm)		Diameter (cm)		Peel thickness (mm)		Juice weight (g)	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	Rhizobacterein	196 e	199 ef	7.8 a	7.7 a	7.3 a	7.2 a	6.2 a	6.3 a	93 bc	92 bc
		Nitrobein	194 e	195 f	7.6 a	7.5 a	7.1 a	7.0 a	6.0 a	6.0 a	89 d	91 c
	Trench	Rhizobacterein	198 de	201 def	7.8 a	7.7 a	7.3 a	7.2 a	6.2 a	6.3 a	94 b	95 b
		Nitrobein	196 e	198 ef	7.7 a	7.5 a	7.2 a	7.0 a	6.1 a	6.2 a	91 cd	92 bc
Poultry Manure	Surface	Rhizobacterein	206 bc	207 bcd	7.8 a	7.7 a	7.3 a	7.2 a	6.2 a	6.3 a	94 b	95 b
		Nitrobein	204 bc	205 bcde	7.6 a	7.5 a	7.1 a	7.1 a	6.0 a	6.0 a	89 d	90 c
	Trench	Rhizobacterein	212 a	215 a	7.9 a	7.7 a	7.4 a	7.3 a	6.3 a	6.3 a	97 a	98 a
		Nitrobein	209 ab	211 ab	7.7 a	7.5 a	7.2 a	7.0 a	6.3 a	6.3 a	92 bc	93 bc
Rabbit manure	Surface	Rhizobacterein	202 cd	205 bcde	7.8 a	7.7 a	7.3 a	7.2 a	6.1 a	6.2 a	94 b	95 b
		Nitrobein	202 cd	203 cde	7.6 a	7.5 a	7.1 a	7.0 a	6.0 a	6.0 a	89 d	90 c
	Trench	Rhizobacterein	206 ab	209 abc	7.8 a	7.7 a	7.3 a	7.2 a	6.2 a	6.3 a	93 bc	92 bc
		Nitrobein	202 cd	204 bcde	7.7 a	7.5 a	7.3 a	7.2 a	6.1 a	6.2 a	91 cd	92 bc

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

Table (50): Specific effect of organic manure source, application method and biofertilizer on fruit chemical properties of Washington navel orange trees (2000 and 2001 seasons).

Factor	Fruit characteristics							
	T.S.S. (%)		Total acidity (%)		T.S.S. (%)/ acid ratio		Ascorbic acid mg/100 ml	
	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
a. Effect of organic manure source								
Cattle manure	9.70 c	9.20 c	0.77 b	0.75 a	12.61 c	12.27 c	50.00 b	54.25 b
Poultry manure	10.60 a	10.13 a	0.77 b	0.75 a	13.77 a	13.47 a	55.50 a	59.41 a
Rabbit manure	10.15 b	9.65 b	0.78 a	0.75 a	13.06 b	12.58 b	52.25 b	56.25 b
b. Effect of application method								
Surface	10.07 b	9.57 b	0.77 a	0.75 a	13.06 b	12.62 b	52.33 a	55.61 b
Trench	10.23 a	9.75 a	0.77 a	0.75 a	13.23 a	12.92 a	52.83 a	57.66 a
c. Effect of biofertilizer								
Rhizobacterien	10.20 a	9.82 a	0.76 b	0.76 a	13.36 a	13.01 a	53.00 a	57.83 a
Nitrobien	10.10 a	9.50 a	0.78 a	0.76 a	12.93 b	12.53 b	52.17 a	55.44 a

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

Table (51): Effect of interaction between organic manure source and application method on fruit chemical properties of Washington navel orange 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 ml)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	9.60 c	9.10 c	0.77 c	0.76 a	12.52 c	12.06 d	50.00 c	53.50 c
	Trench	9.80 c	9.30 c	0.77 c	0.75 a	12.71 c	12.48 c	50.00 c	55.00 bc
Poultry manure	Surface	10.50 a	10.00 a	0.77 c	0.75 a	13.67 a	13.25 b	55.00 a	57.83 ab
	Trench	10.70 a	10.25 a	0.77 c	0.75 a	13.90 a	13.70 a	56.00 a	61.00 a
Rabbit manure	Surface	10.10 b	9.60 b	0.76 b	0.77 a	13.04 b	12.60 c	52.00 b	55.50 bc
	Trench	10.20 b	9.70 b	0.78 a	0.76 a	13.08 b	12.60 c	52.50 b	57.00 b

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

Table (52): Effect of interaction between organic manure source and biofertilizer on fruit chemical properties of Washington navel orange 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 ml)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure →	Rhizobacterien	9.70 c	9.30 cd	0.76 d	0.75 a	12.74 c	12.40 d	50.00 d	55.00 cd
	Nitrobien	9.70 c	9.10 d	0.78 b	0.75 a	12.50 c	12.13 e	50.00 d	53.50 d
Poultry manure →	Rhizobacterien	10.70 a	10.35 a	0.76 d	0.75 a	14.08 a	13.73 a	56.00 a	61.00 a
	Nitrobien	10.50 a	9.90 b	0.78 b	0.75 a	13.50 a	13.20 b	55.00 ab	57.83 b
Rabbit manure →	Rhizobacterien	10.20 b	9.80 b	0.77 c	0.76 a	13.30 b	12.90 c	53.00 bc	57.50 bc
	Nitrobien	10.10 b	9.50 b	0.79 a	0.76 a	12.90 c	12.25 c	51.50 cd	55.00 bcd

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

Table (53): Effect of interaction between method of application and biofertilizer on fruit chemical properties of Washington navel orange trees (2000 and 2001 seasons).

Application Method	Biofertilizer	Fruit characteristics							
		T.S.S. (%)		Total acidity (%)		T.S.S. (%)/ acid ratio		Ascorbic acid (mg/100 ml)	
		(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Surface →	Nitrobien	10.13 ab	9.73 ab	0.76 d	0.76 a	13.33 a	12.81 b	52.67 a	57.00 a
	Rhizobacterien	10.00 b	9.40 c	0.78 a	0.75 a	12.80 c	12.43 c	52.00 a	54.22 b
Trench →	Nitrobien	10.27 a	9.90 a	0.77 c	0.75 a	13.40 b	13.22 a	53.33 a	58.66 a
	Rhizobacterien	10.20 ab	9.60 b	0.78 b	0.75 a	13.09 b	12.63 b	53.33 a	56.66 a

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, application method and biofertilizer on fruit chemical properties of Washington navel orange 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 acid (mg/100 ml) mg/100 juice	
			(2000)	(2001)	(2000)	(2001)	(2000)	(2001)	(2000)	(2001)
Cattle manure	Surface	Rhizobacterein	9.6 f	9.2 f	0.76 b	0.75 a	12.63 ef	12.27 fg	50 c	54 cd
		Nitrobein	9.6 f	9.0 g	0.78 ab	0.76 a	12.40 f	11.84 h	50 c	53 d
	Trench	Rhizobacterein	9.8 ef	9.4 ef	0.76 b	0.75 a	12.86 de	12.53 ef	51 c	56 bcd
		Nitrobein	9.8 ef	9.2 fg	0.78 ab	0.74 a	12.56 ef	12.43 efg	50 c	54 cd
Poultry Manure	Surface	Rhizobacterein	10.6 ab	10.2 ab	0.76 b	0.76 a	13.94 a	13.42 b	55 ab	59 ab
		Nitrobein	10.4 bc	9.8 cd	0.78 ab	0.75 a	13.33 bc	13.07 cd	55 ab	58 abc
	Trench	Rhizobacterein	10.8 a	10.5 a	0.76 b	0.74 a	14.21 a	14.05 a	57 a	62 a
		Nitrobein	10.6 ab	10.0 bc	0.78 ab	0.75 a	13.59 b	13.33 bc	55 ab	59 ab
Rabbit manure	Surface	Rhizobacterein	10.2 cd	9.8 cd	0.76 b	0.77 a	13.42 bc	12.73 de	53 bc	57 bcd
		Nitrobein	10.0 de	9.4 ef	0.79 a	0.76 a	12.65 ef	12.37 fg	51 c	54 cd
	Trench	Rhizobacterein	10.2 cd	9.8 cd	0.78 ab	0.75 a	13.08 cd	13.07 bcd	53 bc	58 abc
		Nitrobein	10.2 cd	9.6 de	0.78 ab	0.76 a	13.07 cd	12.13 gh	52 bc	56 bcd

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