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EFFECT OF CHEMICAL AND BIO FERTILIZATION ON THE GROWTH AND L-ASCORBIC ACID CONTENT OF *MORINGA OLEIFERA* L. PLANTS

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ABSTRACT: *Two field experiments were conducted at the Experimental Farm of Faculty of Agriculture, Menoufia University during two successive seasons 2016 and 2017 to evaluate the effect of different N_2-fixing bacterial strains such as Azospirillium lipoferum, Azotobacter chroococcum and Bacillus polymyxa individually or in combination with urea fertilization rates (0.0, 50, 100 and 200 kg/fed/season). The data reveals that the treated plants with Azotobacter chroococcum gave the highest values of plant height and mean number of branches / plant and consequently heavier fresh weight of plant in addition, L- ascorbic acid content followed by Bacillus polymyxa in the three cuts in both growing seasons. In addition, the vegetative growth parameters as well as L-ascorbic acid gradually increased with increasing urea up to 100 kg/fed/season in the two experimental seasons. Furthermore, the application of Azotobacter chroococcum plus the moderate level of urea (100 kg/fed/season) gave the best values in terms of vegetative growth parameters as well as L-ascorbic acid in comparison with the other interaction treatments and the control in the two experimental seasons.*

Key words: *Moringa oleifera L., N_2-fixing bacteria, urea fertilizer*

INTRODUCTION

Moringa (*Moringa oleifera* Lam.) tree is the most widely cultivated species of a monogeneric family, the Moringaceae, which is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. (Fahey, 2005). *Moringa oleifera* L. has gained much importance in the recent days due to its multiple used and benefits to agriculture and industry. It is considered as one of the World's most useful trees, as almost every part of the moringa tree can be used for food, medication and industrial purposes (Ashfaq *et al*., 2012). Currently, a real challenge for the workers in the field of agricultural research is to stop the use of expensive agrochemicals/chemical fertilizers which negatively affect the environment as well as human health and also results in decrease of soil fertility. Chemical fertilizers are used to replenish soil N, in large quantities, they are highly costly and contaminate environment severely. (Dai *et al*., 2004). Therefore, the application of bio fertilizers in agriculture has become of great necessity nowadays for not only in order to reduce the cost of chemical fertilizers but also to decrease the adverse effects of chemical fertilizers on soil and plant environment and to ensure more crops productivity in addition to get high quality products free of harmful agrochemicals for human safety. Verma and Hock (1995). In this concern, Dash and Gupta (2009) on *Moringa oleifera* L.and Aryeb and Youssef (2013) *Pinus halepensis* L. reported that the application of different biofertilization separately or in combinations with suitable doses from chemical fertilization enhanced plant growth and improved its chemical constituents. Similar results were reported by Fagbenro *et al.* (2013) and Darwish (2015) on *Moringa oleifera* L.

Accordingly, the present investigation was conducted for studying the effect of inoculating the growing media of *Moringa oleifera* L. plants with different N_2 fixing bacterial strains separately or in combination with different urea fertilization doses.

MATERIALS AND METHODS

A field experiment was carried out during the two successive growing seasons of 2016 and 2017 at the Experimental Farm of the Faculty of Agriculture, Menoufia University to evaluate the effect of both different doses of urea fertilizer (46% N) and different N_2-fixing bacterial strains as bio-fertilizers separately or in-combinations on the growth characters, herb yield and chemical constituents of *Moringa oleifera* L. plants.

The experimental soil was clay loamy and its physical and chemical properties are presented in Table (1 a and b).

The seeds were sown in seed beds on the 1st of March in each season and were held in a greenhouse until transplanting date. The soil was carefully prepared and divided into plots 1 × 2 m and each plot contained three lines as replicates at 50 cm between the lines and each line contained 5 plants. The seedlings were transplanted at the Experimental Farm on the 5th of April in both seasons (about 8-10 cm-height) at a distance of 20 cm between plants. During soil preparation, the recommended doses from calcium super phosphate of 150 kg/ fed (15.5% P_2O_5) and 100 kg/fed potassium sulphate (48% K_2O) were added in each growing season. The treatments were arranged in a complete randomized block design including 16 treatments with three replicates for each.

Source of N-chemical fertilizer:

Nitrogen fertilizer was used in the form of urea (46% N) at levels of 0 (N_0), 50 (N_1), 100 (N_2) and 200 (N_3) kg / fed / season. The N-fertilization doses were added in three equal side dressings during the growing period. The first addition was after two weeks from transplanting meanwhile, the second and the third doses were added after two weeks from the first and the second cuts, respectively in both growing seasons.

(Table 1 a): Physical properties of the experimental soil.

Clay %	Silt %	Fine sand %	Coarse sand %	Organic matter %	Water field capacity %	Texture grade
23.20	44.23	27.40	3.84	2.80	38.80	Clay loamy

(Table b): Chemical properties of the experimental soil.

Total P2O5 %	Total N %	Total CaCO3 %	C.E.C mg/100 g	E.C min/hos/cm at 25°C	pH	Soluble ions mg/100g			
						Ca++	Mg++	Na+	K+
0.26	0.12	2.32	25.60	0.40	7.90	0.42	0.68	0.62	0.12

Source of biofertilizers:

The active strains of *Azospirillum lipoferum*, *Azotobacter chroococcum* and *Bacillus polymixa*, which were obtained from Agricultural Microbiology Research Department, Soil, Water and Environment Research Institute, Agricultural Research Center, Giza, Egypt. The bacterial strains were used in current study as biofertilizer treatment. The grown plants were inoculated three times with 300 mL from each bacterial strain added with irrigation water. The first inoculation was applied one week after transplanting while the second and the third inoculations were applied one week after the first and the second harvesting cut, respectively.

The treatments of bio and N- chemical fertilization could be arranged as follows:

1- Control without bio (B_0) or urea fertilization (N_0).
2- Inoculation with *Azospirillum lipoferum* (B1).
3- Inoculation with *Azotobacter chroococcum* (B_2).
4- Inoculation with *Bacillus polymyxa* (B_3)
5- Urea fertilization at 50 kg / fed (N_1) without bio fertilization (B_0).
6- Urea fertilization at 100 kg / fed (N_2) without bio fertilization (B_0).
7-Urea fertilization at 200 kg / fed (N_3) without bio fertilization (B_0).
8- Inoculation with *Azospirillum lipoferum* (B1) + 50 kg / urea / fed (N_1).
9- Inoculation with *Azospirillum lipoferum* (B1) + 100 kg / urea/ fed (N_2).
10- Inoculation with *Azospirillum lipoferum* (B1) + 200 kg/urea/ fed (N_3).
11- Inoculation with *Azotobacter chroococcum* (B_2) + 50kg /urea/fed (N_1).
12- Inoculation with *Azotobacter chroococcum* (B_2) +100kg/urea/fed (N_2).
13- Inoculation with *Azotobacter chroococcum* (B_2)+200kg/urea/fed (N_3).
14- Inoculation with *Bacillus polymyxa* (B_3) +50kg/urea/fed (N_1).
15- Inoculation with *Bacillus polymyxa* (B_3) +100kg/urea/fed (N_2).
16- Inoculation with *Bacillus polymyxa* (B_3) +200kg/urea/fed (N_3).

Harvesting:

The plants were cut three times during the growing season. In each harvest, the plants were cut leaving about 15 cm above the soil surface. The first cut was done on July 15th. Mean while, the second and the third cuts were occurred on September 22nd and November 15th, respectively in both seasons.

1. Vegetative growth characters:

For each cut the following data were recorded:

1- Plant height (cm).
2- Mean number of main branches / plant.
3- Total fresh weight (g /plant).
4- Total fresh weight of plant (ton /fed /season).

2. The determination of chemical constituents:

L-ascorbic acid content (mg /100g fresh leaves) was determined according to the methods described by (A.O.A.C. 1990).

RESULTS AND DISCUSSION

Vegetative growth parameters:

1. Plant height:

1.1. Effect of bio fertilization:

The data in Table (2) show that the plant height significantly increased as a result of inoculation with the different kinds of microbial strains in comparison with uninoculated plants in the three cuts in the two experimental seasons. The tallest plants were produced by *Azotobacter chrocoocum* in comparison with other biofertilization treatments and control plants which produced the shortest plants on the three cuts in both seasons.

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Table (2). Effect of bio-and urea fertilization and their interaction on plant height (cm) of *Moringa* oleifera L. during the growing seasons of 2016 and 2017.

Harvesting cuts	The first cut					The second cut					The third cut				
N.Fert. / Bio.Fert.	N_0	N_1	N_2	N_3	Mean	N_0	N_1	N_2	N_3	Mean	N_0	N_1	N_2	N_3	Mean
	First season (2016)														
B_0	124.77	145.55	155.00	150.11	143.86	143.89	156.22	182.33	180.22	165.67	56.83	79.89	91.89	86.44	78.76
B_1	138.55	147.22	162.11	155.89	150.94	146.56	160.33	201.44	199.89	177.06	59.33	83.33	103.44	87.56	83.42
B_2	148.44	176.77	199.11	172.25	174.14	165.78	180.78	226.33	199.27	193.04	82.17	92.22	121.56	113.56	102.38
B_3	142.89	153.11	172.88	167.99	159.22	153.89	168.33	206.66	193.22	180.53	72.67	86.67	107.67	100.78	91.95
Mean	138.66	155.66	172.28	161.56	-	152.53	166.42	204.19	193.15	-	67.75	85.53	106.14	97.09	-
	Second season (2017)														
B_0	102.89	114.67	125.33	123.22	116.53	124.78	134.22	160.11	152.11	142.81	54.06	70.00	86.78	82.22	73.27
B_1	105.11	119.33	134.00	132.55	122.75	129.17	138.78	169.67	163.22	150.21	61.11	76.17	90.00	86.56	78.46
B_2	124.55	140.66	162.78	159.11	146.78	150.67	163.44	197.44	184.33	173.97	80.11	95.33	112.44	98.62	96.63
B_3	116.56	129.67	148.33	137.55	133.03	142.94	150.11	187.89	172.22	163.29	67.55	79.78	94.00	91.89	83.31
Mean	112.28	126.08	142.61	138.11	-	136.89	146.64	178.78	167.97	-	65.71	80.32	95.81	89.82	-

LSD at 5%	The first season 2016			The second season 2017		
	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Bio (B.)	10.51	9.67	7.94	9.34	8.38	4.44
N-fertilization (N.)	10.51	9.67	7.94	9.34	8.38	4.44
Interaction(B. ×N.)	21.02	19.34	15.88	18.68	16.76	8.88

The increment of plant height as a result of using the different N_2-fixing bacterial strains could be explained through their effect in providing moringa plants with nitrogen required for protein and cytokinins synthesis and consequently enhancing cell division. (Wagner and Michael, 1971). These results agreed with those obtained by Dash and Gupta (2009) and Zayed (2012) on *Moringa oleifera* L.

1.2. Effect of urea fertilization:

As far the data in Table (2) observed that the plant height gradually increased with increasing urea fertilization level up to 100 kg /fed /season. Otherwise, the application of highest urea dose (200 kg / fed /season) caused a reduction in this concern in the two growing seasons. On the other hand, the significantly lowest values in this concern were obtained by the plants grown without urea addition.

These results are in harmony with those obtained by El-sayed and Abdel wahab (2018) on *Moringa oleifera* L.

1.3. Effect of interaction between bio- and urea fertilization levels:

The data in Table (3) indicate that the plant height of moringa plants increased as a result of the application of the different combinations treatments between bio fertilization and the different rates of urea fertilization when compared to control plants. The best results in this respect were realized by the application of Azotobacter or Bacillus + the moderate urea fertilization level (N_2) in the different cuts of both seasons.

These results are similar to those obtained by Dash and Gupta (2009), El-Baha *et al*. (2016) and Balakumbahan *et al*. (2018) on *Moringa oleifera* L.

2. Mean number of branches/plant:

2.1. Effect of bio fertilization:

The data in Table (3) showed clearly that the mean number of branches / plant was significantly augmented in the most cases as a result of inoculating the growing media of moringa with bio fertilizers in comparison with the control plants in the two experimental seasons. The treatment of *Azotobacter chroococum* resulted in the highest values of the mean number of branches/plant followed by the treatments of using *Azospirillum lipoferum* and *Bacillus polymyxa*, respectively.

The effective role of the application of bio fertilization in increasing the mean number of branches / plant could be attributed to the role of the applied N_2-fixing bacteria in producing endogenous phytohormones such as GA_3, IAA and Cytokinins and consequently stimulating cell division and building more vascular tissues Youssef *et al*. (2004).

These results are in accordance with those obtained by Zayed (2012) on *Moringa oleifera* L. and Soliman *et al*. (2015) on *Delonix regia* L.

2.2. Effect of urea fertilization:

The data in Table (3) revealed that the mean number of branches / plant significantly increased with increasing urea fertilization level up to 100 kg / fed in both growing seasons. Whereas the addition of the highest urea level (200 kg / fed) caused a reduction in this respect in the three cuts during two growing seasons.

These results are in harmony with the findings of Badran *et al*. (2016) and Sarwar *et al*. (2017) on *Moringa oleifera* L.

2.3. Effect of interaction between bio- and urea fertilization levels:

Regarding the effect of the combinations treatments between bio fertilization and the different applied urea rates it could be observed that the mean number of branches / plant markedly improved as a result of the interaction between bio fertilization and the urea

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Table (3). Effect of bio-and urea fertilization and their interaction on the mean number of branches / plant of *Moringa oleifera* L. during the growing seasons of 2016 and 2017.

Harvesting cuts	The first cut					The second cut					The third cut				
N.Fert. / Bio.Fert.	N_0	N_1	N_2	N_3	Mean	N_0	N_1	N_2	N_3	Mean	N_0	N_1	N_2	N_3	Mean
	First season (2016)														
B_0	1.22	1.66	2.11	1.99	1.75	1.77	2.00	2.66	2.33	2.19	1.00	1.55	1.89	1.67	1.53
B_1	1.44	1.88	2.44	2.11	1.97	1.89	2.22	2.88	2.55	2.39	1.22	1.67	2.11	1.89	1.72
B_2	1.99	2.11	3.33	2.55	2.50	2.55	2.77	3.67	2.89	2.97	1.78	1.89	3.00	2.55	2.31
B_3	1.66	2.00	2.66	2.33	2.16	2.11	2.44	3.00	2.89	2.61	1.44	1.78	2.44	2.11	1.94
Mean	1.58	1.91	2.64	2.25	-	2.08	2.36	3.05	2.67	-	1.36	1.72	2.36	2.06	-
	Second season (2017)														
B_0	1.00	1.33	1.89	1.77	1.50	1.56	1.78	2.11	2.10	1.89	0.89	1.22	1.56	1.44	1.28
B_1	1.11	1.44	2.22	2.10	1.72	1.67	1.89	2.55	2.33	2.11	1.00	1.33	2.00	1.89	1.56
B_2	1.89	2.00	3.00	2.11	2.25	2.00	2.33	3.22	2.30	2.46	1.67	1.78	2.78	1.89	2.03
B_3	1.67	1.89	2.55	2.00	2.03	1.89	2.00	2.77	2.44	2.28	1.33	1.67	2.11	2.00	1.78
Mean	1.42	1.67	2.42	2.00	-	1.78	2.00	2.66	2.29	-	1.22	1.50	2.11	1.81	-

LSD at 5%	The first season 2016			The second season 2017		
	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Bio- fertilization (B.)	.27	.35	.29	.40	.33	.20
N.fertilization (N.)	.27	.35	.29	.40	.33	.20
Interaction (B.×N.)	.54	.70	.58	.80	.66	.40

fertilization levels in comparison with the control in the three cuts in the two experimental seasons. The highest number of main branches obtained from combination treatment between *Azotobacter chroococcum* plus urea at medium level when compared with the other interaction treatments between bio and urea fertilization levels in the three cuts of the two growing seasons.

These results are in agreement with those obtained by Abdou *et al*. (2016) and Balakumbahan *et al*. (2018) on *Moringa oleifera* L.

3. The total fresh yield / plant

3.1. Effect of bio fertilization

The data in Table (4) clearly indicated that the mean of total fresh weight /plant /cut increased as a result of using different biofertilizer strains in comparison with the control without inoculation in the three harvesting cuts of each experimental season. The treatment of inoculation with Azotobacter resulted in the best results in this concern in comparison with other biofertilizers and control in the three cuts in both season.

These results are in close agreement with those reported by Faramawy (2014) *Prosopis chilensis* L.and Soliman *et al.* (2015) on *Delonix regia* L.

3.2. Effect of urea fertilization:

From the data recorded in Table (4) it could be noticed that that the application of different doses of urea increased the values of the mean of total fresh weight /plant /cut than untreated plants in the three cuts during the two growing seasons. The heaviest fresh weight / plant was obtained by using the moderate doses of urea than those of the highest and lowest urea level and the control plants in both seasons.

The positive effect of using chemical N- fertilization was stated by Matallawa (2012) on *Moringa oleifera* L.

3.3. Effect of interaction between bio- and urea fertilization levels:

It is clear from the data in Table (5) that application of the different urea fertilization levels individually or in combination with the different N_2-fixing bacterial strains gave heavier fresh weight / plant / cut than the untreated plants during both growing seasons. Fertilization with *Azotobacter chroococcum* + medium urea fertilization level resulted in the best results in this respect in both experimental seasons.

These results are in accordance with those obtained by El-Baha *et al*. (2016) and Ganaw (2017) on *Moringa oleifera* L.

L-ascorbic acid content (mg /100g fresh leaves):

As far the data in Table (5) that L-ascorbic acid content in the leaves clearly improved as a result of the application of either biofertilization untreated plants in the two growing seasons. The relatively higher ascorbic acid content was obtained by inoculation with *Azotobacter chroococcum* followed by *Bacillus polymyxa* or *Azospirillum lipoferum* during the two growing seasons. These results could be supported by the findings of Zayed (2012) on *Moringa oleifera* L.

Concerning the effect of using urea it could be noticed that the best results this respect were obtained by providing the plants with the moderate rate (100 kg / fed / season) of urea fertilization Table (5). These results are in accordance with those obtained by Dania *et al*. (2014) and Abdel-Hamid (2015) on *Moringa oleifera* L. Furthermore, the data in Table (4) indicate that L-ascorbic acid content was considerably increased through the synergistic effect between bio-and urea fertilization compared with the control without bio or urea fertilization in the three cuts of the two growing seasons. The highest values in this respect were

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Table (4). Effect of bio-and urea fertilization and their interaction on the total fresh weight of *Moringa oleifera* L. plants (g) / plant during the growing seasons of 2016 and 2017.

Harvesting cuts	The first cut					The second cut					The third cut				
N.Fert. / Bio.Fert.	N_0	N_1	N_2	N_3	Mean	N_0	N_1	N_2	N_3	Mean	N_0	N_1	N_2	N_3	Mean
	First season (2016)														
B_0	197.44	297.66	344.56	319.82	289.87	222.08	314.92	406.91	359.98	325.97	77.84	96.43	221.35	187.57	145.80
B_1	204.11	309.40	409.40	351.56	318.62	226.50	331.20	435.87	419.09	353.17	82.19	100.22	215.11	195.75	148.32
B_2	231.88	329.02	939.22	858.15	589.57	266.98	374.99	1118.57	896.48	664.26	106.94	203.86	316.57	305.62	233.25
B_3	220.88	320.05	567.69	376.55	371.29	251.77	346.86	653.24	597.87	462.44	92.77	150.27	284.60	241.40	192.26
Mean	213.58	314.03	565.22	476.52	-	241.83	341.99	653.65	568.36	-	89.94	137.70	259.41	232.59	-
B_0	158.30	218.06	338.9	327.66	260.73	192.59	314.04	417.62	401.00	331.31	70.87	92.03	165.83	188.93	129.42
B_1	166.46	248.60	454.05	377.07	311.55	202.08	378.69	530.33	435.07	386.54	77.56	89.62	218.52	191.44	144.29
B_2	200.44	380.23	716.64	648.42	486.43	214.77	478.02	747.06	591.84	507.92	95.76	176.17	297.85	256.47	206.56
B_3	185.23	347.33	464.57	404.53	350.42	193.40	423.20	514.11	478.39	402.28	85.65	153.41	246.53	227.14	178.18
Mean	177.61	298.56	493.54	439.42	-	200.71	398.49	552.28	476.58	-	82.46	127.81	232.18	216.00	-

LSD at 5%	The first season 2016			The second season 2017		
	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
Bio-fertilization(B.)	53.31	75.92	11.73	44.75	71.06	6.17
N-fertilization (N.)	53.31	75.92	11.73	44.75	71.06	6.17
Interaction (B. ×N.)	106.62	151.84	23.46	89.50	142.12	12.34

Table (5). Effect of bio-and urea fertilization and their interaction on L- ascorbic acid content (mg/100 g f.w.) in the leaves of *Moringa oleifera* L. plants during the growing seasons of 2016 and 2017.

Harvesting cuts	The first cut					The second cut					The third cut				
Bio.Fert. \ N.Fert.	N_0	N_1	N_2	N_3	Mean	N_0	N_1	N_2	N_3	Mean	N_0	N_1	N_2	N_3	Mean
	First season (2016)														
B_0	200	185	202	198	196.25	190	190	215	230	206.25	175	190	203	185	188.25
B_1	185	198	233	220	209.00	195	225	220	220	215.00	201	198	223	180	200.50
B_2	225	240	230	205	225.00	230	220	255	212	229.25	183	228	230	246	221.75
B_3	204	214	210	240	217.00	190	225	235	240	222.50	215	215	218	213	215.25
Mean	203.50	209.25	218.75	215.75	-	201.25	215.00	231.25	225.50	-	193.50	207.75	218.50	206.00	-
	Second season (2017)														
B_0	185	204	220	215	206.00	192	212	229	225	214.50	180	195	207	205	196.75
B_1	193	213	226	223	213.75	200	220	235	230	221.25	189	203	213	210	203.75
B_2	219	228	244	238	232.25	225	238	254	245	240.50	210	215	232	219	219.00
B_3	212	223	236	230	225.25	218	230	241	240	232.25	200	210	222	217	212.25
Mean	202.25	217.00	231.50	226.50	-	208.75	225.00	239.75	235.00	-	194.75	205.75	218.50	212.75	-

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obtained by the treatment of interaction between *Azotobacter chroococcum* and (N_2) in comparison with the other interaction treatments and the control in the three cuts of both growing seasons.

Such results could be supported by the findings of Darwish (2015) on *Moringa oleifera* L.

CONCLUSION

From the aforementioned results it could be concluded that the application of biofertilization, especially inoculation of the growing media of moringa plant with *Azotobacter chroococcum* and using urea fertilization dose at 100 kg / fed/season realized the best growth and L-ascorbic acid content in fresh leaves when compared with the other fertilization treatments and the control.

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تأثير التسميد الكيماوى على نمو والمحتوى من حمض الاسكوربيك فى نباتات المورينجا أوليفيرا

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الملخص العربى

تم فى هذه الدراسة إجراء تجربتين حقليتين على نبات المورينجا أوليفيرا بمزرعة كلية الزراعة جامعة المنوفية خلال موسمين متتالين 2016 ، 2017 وكان الهدف الرئيسى لهذه التجربة هو تقييم تأثير المعاملة بالتسميد الحيوى بثلاث سلالات من البكتريا المثبتة للأزوت الجوى وهى أزوسبيريلليم ليبوفورم ، أزوتوباكتر كروكوكم ، الباسيلس بوليمكسا والتى تم إضافتها ثلاث مرات لنمو الحشات الثلاث فى كل من موسمى التجربة.بالإضافه إلى ذلك تم دراسة تأثير التسميد باليوريا (ن46%) بمعدلات صفر ,50، 100, 200 كجم / للفدان / موسم والتى تم توزيعها بالتساوى على ثلاث دفعات للحشات الثلاث فى كل من موسمى التجربة. وقد تم دراسة تأثير كل من نوعى الأسمدة بصورةٍ منفردةٍ أو متداخلةٍ وقد أوضحت النتائج المتحصل عليها أن إستعمال كل من نوعى الأسمده بصوره منفرده أو متداخله أدى إلى حدوث زياده معنويه فى الصفات الخضريه التى تم تسجيلها مثل طول النبات ، عدد الأفرع للنبات ، الوزن الطازج للنبات / حشة مقارنة بالكنترول (بدون إضافة سماد) وذلك فى الثلاث حشات المتحصل عليها خلال عامى التجربة. وأشارت النتائج آيضا أن التسميد بمعدلات اليوريا المختلفة بصورةٍ منفردةٍ أو متداخلةٍ أدى إلى حدوث تحسن معنوى فى محتوى الأوراق الطازجة من حمض الأسكوربيك.

الكلمات المفتاحية: المورينجا أوليفير ، أزوتوباكتر كروكوكم، اليوريا (ن46%).

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