EFFECT OF BIOFERTILIZERS APPLICATION ON THE GROWTH AND YIELD OF *HIBISCUS SABDARIFFA* L. PLANT

M. M. Mazrou[1], M. M. Afify[1], F. A. Hassan[2] and E. M. Amer[1]
[1] Horticulture Dept., Fac., Agric., Minufiya University.
[2] Horticulture Dept., Fac., Agric., Tanta University.

(Received : Mar. 31 , 2013)

ABSTRACT: *This field experiment was carried out on roselle plants during the two seasons of 2009 and 2010 at the experimental farm of Faculty of Agriculture, Minoufiya University, Shibin El-Kom, Egypt. The objective of this work was to investigate the effect of biofertilizers in combination with different rates of chemical fertilizers on growth characters, yield component and chemical constituents of Hibiscus sabdariffa L plant. The biofertilizers were used as seeds inoculation with Microbein, Phosphorein and Halex2. The biofertilizers were used under 0, 25, 50 and 100% of recommended dose (RD) of chemical fertilizers (NPK). The obtained results showed that using biofertilizers inoculation separately or when combined with chemical fertilizers significantly improved growth characters and increased sepal's yield of roselle plant compared to the control in the two experimental seasons. In addition, total anthocyanin content, total carbohydrate, chlorophyll content and NPK percentages were increased as a result of biofertilizers alone or when combined with chemical fertilizers. The best results were recorded with combination between biofertilizers and 100% of chemical fertilizers.*

Key words: *Roselle, biofertilizers, chemical fertilizers, growth characters, sepal yield, anthocyanin.*

INTRODUCTION

Roselle (*Hibiscus sabdariffa* L.) is a subtropical plant belonging to Family Malvaceae, which is known in Egypt under the name of Karkade. The fruit calyxes of this plant are used for preparing refreshing beverage and jellies of brilliant red color with pleasant acidic taste. In Nigeria, dried roselle calyces are prepared into a refreshing drink called zobo (fasoyiro *et al* 2005). In addition, the drink has a laxative effect (Leupin, 1935) and the calyx extraction is of a great therapeutic action for curing heart and nerve diseases, high blood pressure and arteriosclerosis (Rovesti, 1936 and Sharaf, 1962).

Moreover, various bacterial species are killed by flower extraction of this plant, so it might be used for bacterial injection (Sharaf, 1962). Also the calyxes of roselle represent a main source for natural coloring pigments such as anthocyanins and flavones compounds (Diab, 1968). Furthermore, the plant is gaining importance as a supplier of organic acid and mucilage for pharmaceutical and cosmetic purposes.

In additions, the seeds of roselle plants contain about 17% fixed oil which is similar in its properties to cotton seed oil (Hussein, 1989).

In Egypt, the plant has been cultivated in extended areas from the north to south and in the new reclaimed regions. Fertilization is a major factor affecting the production of this plant. However, the chemical fertilizers represent the major cost of plant production. In addition, the excessive use of chemical fertilizers creates pollution of agro-ecosystem as well as deterioration of soil fertility. One of the main problems of excessive use of N-fertilization is nitrate accumulation in the plant and it can directly inhibit oxygen transport by blood, a medical condition known as methemoglo, binemia because of the reduction of converting nitrate to nitrite (Lyons *et al* 1994).

Recently, the production of chemical-free medicinal and aromatic plants has been the focus of interest of many researchers and producers in order to ensure the high quality and safety, not only for human, but also for the environment which we live in. Therefore, it has become essential to use untraditional fertilizers. It is well known that a considerable number of bacterial species, mostly those associated with the plant rhizosphere, are able to exert a beneficial effect upon plant growth. Therefore, their use as biofertilizers or control agents for agricultural improvement has been a focus of numerous researchers for a number of years (Rodriguez and Fraga, 1999). Crop stimulation of different medicinal and aromatic plants by this plant growth promoting rhizobacteria has been demonstrated in different field trials. The vegetative growth parameters as well as sepal yield of roselle plant were increased as a result of using biofertilizers. Inoculation of roselle seeds before sowing by some strains of bacteria gave mostly good results in the growth especially with Rhizobium followed by Azotobacter and Azospirillum (Harridy and Amara, 1998). Inoculation with Azotobacter chroococcum and Bacillus megatarium stimulated all recorded growth parameters of Rose plants (Desouky, 2006). The anthocyanin content of roselle sepal's yield was increased when biofertilizers were applied (Harridy and Amara, 1998 and Shaalan *et al* 2001). The inoculation of roselle seeds with nitrobein (a bio-source of nitrogen) significantly increased the number of fruits as well as sepals yield compared to the control (Shaalan *et al* 2001).

The inoculation of biofertilizers (Azospirillium, Azotobacter and Rhizobium) increased total yield of fresh herb especially when plants inoculation with Azotobacter of lemongrass (Harridy *et al* 2001). The CO2 evolution was increased over the control by 48.25, 42.25 and 38.50% for the inoculation fennel seeds with Azospirillum, Azotobacter and Rhizobium respectively (Afify, 2002). The concentrations of N, P and K have been increased in the tubers when plants treated with Esterna biofert as compared with the control of *Helianthus tuberosus* (El-Gamal and Hammad 2005).

Improving not only the quantity but also the quality of roselle plants was and still the main goal of several investigators. Therefore, it would be beneficial to use alternatives to chemical fertilizers or at least to minimize the levels of these chemicals in order to protect the environment from pollution, decrease the production cost and produce chemical-free product.

So, the aim of this study was to investigate the effect of some biofertilizers in combination with chemical fertilizers on the growth characters, yield component and chemical constituents *of Hibiscus sabdariffa* L. plant.

MATERIALS AND METHODS

The present study was carried out during the two successive growing seasons of 2009 and 2010 at the Experimental Farm of the Fac. Agric., Shebin El-Kom, Minoufiya Univ., Egypt. This study aimed to investigate the effect of some biofertilizers, chemical fertilization levels of NPK and their combination on the growth, yield and chemical constituents of *Hibiscus sabdariffa* L. Plant.

Seeds of roselle (Dark red variety) were obtained from Medicinal and Aromatic plants Department, Horticulture Research Institute, Ministry of Agriculture, Egypt. The soil was prepared and divided into plots, each of them was 1.5x2 m and contained 3 rows at 50 cm apart and each row contained 5 plants. The physical and chemical properties of experimental soil were presented bellow:

Sand = 31.89%	EC=0.42 m. mhos/cm.
Silt = 23.93%	PH = 7.55
Clay = 41.29%	N=50.12 mg/100g. soil
Field capacity= 36.5%	P=15.27 mg/100g. soil
Organic matter=1.73%	K=41.16 mg/100g. soil

The biofertilizers used for seed inoculation were Microbein which contains (Pesedomanas - Azosprillium - Azotobacter), Phosphorein which contains (Bacillus Magatherium) which obtained from Agriculture Research Center, Giza, Egypt and Halex2 biofertilizer which contains a mixture of growth promoting N-fixing bacteria of genera Azospirillum, Azotobacter and Klebsiella.which obtained from Biofertilization Unit. Plant Pathology Dept., Alex. Univ.

After 2 h. from biofertilzers inoculation, seeds were sown in hills at a distance of 40 cm. on the 27 of April in the two experimental seasons. One month later, the plants were thinned at one plant per each hill.

The recommended dose (RD) of NPK chemical fertilizers used in this experiment was 400 kg/fed ammonium sulphate (20.5 % N), 200 kg/fed calcium super phosphate (15.5 % P2O5) and 100 kg/fed potassium sulphate (48 % K2O) according to Ministry of Agriculture, Egypt. Ammonium sulphate was added as a basal dressing, in three doses, (100 kg/fed was added one month after sowing then two equal doses of 150 kg/fed each, was applied at monthly intervals), while calcium super phosphate was added during soil preparation prior to sowing and potassium sulphate was added in two equal doses, which were added at the same time of the second and third doses of ammonium sulphate. Neither chemical fertilizers nor biofertilizers were added to control plants.

The experiment was planned (as factorial) in a complete randomized block design with three replicates. The plants were harvested at the first of November during maturity stage. The following measurements were recorded after maturity of fruits: plant height, number of branches, stem diameter, fresh and dry weight of leaves, number and fresh weight of fruits per plant as well as fresh and dry weights of sepals per both plant and feddan.

Sepals of each plant were air dried and the dry weight was recorded. The powder of sepals was taken for determination of total anthocyanin content as percentage according to Fuleki and Francis (1968) and developed by Du and Francis (1973).

- Total soluble solids were determined by using the method described by Diab (1968).

The following chemical analyses were done in the leaves:

- Total chlorophyll content of fresh leaves was determined as mg g^{-1} fresh weight by the method of Lichten-Thaler and Wellbuen (1983).
- Total carbohydrate percentages were determined in the dried leaves as previously described by Dubios *et al.* (1956).
- Nitrogen, phosphorus and potassium percentages were determined in dried leaves. Nitrogen percentages were determined by using micro Kieldahl method, phosphorus was spectrophtometricaly determined Jakson (1973) and potassium was determined by flame photometer as described by A. O. A. C. (2005).

RESULTS

1-Vegetative growth characteristics

1.1. Plant height and number of branches /plant.

It is evident from data in Table (1) that both plant height of roselle plant and number of branches per plant were significantly increased as a results of applying different biofertilizer treatments in comparison with untreated plant. Also, the different chemical fertilization levels significantly increased plant height and number of branches per plant compared to the control in the two experimental seasons. The best treatment in this respect was Microbein plus the highest chemical fertilization rate.

1.2. Stem diameter

Data in Table (1) showed that the mean stem diameter of roselle plant was increasing by using different biofertilizers i.e. Microbein, Phosphorein and Halex2 when compared to the uninoculated seeds during the two seasons. The stem diameter increased gradually by increasing chemical fertilization rate in the seasons 2009 and 2010. The application of Microbein plus the highest chemical fertilization level resulted in the best results in this respect.

1.3. Fresh and dry weights of leaves

The fresh and dry weights of roselle leaves were significantly increased by using biofertilizers treatments. The gradual increase in chemical fertilizers in combination with biofertilizers gradually increased the fresh and dry weights of leaves during the two growing seasons (Table 1). Treatment of Microbein when combined with the highest chemical fertilization resulted in the best results in this respect.

Table (1): Effect of different biofertilizers, chemical fertilization levels and their combinations treatments on growth characters of *Hibiscus sabdariffa* L. plant during 2009 and 2010 seasons.

Treatments	Plant height (cm)	Number of branches	Stem diameter (cm)	Fresh weight of leaves (g)	Dry weight of leaves (g)
	First season 2009				
Control	170..0	6.15	0.95	126.20	25.23
RD[1] of NPK	241.3	12.30	1.49	481.70	96.33
¼ RD	189.3	8.07	1.01	245.00	39.13
½ RD	216.5	11.35	1.37	352.70	50.53
Phosphorein	177.7	6.70	1.02	143.30	25.80
Phosphorein + ¼ RD	191.9	8.77	1.19	287.00	44.20
Phosphorein + ½ RD	221.6	12.00	1.43	456.60	59.79
Phosphorein+RD[1] of NPK	242.1	12.44	1.53	500.10	100.00
Microbein	182.1	7.07	1.07	164.10	30.36
Microbein + ¼ RD	189.7	8.75	1.19	319.80	63.96
Microbein + ½ RD	239.7	12.93	1.48	592.30	85.89
Microbein + RD[1] of NPK	245.1	13.22	1.55	600.30	108.1
Halex2	191.3	7.23	0.96	154.20	27.75
Halex2+ ¼ RD	194.2	8.58	1.10	255.00	41.23
Halex2 + ½ RD	227.7	11.87	1.40	453.20	58.81
Halex2 + RD[1] of NPK	244.0	12.89	1.51	502.11	100.95
	Second season 2010				
Control	193.7	4.00	1.00	175.60	28.69
RD[1] of NPK	226.7	8.50	1.55	473.30	80.46
¼ RD	209.0	5.67	1.14	220.00	36.66
½ RD	221.7	7.67	1.38	359.20	61.05
Phosphorein	199.3	5.67	1.07	194.80	35.27
Phosphorein +¼ RD	213.8	7.17	1.19	228.30	39.29
Phosphorein + ½ RD	223.8	8.00	1.44	448.90	76.63
Phosphorein+RD[1] of NPK	229.7	9.20	1.56	476.20	83.80
Microbein	207.7	6.50	1.09	200.00	38.00
Microbein + ¼ RD	214.7	7.10	1.20	230.70	39.92
Microbein + ½ RD	223.0	8.50	1.50	455.60	78.19
Microbein + RD[1] of NPK	230.9	8.98	1.56	478.90	85.24
Halex2	202.5	5.67	1.07	176.10	30.52
Halex2+ ¼ RD	213.5	6.50	1.19	225.60	39.08
Halex2 + ½ RD	224.0	8.17	1.43	446.70	75.71
Halex2 + RD[1] of NPK	229.9	8.84	1.55	474.40	83.49

RD means recommended dose of chemical fertilization

2- The yield parameters

2.1. Number and fresh weight of fruits/plant

It is evident from data Table (2) that different biofertilizer treatments positively affected both number and fresh weight of fruits per plant in the two experimental seasons. The increment in both number and fresh weight of fruits was happened whether biofertilizers used alone or under graded levels of chemical fertilizers. The maximum both number and fresh weight of fruits was obtained in the plants treated with Microbein plus the highest chemical fertilization dose when compared to the control during the two growing seasons.

2.2. Fresh and dry weights of sepals

Data recorded in Table (2) showed that there were significant increases in fresh and dry weights of sepals per plant as well as per feddan as a result of inoculation with biofertilizers i.e. Microbein, Phosphorein and Halex2 when compared to the uninoculated seeds during the two experimental seasons. The effect of Microbein inoculation was higher than Phosphorein or Halex2 inoculation in this respect. The treatment of Microbein plus the highest chemical fertilization level resulted in the best sepals yield during the two experimental seasons.

3. Chemical constituents

3.1. Total anthocyanin content of sepals

The total anthocyanin content in the dry sepals of roselle plants was increased as a result of applying different treatments of biofertilizers i.e. Microbein, Phosphorein and Halex2 when compared with untreated plants (Table 3). The total anthocyanin content was gradually increased by increasing the chemical fertilizer levels. The total anthocyanin content was (25.37 and 25.97 mg/g) when the treatment of Microbein plus the highest chemical fertilization rate was applied, but it was (23.97 and 24.14 mg/g) for the treatment of the highest chemical fertilization during the two seasons respectively.

3.2. Total soluble solids

Data in Table (3) indicated that the total soluble solids in sepals of roselle plants were significantly improved when biofertilizers was applied compared to the untreated plants. The combination between chemical and biofertilizers resulted in higher Total soluble solids than each of them separately applied during the two seasons. Biofertilization treatments of Microbein plus the highest chemical fertilization level was the best in this respect during the two experimental seasons.

3.3.Total carbohydrate percentage

The total carbohydrate percentage in roselle leaves increased by inoculation the roselle seeds with different biofertilizers i.e. Microbein, Phosphorein and Halex2 than uninoculated plants. The effect of biofertilizers was more appeared when chemical fertilizers were combined with them in both seasons. The highest carbohydrate percentages (23.42 and 23.55%) were obtained by Microbein plus the highest chemical fertilization level followed by (23.36 and 23.31%) for Halex2 plus highest chemical fertilization rate during the two growing seasons respectively Table (3).

3.4. Total chlorophyll content

Data in Table (3) revealed that the total chlorophyll content in roselle leaves was significantly improved when biofertilizers inoculation was applied compared to the untreated plants. The combination between chemical and biofertilizers resulted in higher chlorophyll content than the other treatments. Microbein plus the highest chemical fertilization dose was the best treatment in this respect during the two experimental seasons.

Table (2): Effect of different biofertilizers, chemical fertilization levels and their combinations treatments on fruit component of *Hibiscus sabdariffa* L. plant during 2009 and 2010 seasons

Treatments	Number of friuts	Fresh weight of fruits (g)	Fresh weight of sepals (g)	Dry weight of sepals per plant (g)	Dry weight of sepals per feddan (K.g.)
	First seasons 2009				
Control	61.90	245.00	94.47	10.81	216.2
RD of NPK	126.70	792.30	220.7	28.67	573.3
¼ RD	80.30	382.30	115.3	14.41	288.3
½ RD	100.3	555.00	145.0	18.83	376.7
Phosphorein	63.53	310.00	108.9	13.07	261.3
Phosphorein + ¼ RD	87.17	474.00	134.4	16.80	336.0
Phosphorein + ½ RD	108.00	666.30	203.3	26.23	524.7
Phosphorein + RD of NPK	127.90	804.40	223.0	28.99	579.7
Microbein	67.70	336.20	113.8	13.65	271.7
Microbein + ¼ RD	87.93	481.40	141.9	17.53	350.5
Microbein + ½ RD	120.7	782.00	212.2	27.58	551.7
Microbein + RD of NPK	135.30	809.70	229.1	29.78	595.7
Halex2	66.63	328.80	113.3	13.60	272.0
Halex2 + ¼ RD	87.50	435.70	135.3	16.90	338.1
Halex2 + ½ RD	110.00	776.70	198.3	25.74	514.9
Halex2 + RD of NPK	128.80	799.60	222.7	28.94	578.9
	Second seasons 2010				
Control	74.00	285.00	97.13	11.0	220.0
RD[1] of NPK	179.00	792.80	223.8	29.03	580.0
¼ RD	101.30	401.10	127.6	15.27	305.4
½ RD	154.70	566.10	149.0	19.29	385.8
Phosphorein	86.00	352.30	119.3	13.73	274.4
Phosphorein + ¼ RD	112.7	473.30	137.6	16.52	330.4
Phosphorein + ½ RD	197.00	733.90	206.6	26.67	533.2
Phosphorein+ RD of NPK	219.60	799.30	227.1	29.52	590.4
Microbein	79.00	385.00	122.3	13.95	278.0
Microbein + ¼ RD	113.70	483.80	143.2	17.17	343.4
Microbein + ½ RD	214.70	761.10	215.1	27.96	559.0
Microbein + RD of NPK	220.30	801.10	230.2	29.95	599.0
Halex2	79.33	383.30	116.7	13.35	266.8
Halex2 + ¼ RD	101.30	474.40	137.1	16.45	328.8
Halex2 + ½ RD	204.30	750.60	202.2	26.20	524.0
Halex2 + RD of NPK	213.20	797.10	226.77	29.47	589.4

RD means recommended dose of chemical fertilization

Table (3): Effect of different biofertilizers, chemical fertilization levels and their combinations treatments on chemical constituents of *Hibiscus sabdariffa* L. plant during 2009 and 2010 seasons.

Treatments	Total antho. content %	Total soluble solids %	Total carbo. content , %	Total chloro. content (m/g)	N % in dried leaves	P% in dried leaves	K % in dried leaves
	First season 2009						
Control	18.20	27.23	16.02	0.74	1.62	0.33	2.16
RD of NPK	23.97	47.53	22.28	1.52	2.73	0.51	2.67
¼ RD	20.17	32.50	16.50	0.99	1.74	0.35	2.28
½ RD	22.44	39.20	18.07	1.23	1.84	0.42	2.39
Phosphorein	19.0	28.47	16.39	0.81	1.66	0.35	2.20
Phosphorein + ¼ RD	21.0	33.53	17.06	1.04	1.76	0.38	2.31
Phosphorein + ½ RD	23.93	42.67	19.09	1.26	2.06	0.49	2.42
Phosphorein+RD of NPK	25.07	48.0	22.86	1.62	2.75	0.56	2.73
Microbein	19.61	29.93	16.47	0.91	1.71	0.34	2.25
Microbein + ¼RD	21.61	34.03	17.09	1.11	1.80	0.39	2.33
Microbein + ½RD	24.60	43.73	19.97	1.39	2.45	0.48	2.44
Microbein + RD of NPK	25.37	49.20	23.42	1.95	2.81	0.52	2.76
Halex2	18.91	28.60	16.21	0.88	1.67	0.34	2.19
Halex2 + ¼RD	21.18	33.0	16.87	1.09	1.77	0.37	2.31
Halex2 + ½RD	24.10	43.50	19.17	1.29	2.32	0.45	2.40
Halex2 + RD of NPK	25.17	48.73	23.36	1.78	2.77	0.51	2.74
	Second season 2010						
Control	18.47	27.67	16.31	0.77	1.65	0.35	2.18
RD of NPK	24.14	47.93	22.91	1.57	2.79	0.52	2.69
¼ RD	20.90	33.40	16.89	1.01	1.77	0.36	2.30
½ RD	23.30	39.50	18.34	1.25	1.87	0.41	2.40
Phosphorein	19.23	28.77	16.45	0.82	1.68	0.35	2.23
Phosphorein +¼ RD	21.13	33.97	17.11	1.08	1.79	0.39	2.33
Phosphorein + ½ RD	24.03	43.43	19.22	1.29	2.11	0.50	2.41
Phosphorein+RD of NPK	25.47	48.07	23.18	1.65	2.80	0.57	2.74
Microbein	19.87	30.13	16.63	0.95	1.72	0.36	2.26
Microbein + ¼ RD	21.73	34.53	17.22	1.15	1.84	0.41	2.35
Microbein + ½ RD	24.77	44.23	20.75	1.41	2.52	0.50	2.46
Microbein + RD of NPK	25.97	49.27	23.55	1.94	2.84	0.55	2.78
Halex2	19.0	29.73	16.40	0.92	1.70	0.35	2.21
Halex2 +¼ RD	21.27	34.10	16.98	1.11	1.80	0.39	2.32
Halex2 + ½ RD	24.23	43.83	20.37	1.40	2.36	0.47	2.44
Halex2 + RD of NPK	25.77	48.40	23.31	1.83	2.81	0.53	2.75

RD means recommended dose of chemical fertilization
Antho. means anthocyanin
Carbo. means carbohydrate
Chloro. means chlorophyll

3.5. Total N, P and K percentages in leaves

The total nitrogen, phosphorus and potassium percentages in the dried leaves of roselle plants were increased as a result of using different biofertilizer treatments compared to the untreated plants during the two experimental seasons. These percentages were gradually increased by increasing the level of chemical fertilizers which combined with control plants. The highest N and K percentages were obtained by Microbein plus the highest chemical fertilization level. On the other hand, the highest P percentage was obtained by Phosphorein plus the highest chemical fertilization rate during the two growing seasons Table (3).

DISCUSSION

The obtained results show that biofertilizers treatments promoted the growth characters and increased the yield component of roselle plants. These results are in agreement with those of Harridy and Amara (1998), Shalan *et al.*, (2001), Badawi (2000), Hassan (2009) and Abo-Baker and Mostafa (2011) on roselle plants.

These results could be attributed to the effect of biofertilizers producing adequate amounts of IAA, gibberellins, cytokinins and B group vitamins that promote rooting capacity, root length and root hair branching with an eventual increase on the uptake of nutrients from the soil (Rodriguez and Frage, 1999; Revilas *et al.*, 2000).

It is well known that the chemical fertilizers promote plant growth through the role of nitrogen in protein synthesis and increasing the meristmatic activity. In addition, mineral-p is an essential component of the energy compounds (ATP and ADP) and phosphoproteins. Similar results have been reported when roselle plants treated with NPK fertilizers (El-Shafie *et al.*, 1994 and Harridy and Amara, 1998). Therefore, adding 25, 50 and 100% of chemical fertilizers to biofertilizers improved the plant growth and increased the sepals yield. However, the 25% of chemical fertilizers may be not enough for maximum promotion of microorganisms therefore, 50 and 100% of chemical fertilizers resulted in maximum increment of growth and yield of roselle plants when combined with biofertilizers. This improvement may be due to the direct effect of chemical fertilizers or indirect through the biofertilizers. These results are in accordance with those obtained by Harridy and Amara, 1998 and Shaalan *et al.*, (2001) on roselle plants and Shaalan (2005) on *Nigella sativa* plants.

The growth promotion caused by biofertilizers treatments was reflected in increasing the total anthocyanin content of sepals, total carbohydrate as well as total chlorophyll in leaves as shown in Table (3). Increasing the total carbohydrate contents may be due to the promotion effects of these biofertilizers on the photosynthetic pigments as observed in our results (Hassan, 2009). Similar results were obtained by Harridy and Amara (1998) and Shalan *et al.*, (2001) on roselle plants.

Increasing the microorganisms in the soil had a positive effect in converting the unavailable forms of nutrient elements to available forms. The microorganisms also produce growth promoting substances resulting in more efficient absorption of nutrients, which main components of photosynthetic pigments and consequently the chlorophyll content as well as N, P and K percentage were increased (Hassan, 1999).

Adding of 100% of the recommended dose of chemical fertilizers improved the plant growth and increased the sepals yield. This improvement may be due to the direct effect of chemical fertilizers or indirect through the microbial propagation activation. These results are in accordance with those obtained by Abo-Baker and Mostafa (2011) on roselle plants.

CONCLUSION

It could be concluded that biofertilizers promoted the growth and increased the sepal's yield of roselle plants compared to the chemical fertilization alone. Applying 100% of recommended dose of NPK plus biofertilizers, we can obtain high quality product.

REFERENCES

A.O.A.C. (2005). Association of Official Chemists. Official Methods of Analysais 18th ed. Association of Official Analytical Chemists, Washington, D.C., USA.

Abo-Baker, A. A. and Gehan G. Mostafa (2011). Effect of bio and chemical fertilizers on growth, sepals yield and chemical composition of *Hibiscus sabdariffa* at new reclaimed soil of south valley area. Asian J. of Crop Sci., 3(1): 16-25.

Afify, M. M. (2002). Effect of biofertilization on the growth and essential oil yield of Fennel plant. M. Sc. Thesis, Fac. of Agric. Minufiya Univ.

Badawi, A. M. A. (2000). Effect of some Agricultural treatments on growth and active ingredients in roselle plants in north Sinai. Ph. D. Thesis, Zagazig Univ.

Desouky, M. T. (2006). Influence of some biofertilizers on growth and flowering of Rose plants. Minufiya J. Agric. Res., 31(4): 991-995.

Diab, M. A. (1968). The chemical composition of *Hibiscus sabdariffa* L. M. Sc. Thesis, Fac. Of Agric. Cairo Univ.

Du, C. T. and F. J. Francis (1973). Anthocyanin of roselle. J. Food Sci., 38: 8110- 812.

Dubios, A., A. Gilles, J. K. Hamelton, P. A. Robers and P. A. Smith (1956). Acolornmeteric method for determination of sugar and related substances. Anal Chem. 28, 350

El-Gamal, S. M. A. and Salwa A. Hammad (2005). Response of *Helianthus tuberosus* L. to organic and bio-organic fertilizers. Arab Univ. J. Agric. Sci., Ain shams Univ., Cairo, 13 (3):609-623.

El-Shafie, S. A., M. M. Mazrou, M. A. Eraki and S.A. Saafan (1994a). Physiological studies on roselle (*Hibiscus sabdariffa* L.) plants. (A)- Effect of watering intervals, nitrogen fertilization levels and their combination on the growth, yield and uptake of some nutrient elements. Zagazig J. Agric. Res., 21(1): 209-226.

Fasoyira, S.B., O. A. Ashaye, A. Adeola and F. O. Samuel (2005). chemical and storability of fruits flavored (*Hibiscus sabdariffa*) drinks. World J. agric. Sci., 1: 165-168.

Fuleki, M. A. and F. J. Francis (1968). Quantitative method of anthocyanin. J. Food Sci., 23: 65- 72.

Harridy, I. M. A. and M. T. Amara (1998). Effect of per-sowing inoculation of seed by nitrogen fixed bacteria on growth, fruit production, sepals yield and the chemical composition of Roselle plants. Egypt. J. Appl. Sci., 13(6): 217-231.

Harridy, I. M. A., S. G. I. Soliman and Mervat A. T. Amara (2001). Physiological, chemical and biological studies on Lemongrass "*Cymbopogon citratus*" (DC) stapf in response to diazotrophic bacteria. J. Agric. Sci. Mansoura Univ., 26(10): 6131-6152.

Hassan, F. A. S. (2009). Response of *Hibiscus sabdariffa* L. plant to some biofertilization treatments. Annals Agric. Sci., Ain Shams Univ., Cairo, 54(2): 437-446.

Hussein, M. S., S. E. El-sherbeny, H. M. E. Saeid and M. M. Kandeel (1989). Field experiments of foliar application with B-9 and micronutrients on *Hibiscus sabdariffa* L. growth, yield and hormonal content. Egypt. J. Hort. 16(1): 59-68.

Jakson, M.L. (1973). Soil Chemical Analysis, Prentice-Hall, Inc., India.

Leupin, K. (1935). Karkade. Pharm. Acta Helv. 10, 138.

Lichten-Thaler, H.K. and A.R. Wellburn (1983). Determination of total carotenoids and chlorophylls A and B of leaf extracts in different solvents. Biochem. Soc. Trans. 603: 591-592.

Lyons, D.J., G. E. Rayment, P.E. Nobbs and L McCallum (1994). Nitrate and nitrite in fresh vegetables from Queensland. J. Sci. Food Agric., 64: 279-281.

Revilas, J. J., B. Rodelas, C. Pozo, M. V. Martinez-Toledo and J. Gonzalez-Lopez (2000). Production of B- group vitamins by two Azotobacter strains with phenolic compounds as sole carbon source under diazotrophic and adiazotrophic conditions. J. Applied Microbiol., 89: 486-493.

Rodriguez, H. and R. Fraga (1999). Phosphate solubilizing bacteria and their role in plant growth promotion. Biotech. Advan., 17: 319-339

Rovesti, P. (1936). Thera peutic and dietetic properties of "Karkade" (*Hibiscus sabdariffa* L.) a new colonial pink tea, Farm. Ital, 3, 13.

Shaalan, M. N. (2005). Influence of biofertilizers and chicken manure on growth, yield and seeds quality of *Nigella sativa* L. plants. Egypt. J. Agric. Res., 83(2): 811-828.

Shaalan, M. N., T. A. Abo-El Latif, S. G. I. Soliman and E. O. El Gaawwas (2001). Effect of some chemical and biofertilizer treatments on Roselle plants "Hibiscus sabdariffa L.". Egypt J. Agric. Res., 79(2).

Sharaf, A. (1962). The pharmacological characteristics of *Hibiscus sabdariffa*. Planta Med. 10, 48.

تأثير استخدام الأسمدة الحيوية علي النمو والمحصول في نبات الكركدية

متولي مسعد مزروع[١] ، محمد موسي عفيفي [١] ، فهمي عبد الرحمن [٢] ، عصام محمد عامر[١]

[١] قسم البساتين- كلية الزراعة- جامعة المنوفية

[٢] قسم البساتين- كلية الزراعة- جامعة طنطا

أجريت هذه التجربة على نبات الكركديه خلال موسمى ٢٠٠٩ و ٢٠١٠ بمزرعة كلية الزراعة- جامعة المنوفية بشبين الكوم وكان الهدف من هذا العمل هو دراسة تأثير الأسمدة الحيوية منفردة أو بالتداخل مع مستويات مختلفة من السماد الكيماوى علي النمو والمحصول والتركيب الكيماوي لنبات الكركدية الصنف الأحمر الغامق, تم تلقيح بذور نبات الكركدية بالأسمدة الحيوية (الميكروبين والفوسفورين والهالكس٢) بالتداخل مع صفر, ٢٥, ٥٠, ١٠٠% من الجرعة الموصى بها من السماد الكيماوي.

وكانت أهم النتائج تشير إلي التالي:

التلقيح بالأسمدة الحيوية سواء كانت منفردة أو بالتداخل مع الأسمدة الكيماوية أدت إلي زيادة معنوية في صفات النمو ومحصول السبلات لنبات الكركديه بالمقارنة بالكنترول خلال موسمي التجربة.

كما أدت كل معاملات التسميد الحيوى إلى زيادة فى محتوي السبلات من صبغة الأنثوسيانين ونسبة الكربوهيدرات والكلوروفيل في أوراق النبات وأيضا زيادة نسبة النيتروجين والفوسفور والبوتاسيوم.

وكانت أفضل النتائج مع الأسمدة الحيوية بالتداخل مع المستوى العالي من السماد الكيماوي.