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EFFECT OF SOME CHEMICAL AND BIOFERTILIZER TREATMENTS ON ROSELLE PLANTS "*HIBISCUS SABDARIFFA*, L"

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Abstract

Field experiment was conducted during the two successive seasons (1998 and 1999) on roselle plants at Barramoon Experimental Farm, Dakahlia Governorate to investigate the effects of nitrobein (biofertilizer) and other levels of nitrogen fertilizer (0, 40, 60 kg N/fed) combined with potassin (foliage spray) or different levels of potassium sulphate (0, 50, 100 kg/fed). The interaction between the two factors was studied.

The most important results were as follows:

- Nitrogen (N) sources in addition to potassium (K) sources both at different levels increased plant height, number of branches, number of fruits/plant, sepals weight (fresh and dry), anthocyanin, sugars and protein contents of sepals.
- Ammonium sulphate gave significantly tallest plants than nitrobein as a source of nitrogen.
- Nitrobein gave less number of branches than ammonium sulphate at 40 kg /fed, however it produced more number of branches than ammonium sulphate at 60 kg /fed.
- Nitrobein as a bio-source of nitrogen gave significant higher number of fruits, yield of sepals (fresh and air dried), acidity, anthocyanin, sugars and protein content.
- Potassin as a source of potassium caused highly significant increase in most characters (number of branches, number of fruits /plant, acidity, as well as anthocyanin, sugars and protein contents), while potassium sulphate (50 kg /fed) was the most effective than other levels in increasing sepals fresh and air dried weights.

INTRODUCTION

Roselle plant (*Hibiscus sabdariffa*, L.) Fam. Malvaceae, is cultivated in Egypt for its delicious drinkable especially after addition sugar which extracted waterly from its fleshly calyxes of flowers. However, the extraction after concentrated is considered as coloured substance which jelly, jams and beverages are made (Osman and Jacob, 1970). Extraction drinkable has antibacterial effect, fungal and diuretic activities (Caceres *et al.*, 1987).

Badr (1976) reported that nitrogen was more effective on early than on later sown crops, resulting in increases in plant height, number of fruits, as well as the fresh and dry weight of calyxes. El-Dahab *et al.* (1984) on roselle plants showed that, the higher rate of nitrogen (200 – 300 kg ammonium sulphate /fed) increased the plant height, number of fruits, fresh and dry weight of sepals as well as the anthocyanin content of sepals

Nitrogen has many functions in plant life being a part of protein, it is an important constituent of protoplasm, enzymes, the biological catalytic agents, which speed up life processes, have N as their major constituent. Nitrogen also occurs as nucleoproteins, amino acids, amines, polypeptides and many other organic compounds in plant system. A sufficient supply of various nitrogenous compounds is, therefore, required in each plant cell for its proper functioning (Mengel and Kirkby, 1987).

Potassium is a constituent of all plant tissues and is found especially concentrated in younger parts, in flowers and in seeds. This element is particularly important in. germination of seeds and fruits. Potassium is essential for cell division and the development of meristematic tissue (Mengel and Kirkby, 1987).

The form of K in plants is ionic as it doses not join together with other elements to form compound. This helps K to move to where it is needed, especially the merstimatic tissue where growth occurs.

Actually, the most important role of potassium is the activation of enzymes in plant tissues. Over 60 enzymes have been identified that require K for their activation (Evans and Sorger, 1966; Suelter, 1970 and Mengel and Kirkaby, 1978).

Plant requires K for the production of high energy phosphate molecules (ATP), which are produced in both photosynthesis and respiration processes, (Mengel and Viro, 1974).

Potassium is required for N uptake and nitrogen metabolism. The protein synthesis as affected by potassium is related to ATP (Mengel and Header, 1973). Pfluger and Mengel (1972) observed that increased rates of photo-phosphorylation and photosynthetic electron transport in plants well supplied with K.

The continuos increase in the cost of using chemical nitrogen fertilizers prevents farmers to use sufficient amounts of nitrogen fertilizers. Therefore, it has become necessary to search about untraditional fertilizers as substitutes for chemical nitrogen fertilizers. Remarkable effects of untraditional fertilizers, especially the biofertilizers, have been reported growth and yield of potato. Sidorov (1954); Volodin (1969) and Imam and Badawy (1978) found that treating seed potato tubers with *Azotobacter choococcum* increased potato plant growth and yield.

Harridy and Amara, Mervat (1998) on roselle plant found that, generally a positive response was shown on the growth and yield especially with Rhizobium and Azotobacter with (0 and 40 kg N fert./fed). Also, Rhizobium was the most effective bacteria with regard to anthocyanin content. N content was also affected by bacteria.

Benemann and Valentine (1972) found that species of Azotobacter produce compounds detrimental to pathogens or that act as plant growth regulators and indeed Azotobacters do synthesize stimulatory compounds such as gibberellins, cytokinins and indole acetic acid.

Fouad (1981) found that Azotobacter produced considerable quantities of indole acetic acid which stimulated the plant cell expansion. The production of biologically active substances by the bacteria was the principal factor responsible for plant growth promotion.

The present study was undertaken to investigate the different nitrogen levels , potassium levels and biofertilizer of nitrogen (nitrobein) and potassium (foliar spray) as well as their interactions on plant growth and its components under the conditions of Dakahlyia Governorate.

MATERIALS AND METHODS

Two field experiments were carried out on roselle (*Hibiscus sabdariffa*, L.) plants at Barramoon Experimental Farm (Dakahlia Governorate), during the growing seasons of 1998 and 1999 to investigate the effects of different sources of nitrogen i.e. biofertilizer (nitrobein) and chemical one (ammonium sulphate) interaction with different sources of potassium, potassin and potassium sulphate on the growth characters, yield and chemical composition of roselle plants (*Hibiscus sabdariffa*, L. cv. Sabhia 17 light red).

Physical and chemical analysis of the experiment soil are shown in Table (1), 1998.

Sand %	Silt %	Clay %	$CaCO_3$ %	pH	Available nutrients (ppm)		
					N	P	K
25.2	30.6	43.9	3.2	7.5	13.9	11.4	33.2

(Using standard method described by Jackson, 1967)

Seeds of roselle (*Hibiscus sabdariffa*, L.cv. Sabhia 17 light red) were sown in hills 50 cm apart (3 seeds /hill), each plot contained 4 rows (60 cm wide with 4 m length), the area of each plot was 4 x 2.4 m (9.6 m^2).

Some seeds were mixed with nitrobein (biofertilizer) before planting at the rate of 5 kg /fed. After that plants were fertilized with ammonium sulphate [$(NH_4)_2$ SO_4] 20.5 % N at the rate of 50 and 100 kg /fed. Half the amount of (N) fertilization was applied 15 days after thinning and the other half was added one month later.

Plants receiving each of the nitrobein and different levels of nitrogen were fertilized with potassin as foliar spray or potassium sulphate at the rate of 0, 50 and 100 k/fed.

Potassium composition (30% K_2O and P_2O_5) was used as a foliar spray with one concentration (one litre of potassin per 300 litre water) during the growing season and the treatments were as follow:

1. First spray after one month of sowing.
2. Second spray after 21 day from the first one.

The experimental layout was a split plot design with three replicates. The main plots were received the sources of nitrogen, while the sub-plot received the different potassium sources. A ditch (100 cm wide) separated the plots to avoid any possible leaching from one plot to another. All plots were not fertilized with any chemical before cultivation.

At the harvest time October 15th in two seasons, growth parameters were recorded including plant height (cm), number of branches, number of fruits /plant, fresh and air dried weights of sepals/plant. Dry sepals were used to prepare extract (0.2 gm of dry sepals /100 ml of tap water) in which the acidity (pH) was determined as described by Diab (1968).

The extraction of total anthocyanin pigments were done by using ethyl alcohol according to the method described by Tribor and Francis (1968) and the determination of total anthocyanin was made according to the method of Fuleki and Francis (1968), developed by Due and Francis (1973). Total sugars (according to Smith *et al.*, 1956). Protein (as described by Rangana, 1978).

Statistical analysis of the data was performed using the new-L.S.D. method described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

1. Plant height:

The data in Table (2) clearly indicated that, growth of roselle plant in term of plant height was found to be significantly affected by N and K solely as well as its combinations during the growing seasons. Plants showed gradual increasing in height in response to increasing the doses of each N and K solely.

Table 2. Effect of nitrogen and potassium fertilization on height (cm) of roselle (*Hibiscus sabdariffa*, L.) plants in 1998 and 1999 seasons.

Potassium (K) sources (kg/fed)	Nitrogen (N) sources (kg/fed)				Means of K
	0	Nitrobein	Ammonium sulphate (200)	Ammonium sulphate (300)	
1998					
0	124.2	140.0	148.0	160.0	143.1
Potassin	148.6	191.9	197.4	204.7	185.6
Potassium sulphate (50)	182.2	199.6	196.0	201.4	194.8
Potassium sulphate (100)	193.8	206.4	204.3	212.6	204.3
Means of N	162.2	184.5	186.4	194.7	
L.S.D. at 5 %	- Nitrogen sources = 3.0 - Potassium sources = 1.2 - N x K = 2.4				
1999					
0	131.6	143.0	145.5	152.6	143.2
Potassin	173.3	187.5	195.1	203.4	189.8
Potassium sulphate (50)	186.3	195.4	193.6	201.8	194.3
Potassium sulphate (100)	192.6	205.6	199.2	210.2	201.9
Means of N	170.9	182.9	183.3	192.0	
L.S.D. at 5 %	- Nitrogen sources = 1.6 - Potassium sources = 1.0 - N x K = 2.0				

The tallest plants were obtained by the highest N rate (194.7 and 192.0 cm / plant) and the highest K rate (204.3 and 201.9 cm /plant) in the first and second seasons, respectively. These results revealed that K was most effective than N in this respect.

Results of the interaction treatments (N x K) were found to be in harmony with those of N and K solely. The tallest plants were produced from the combined treatments of the highest rate of both N and K (212.6 and 210.2 cm /plant) for both seasons, respectively. While the shortest ones were found in case of control plants (0 N and 0 K), (124.2 and 131.6 cm /plant) in 1^{st} and 2^{nd} seasons.

As for foliar spray treatments, potassin (148.6 and 173.3 cm) was found to be more effective than nitrobein (140.0 and 143.0 cm) in stimulating the elongation of roselle plants in both seasons, respectively.

2. Number of branches:

Data in Table (3) show out that, nitrogen and potassin were found to be good agent in stimulating the branching in roselle plants. So, maximum values were recorded in, response to nitrobein and potassin solely in the two seasons. Also, it was found that, the interaction treatments gave the same trend i.e. the highest values of branches number (25.9 and 26.2 branches /plant) produced when nitrobein interacted with potassin in the two seasons, respectively. However, potassin alone gave the best results in this respect especially in the 2^{nd} season. Control plants recorded the lowest values of branching in the two seasons.

3. Fruits number:

Results of fruiting in roselle plants, Table (4) emphasized that, fruit set as influenced by N and K (different sources and levels) solely and in combinations showed the same response previously shown in case of branching habit.

Nitrobein followed by potassin solely gave best results in this respect. In case of combinations, nitrobein + 50 kg potassium sulphate produced the maximum fruiting (255.5 and 259.7 fruits /plant) followed by nitrobein combined with potassin (234.3 and 246.6 fruits /plant) in the first and second seasons, respectively. Control plants produced the lowest fruits number in both seasons.

The increase in fruits production as a result of fertilization by nitrobein may be due to the production of compound detrimental pathogens or that act as plant growth

Table 3. Effect of nitrogen and potassium fertilization on number of branches in roselle (*Hibiscus sabdariffa*, L.) plants in 1998 and 1999 seasons.

Potassium (K) sources (kg/fed)	Nitrogen (N) sources (kg/fed)				Means of K
	0	Nitrobein	Ammonium sulphate (200)	Ammonium sulphate (300)	
1998					
0	11.2	21.6	23.6	19.6	19.0
Potassin	24.7	25.9	22.2	20.1	23.2
Potassium sulphate (50)	19.6	25.7	21.6	19.1	21.5
Potassium sulphate (100)	24.2	22.6	20.3	19.9	21.8
Means of N	19.9	23.9	21.9	19.7	
L.S.D. at 5 %	- Nitrogen sources = 0.7 - Potassium sources = 0.6 - N x K = 1.2				
1999					
0	13.7	25.3	24.2	21.3	21.1
Potassin	28.9	26.2	23.1	21.1	24.8
Potassium sulphate (50)	20.3	25.3	22.2	20.2	22.0
Potassium sulphate (100)	25.6	23.4	21.6	21.9	23.1
Means of N	22.1	25.1	22.8	21.1	
L.S.D. at 5 %	- Nitrogen sources = 0.5 - Potassium sources = 0.3 - N x K = 0.6				

Table 4. Effect of nitrogen and potassium fertilization on number of fruits /plant in roselle (*Hibiscus sabdariffa*, L.) plants in 1998 and 1999 seasons.

Potassium (K) sources (kg/fed)	Nitrogen (N) sources (kg/fed)				Means of K
	0	Nitrobein	Ammonium sulphate (200)	Ammonium sulphate (300)	
1998					
0	111.3	200.2	142.5	150.0	151.0
Potassin	188.0	234.3	155.8	196.4	193.6
Potassium sulphate (50)	172.6	255.5	157.3	138.9	181.1
Potassium sulphate (100)	180.3	202.6	161.3	147.6	172.9
Means of N	163.1	223.2	154.2	158.2	
L.S.D. at 5 %	- Nitrogen sources = 2.3 - Potassium sources = 1.5 - N x K = 2.9				
1999					
0	118.6	180.2	137.2	156.3	148.1
Potassin	186.2	246.6	210.7	198.2	210.4
Potassium sulphate (50)	175.3	259.7	150.2	142.3	181.8
Potassium sulphate (100)	179.2	210.3	154.6	143.9	172.0
Means of N	164.8	224.2	163.2	160.2	
L.S.D. at 5 %	- Nitrogen sources = 2.4 - Potassium sources = 2.2 - N x K = 4.5				

regulators and indeed Azotobacters do synthesize stimulatory compounds such as gibberellins, cytokinins and indole acetic acid. These results are supported by Benemann and Valentine (1972). The increase in fruit production as a result of fertilization using ammonium sulphate and its absorption by the plant. Similar conclusion were reached by Blancher and Caldwell (1966) and by Khasawench *et al.* (1974) who found that, physiologically acid fertilizers, such as ammonium sulphate, increase the availability of phosphorus in the soil.

4. Sepals fresh weight (gm/plant and kg /plot):

Data in Tables (5 and 6) demonstrated that, yield of roselle plants in term of sepals fresh weight (gm/plant and kg /plot) was found to be significantly affected by both N, K (sources and levels) solely and in combinations.

It was observed that, nitrobein was the most effective in stimulating fruits growth as their sepals fresh weight recorded the highest values in comparison with those plants dressed by the chemical nitrogen levels.

Regarding the effect of potassium, results pointed out that, potassin and potassium sulphate (50 kg /fed) produced the highest fresh weight of sepals in the two seasons.

As for the combination treatments, data clearly emphasized that, plants fertilized with (60 kg N/fed and 50 kg /fed of potassium sulphate) produced the heaviest sepals weight in comparison with the rest of combination treatments .

Also, it was observed that, sepals yield (gm /plant and kg /plot) recorded good values when roselle plants treated with (nitrobein) and (50 kg /fed of potassium sulphate). These results hold true in the two seasons.

5. Sepals dry weight (gm/plant and kg /plot):

Data in Tables (7 and 8) indicated that sepals dry weight behaved in the same manner as previously shown in case of sepals fresh weight.

It could be concluded that, the highest yield of air dried sepals was produced by the plants fertilized by either nitrobein (97.8, 95.8 gm /plant and 3.14, 3.04 kg/plot) or 50 kg /fed potassium sulphate (113.2, 106.8 gm /plant and 3.63, 3.42 kg/plot) individually in the 1^{st} and 2^{nd} seasons, respectively.

In case of combination treatments, it was found that, nitrogen at 60 kg /fed in

Table 5. Effect of nitrogen and potassium fertilization on fresh weight of sepals /plant (gm) in roselle (*Hibiscus sabdariffa*, L.) plants in 1998 and 1999 seasons.

Potassium (K) sources (kg/fed)	Nitrogen (N) sources (kg/fed)				Means of K
	0	Nitrobein	Ammonium sulphate (200)	Ammonium sulphate (300)	
1998					
0	142.7	520.2	312.0	216.7	297.9
Potassin	543.3	536.7	435.5	617.7	533.3
Potassium sulphate (50)	490.3	608.0	544.5	726.3	592.2
Potassium sulphate (100)	419.9	503.3	331.9	309.6	391.2
Means of N	399.1	542.1	406.0	467.6	
L.S.D. at 5 %	- Nitrogen sources = 16.2 - Potassium sources = 25.7 - N x K = 45.4				
1999					
0	145.2	490.6	321.9	254.7	303.1
Potassin	552.6	498.7	428.2	580.3	514.9
Potassium sulphate (50)	462.7	592.6	520.7	687.2	565.2
Potassium sulphate (100)	425.3	460.7	350.2	289.6	381.4
Means of N	396.5	510.6	405.3	453.0	
L.S.D. at 5 %	- Nitrogen sources = 9.9 - Potassium sources = 20.1 - N x K = 35.7				

Table 6. Effect of nitrogen and potassium fertilization on fresh weight of sepals /plot (kg) in roselle (*Hibiscus sabdariffa*, L.) plants in 1998 and 1999 seasons.

Potassium (K) sources (kg/fed)	Nitrogen (N) sources (kg/fed)				Means of K
	0	Nitrobein	Ammonium sulphate (200)	Ammonium sulphate (300)	
1998					
0	4.57	16.52	9.49	6.93	9.50
Potassin	18.27	17.37	13.87	19.78	17.35
Potassium sulphate (50)	15.69	19.55	17.45	23.29	19.00
Potassium sulphate (100)	12.48	16.10	10.62	11.78	12.87
Means of N	12.88	17.39	13.01	15.45	
L.S.D. at 5 %	- Nitrogen sources = 1.52 - Potassium sources = 1.63 - N x K = 2.10				
1999					
0	5.29	15.67	10.30		9.86
Potassin	17.92	16.23	13.75		16.47
Potassium sulphate (50)	14.81	18.96	16.73		18.12
Potassium sulphate (100)	13.11	14.78	11.35		12.47
Means of N	12.78	16.41	13.03	14.69	
L.S.D. at 5 %	- Nitrogen sources = 1.53 - Potassium sources = 1.67 - N x K = 2.00				

Table 7. Effect of nitrogen and potassium fertilization on the weight of air-dried sepals / plant (gm) of roselle (*Hibiscus sabdariffa*, L.) plants in 1998 and 1999 seasons.

Potassium (K) sources (kg/fed)	Nitrogen (N) sources (kg/fed)				Means of K
	0	Nitrobein	Ammonium sulphate (200)	Ammonium sulphate (300)	
			1998		
0	25.2	85.9	49.6	45.8	51.6
Potassin	101.0	99.9	77.8	114.3	98.2
Potassium sulphate (50)	94.3	120.9	100.6	137.3	113.2
Potassium sulphate (100)	78.7	84.6	62.6	57.3	70.8
Means of N	74.8	97.8	72.6	88.7	
L.S.D. at 5 %	- Nitrogen sources = 1.8 - Potassium sources = 1.2 - N x K = 2.0				
			1999		
0	26.9	90.5	61.9	47.8	56.8
Potassin	102.3	94.3	82.3	107.1	96.5
Potassium sulphate (50)	88.9	109.7	98.2	130.7	106.8
Potassium sulphate (100)	80.2	88.6	64.9	55.6	72.3
Means of N	74.5	95.8	76.8	85.3	
L.S.D. at 5 %	- Nitrogen sources = 1.7 - Potassium sources = 1.4 - N x K = 2.7				

Table 8. Effect of nitrogen and potassium fertilization on fresh weight of sepals /plot (kg) in roselle (*Hibiscus sabdariffa*, L.) plants in 1998 and 1999 seasons.

Potassium (K) sources (kg/fed)	Nitrogen (N) sources (kg/fed)				Means of K
	0	Nitrobein	Ammonium sulphate (200)	Ammonium sulphate (300)	
			1998		
0	0.87	2.75	1.59	1.46	1.67
Potassin	3.25	3.20	2.49	3.66	3.15
Potassium sulphate (50)	3.02	3.89	3.22	4.39	3.63
Potassium sulphate (100)	2.52	2.23	2.00	1.83	2.27
Means of N	2.42	3.14	2.33	2.84	
L.S.D. at 5 %	- Nitrogen sources = 0.15 - Potassium sources = 0.18 - N x K = 0.25				
			1999		
0	0.86	2.90	1.48	1.53	1.82
Potassin	3.27	3.01	2.63	3.45	3.09
Potassium sulphate (50)	2.85	3.51	3.14	4.18	3.42
Potassium sulphate (100)	2.50	2.73	2.07	1.77	2.27
Means of N	2.37	3.04	2.46	2.73	
L.S.D. at 5 %	- Nitrogen sources = 0.16 - Potassium sources = 0.19 - N x K = 0.28				

addition to 50 kg/fed potassium sulphate gave the highest yield of air dried sepals (137.3, 130.7 gm/plant and 4.39, 4.18 kg/plot) followed by those plants treated with nitrobein and the same rate of potassium sulphate (120.9, 109.7 gm/plant and 3.89, 3.51 kg/plot) in the two seasons, respectively.

Generally nitrobein solely was found to be most effective in stimulating growth characters in term of branching habit, fruits number and sepals (fresh & dry), while N at 60 kg /fed was effective in stimulating the elongation.

In case of (k sources) it was observed that, different responses were shown i.e. potassin stimulated branching and fruiting whereas potassium sulphate was most effective in elongation (100 k/fed), sepals fresh weight and dry weight (50 kg /fed).

Regarding combination treatments, it was noticed that, growth of roselle plant showed different behaviour i.e. elongation was stimulated by (N +K) at the highest rates while branching responded well to (potassin + nitrbien).

As for fruiting, it was found that, the most effective treatment was (N) at the highest rate + 50 kg potassium sulphate followed by nitrobein + 50 kg potassium sulphate.

6. Actidity (pH value) of the water extract sepals:

Data in Table (9) revealed the acidity of the extract of roselle sepals which illustrated that, using nitrobein as a source of nitrogen resulted in higher acidity of the extract than that dressed by ammonium sulphate at rate 300 kg /fed. The lowest pH values of roselle extract were obtained from plants treated with ammonium sulphate (200 kg /fed) in both two seasons.

Foliar spray of potassin resulted in the highest pH values of the extract, compared to using different levels of chemical potassium . The results were significant in the two seasons.

In both two seasons the highest pH values of the extract were obtained from plants supplied with nitrobein as a source of nitrogen and sprayed with potassin as a source of potassium, compared to values resulting from any other combination of nitrogen and potassium sources.

Table 9. Effect of nitrogen and potassium fertilization on the pH values of the water extract of roselle (*Hibiscus sabdariffa*, L.) plants in 1998 and 1999 seasons.

Potassium (K) sources (kg/fed)	Nitrogen (N) sources (kg/fed)				Means of K
	0	Nitrobein	Ammonium sulphate (200)	Ammonium sulphate (300)	
1998					
0	3.05	3.85	2.90	3.52	3.33
Potassin	3.67	3.76	3.29	3.71	3.61
Potassium sulphate (50)	3.35	3.60	3.13	3.42	3.37
Potassium sulphate (100)	3.55	3.70	3.23	3.54	3.51
Means of N	3.41	3.73	3.14	3.55	
L.S.D. at 5 %	- Nitrogen sources = 0.08 - Potassium sources = 0.07 - N x K = 0.13				
1999					
0	2.91	3.78	2.59	3.54	3.21
Potassin	3.64	3.72	3.17	3.59	3.53
Potassium sulphate (50)	3.29	3.54	2.98	3.41	3.31
Potassium sulphate (100)	3.54	3.65	3.11	3.56	3.47
Means of N	3.35	3.67	2.96	3.53	
L.S.D. at 5 %	- Nitrogen sources = 0.04 - Potassium sources = 0.03 - N x K = 0.07				

7. Anthocyanin content of sepals:

Data presented in Table (10) showed that, nitrobein gave significantly higher anthocyanin content in the dry sepals in both two seasons (31.69 and 29.40 mg/gm dry weight) compared to those fertilized with ammonium sulphate. Those results may be due to synthesize stimulatory compounds produced by bacteria such as gibberellins, cytokinins and indole acetic acid.

Potassin (as a source of potassium) gave significantly higher anthocyanin content in the dry sepals than the chemical sources of potassium in both two seasons (31.81 and 31.14 mg /gm dry weight).

Different combinations of nitrogen and potassium sources gave different values of anthocyanin contents which varied considerably.

Table (10), in general, plant supplied with (nitrobein as a source of nitrogen and potassium sulphate 50 kg /fed) gave the highest values. Those values were significantly higher in both seasons than those obtained from plants grown under other combinations of nitrogen and potassium sources in most cases.

Table 10. Effect of nitrogen and potassium fertilization on the the anthocyanin content (%) of rosselle (*Hibiscus sabdariffa*, L.) plants in 1998 and 1999 seasons.

Potassium (K) sources (kg/fed)	Nitrogen (N) sources (kg/fed)				Means of K
	0	Nitrobein	Ammonium sulphate (200)	Ammonium sulphate (300)	
1998					
0	19.20	29.70	23.20	25.60	24.42
Potassin	35.20	32.45	29.20	30.40	31.81
Potassium sulphate (50)	23.90	36.97	23.55	28.08	28.12
Potassium sulphate (100)	25.60	27.65	24.40	25.65	25.82
Means of N	25.97	31.69	25.09	27.43	
L.S.D. at 5 %	- Nitrogen sources = 2.16 - Potassium sources = 1.28 - N x K = 2.56				
1999					
0	20.10	30.60	22.10	23.70	24.12
Potassin	34.30	32.45	28.21	29.61	31.14
Potassium sulphate (50)	24.20	37.45	23.15	23.95	24.69
Potassium sulphate (100)	23.60	27.11	22.85	23.65	24.30
Means of N	25.55	29.40	24.08	25.23	
L.S.D. at 5 %	- Nitrogen sources = 1.04 - Potassium sources = 0.49 - N x K = 0.99				

8. Total sugars content of sepals:

Data presented in Table (11) showed that, nitrobein resulted in significantly the highest values of sugars content than rates of ammonium sulphate in both seasons (152.9 and 152.6 mg/gm D.W.). This stimulation of nitrobein may be due to the active substances which produced by bacteria.

Also, potassin foliar spray resulted in the highest increase in sepals sugar content in the two seasons (154.4 and 153.7). It appears that sugar accumulation was more affected by the potassium sources than by the nitrogen sources.

The highest values recorded in both two seasons were obtained from plants supplied with nitrobein combined with potassin. These two factors provided better conditions for accumulation of sugars than any other combinations of nitrogen and potassium sources.

Table 11. Effect of nitrogen and potassium fertilization on the total sugars content (mg/gm dry matter) of roselle (*Hibiscus sabdariffa*, L.) plants in 1998 and 1999 seasons.

Potassium (K) sources (kg/fed)	Nitrogen (N) sources (kg/fed)				Means of K
	0	Nitrobein	Ammonium sulphate (200)	Ammonium sulphate (300)	
1998					
0	116.1	154.2	139.6	150.6	140.1
Potassin	158.3	156.3	149.0	154.2	154.4
Potassium sulphate (50)	143.2	148.7	141.3	145.9	144.8
Potassium sulphate (100)	150.5	152.4	145.1	150.6	149.6
Means of N	142.0	152.9	143.7	150.3	
L.S.D. at 5 %	- Nitrogen sources = 1.3 - Potassium sources = 0.9 - N x K = 1.8				
1999					
0	122.2	153.1	142.7	151.9	142.5
Potassin	156.4	154.8	149.6	154.2	153.7
Potassium sulphate (50)	145.4	149.6	144.2	148.8	147.0
Potassium sulphate (100)	152.6	152.9	147.7	152.4	151.4
Means of N	144.1	152.6	146.1	151.8	
L.S.D. at 5 %	- Nitrogen sources = 0.8 - Potassium sources = 1.1 - N x K = 2.1				

9. Protein content of sepals:

Results of the two seasons (Table 12) showed that, when the plants were supplied by nitrobein, protein content recorded the highest values (60.9 and 58.9 mg /g D.W) as compared with other sources of nitrogen in both two seasons.

Table 12. Effect of nitrogen and potassium fertilization on the protein content (%) of roselle (*Hibiscus sabdariffa*, L.) plants in 1998 and 1999 seasons.

Potassium (K) sources (kg/fed)	Nitrogen (N) sources (kg/fed) 0	Nitrobein	Ammonium sulphate (200)	Ammonium sulphate (300)	Means of K
1998					
0	37.2	64.6	54.9	57.6	53.4
Potassin	58.4	61.7	56.4	58.1	58.6
Potassium sulphate (50)	54.7	59.3	54.5	56.2	56.2
Potassium sulphate (100)	51.5	58.2	52.9	54.6	54.3
Means of N	50.4	60.9	54.5	56.6	
L.S.D. at 5 %	- Nitrogen sources = 0.8 - Potassium sources = 0.6 - N x K = 1.2				
1999					
0	35.6	62.3	55.4	59.6	53.2
Potassin	57.3	59.8	56.4	58.5	58.0
Potassium sulphate (50)	52.6	58.2	54.0	56.1	55.2
Potassium sulphate (100)	48.6	55.3	51.9	53.8	52.4
Means of N	48.5	58.9	54.4	57.0	
L.S.D. at 5 %	- Nitrogen sources = 2.0 - Potassium sources = 0.9 - N x K = 1.4				

This increment may be due to the role of nitrogen which occurs as a nucleoprotein amino acids, amines and polypeptides (Mengel and Kirkby, 1987). As with most of measurements recorded, using potassium as a source of potassium, gave higher protein than using potassium sulphate (50 or 100 kg /fed) in both seasons.

Generally, sources of potassin gave significantly higher values than control plants. The protein synthesis as affected by potassium is reflected ATP (Mengel and Header, 1973).

Data in Table (12) also showed that, combining nitrobein with potassin resulted in the most favourable condition for protein synthesis. Plants receiving this treatment gave significantly higher protein contents than plants receiving other combinations treatments in most cases.

Recommendation:

It could be recommended to use nitrobein as a safety source of nitrogen than chemical sources of nitrogen which enhanced growth, fruiting with a good quality i.e. acidity, anthocyanin, sugars and protein content.

REFERENCES

1. Badr, A. K. 1976. Deficiency effect of some major elements on the yield and some qualities roselle. M.Sc. Thesis, Fac. of Agric., Ain Shams Univ.

2. Benemann, J.R. and R.C. Valentine. 1972. The pathways of nitrogen fixation. Advan. Microbiol. Physiol., 8: 59 – 104.

3. Blanchar, R.W. and A.C. Caldwell. 1966. Phosphate-ammonium moisture relationships in soils. II. Ion concentrations in leached fertilizer zones and effects on plants. Soil Sci. Soc. Am. Proc., 30: 43 - 48.

4. Caceres, A., L.M. Giron and A.M. Martinez. 1987. Diurefic activity of plants used for the treatment of urinary ailments in Guatemala. J. of Ethnopharmacology, 19 (3): 133 – 245.

5. Diab, M.A. 1968. The chemical composition of *Hibiscus sabdariffa*. M.Sc. Thesis, Fac. Agric, Cairo Univ.

6. Due, C.T. and F.J. Fransis. 1973. Anof roselle (Dep. Food Sci. Tech. Univ. Massachusetts, Amherst, Mass). Food Sci., 38 (5): 810 – 12.

7. El-Dahab, R.S., A.M. Abou-Dahab and S.H. El-Kashlan. 1984. Effect of nitrogen fertilization on growth, yield and constituent of *Hibiscus sabdariffa*, L. First Arab Conf. of Med. Plant, Cairo, Nov., 17 – 21.

8. Evans, H.J. and G.J. Sorger. 1966. Role of mineral elements with emphass on the univalent cations. Ann. Rev. Plant Physiol., 17: 47 – 77.

9. Fouad, M.F. 1981. Studies on the associative symbiosis between N2-fixing bacteria and wheat *Triticum aestivum* under semi-arid and temperature conditions. Ph. D. Dissertation, Katholiek Univ. Leuven, Belgium.

10. Fuleki, T. and F.J. Fransis. 1968. Quantitative methods of anthocyanins.1. Extraction and determination of anthocyanin in cranberries. J. of Food Sci., 33 (1): 72.

11. Harridy, I.M.A. and Amara, Mervat. 1998. Effect of pre-sowing inoculation of seeds by nitrogen fixed bacteria on growth fruit production, sepals yield and the chemical composition of roselle plants. Egyptian Journal applied Science, 13 (6): 217 – 231.

12. Imam, M.R. and F.H. Badawy. 1978. Response of three potato cultivars to inoculation with Azotobacter. J. Potato Res., 21: 1 - 8, 1978.

13. Jackson, M.L. 1967. Soil chemical analysis. Prentice –Hall of India Private Limited-Newdelhi, p. 115.

14. Kasawerch, F., E. E. Sample and I. Hushimoto. 1974. Reactions of ammonium-ortho and poly-phosphate fertilizer in soil. 1- Mobility of phosphorus. Soil Sci. Soc. Am. Proc., 38: 446 – 451.

15. Mengel, K. and E.A. Kirkby. 1978. Principles of plant nutrition. Inst. Potash, pp.: 374 – 390. In advances in Agron., 33: 60 – 106.

16. Mengel, K. and E.A. Kirkby. 1987. Principles of plant nutrition. 4^{th} Ed. International potash Institute. Pern, Switzerland, pp. 687.

17. Mengel, K. and H.E. Header. 1973. Potassium availability and its effects on crop production. Potash Review. Sub., 6, No. 11.

18. Mengel, K. and M. Viro. 1974. Effect of potassium supply on the transport of photosynthates to the fruits of tomatoes. Physiol. Plant, 30: 295 – 300.

19. Miller, R.I. 1965. Influence of $(NH_4)_2 SO_4$ on root growth and P-absorption by corn fom a fertilizer band. Soil Sci. Soc. Am. Proc., 57: 393 – 396.

20. Osman, A.E. and V. Jacob. 1970. Effect of the cultivation locality on the loste, favor and colour of roselle. Agric. Res. Rev., Ministry of Agric., 48: 181 – 192.

21. Pfluger, R. and K. Mengel. 1972. The photochemical activity of chloroplasts obtained from plants with a different potassium nutrition. Plant and Soil, 36: 417 – 425.

22. Rangana, S. 1978. Manual of analysis of fruit and vegetatable products. Tata McGraw Nipp Publishing Co. Ltd., New Delhi, Second Reprint, 634.

23. Sidorov, F.F. 1954. The effect of Azotobacter on the yield of potato Doki Akad. S. Kh. Nauk,1: 25 – 27. (C.F. Soil & fert. Abst., 17 No. 195).

24. Smith, F., M.A. Gilleo, D.K. Hamilton and P.A. Gafars. 1956. Colorimetric methods for determination of sugar and related substances. Annual Chemi. 28: 350.

25. Steel, R.G.D. and S.H. Torrie. 1980. Principles and Procedures of Statistical, second Ed. McGraw-Hill, Inc.

26. Suelter, G.H. 1970. Enzymes activated by monovalent cations. Sci., 168: 789 – 795.

27. Tribor, F. and F.J. Fransis. 1968. Quantitative methods for anthocyanins. 1. Extraction and determination of total anthocyanin in cranberries. J. of Food Sci. V. 33.

28. Volodin, V. 1969. Effect of treating seed potatoes with molybdenum and azotobacterin. Kartofel Oveshchi, 6: 46. (C.F. Soil&Fert. Abst., 33: 2431, 1970)

تأثير بعض معاملات الأسمدة الكيماوية والحيوية على نبات الكركديه

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أقيمت تجربتان حقليتان خلال موسمى ١٩٩٨ ، ١٩٩٩ واشتملت كل تجربة على أربعة مصادر للنتروجين (صفر، كبريتات النشادر ٢٠٠ كجم/فدان ، كبريتات النشادر ٣٠٠ كجم / فدان، نتروبين سماد حيوى) وكذلك أربعة مصادر للبوتاسيوم (صفر، كبريتات البوتاسيوم ٥٠ كجم /فدان، كبريتات البوتاسيوم ١٠٠ كجم / فدان ، بوتاسين كسماد ورقى عن طريق الرش) وكانت أهم النتنائج المتحصل عليها كما يلى:

١- أدى استخدام مصادر النتروبين كمصدر للتسميد الآزوتى الحيوى إلى إعطاء أفضل النتائج لكل من عدد الأفرع الجانبية ، عدد الثمار ، الوزن الطازج والجاف، الحموضة ، الأنثوسيانين ، الكربوهيدرات والبروتين .

٢- أدى استخدام سلفات الآمونيوم ٣٠٠ كجم/فدان كمصدر للتسميد الآزوتى إلى الحصول على أطول النباتات مقارنة بباقى المعاملات.

٣- أدى استخدام البوتاسيوم كمصدر للتسميد البوتاسى رشا على الأوراق إلى الحصول على أفضل النتائج للقياسات النباتية مثل عدد الأفرع الجانبية ، عدد الثمار ، الحموضة ، الأنثوسيانين، الكربوهيدرات والبروتين .

٤- أدى استخدام سلفات البوتاسيوم بمعدل ٥٠ كجم/فدان كمصدر للتسميد البوتاسى للحصول على أعلى النتائج لكل من الوزن الطازج والوزن الجاف هوائيا على النبات الواحد مقارنة بباقى المعاملات.

٥- أدى استخدام سلفات البوتاسيوم ١٠٠ كجم /فدان كمصدر للتسميد البوتاسى إلى إعطاء أطول النباتات.