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RESPONSE OF ROSELLE PLANTS (*Hibiscus Sabdariffa*, L.) TO CHEMICAL AND BIO-FERTILIZERS.

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ABSTRACT

This study was carried out in two field experiments during the two successive seasons of 2006 and 2007 to investigate the effect mixture of biofertilizers (namely, *Rhizobium leguminosarum* and *Azotobacter chroococcum*) either alone or in combination with chemical fertilizers (NPK at the rates of 50 ,75 and 100% of the recommended by Ministry of Agriculture, Egypt) on growth, yield and chemical constituents of roselle plants.

The obtained results indicated that, inoculation of roselle seeds with *Rhizobium* and *Azotobacter* alone significantly decreased vegetative growth (i.e. plant height, number of branches, number of leaves, leaf area and dry weight of leaves) and yield (i.e. number of flowers, fresh and dry weights of sepals/plant and per Fadden). Also, chemical constituents (i.e. N, P, K, chlorophyll a, b, carotenoids, anthocyanin, total carbohydrates, and acidity) were increased as compared to control plants during the two successive seasons. On the other side, the treatment 50 % NPK in combination with mixture of biofertilizers gave a slight decrease in the previous plant characters. On contrary, a significant increase of the above plant characters was obtained by the treatment with 75 and 100 % NPK in combination with mixture of biofertilizers as compared with the control plants. The difference between the treatments 50 or 75 % NPK in combination with mixture of biofertilizers and 100% NPK alone (control plants) were slight. So, it is recommended to use biofertilizers in combination with chemical fertilizer (especially, 50 or 75 % NPK) to obtain a safety agricultural products for human health and the environment,

Keywords*:* Biofertilizers, Chemical fertilizers, Roselle, Growth, Yield and Chemical constituents.

INTRODUCTION

Hibiscus sabdariffa L., family Malvaceae is one of the most important medicinal plants used in traditional folk medicine. El-Sheikh *et al.* (1990) found that an aqueous extract of *H. sabdariffa* L. at 50-100mg/l was toxic to cercariae and miracidia of *Schistosoma mansonii*. Its importance is due to the dried fleshy sepals which highly prized for making jams, jellies and cold or hot beverage Abd El-Moez and Saleh, (1999) and contain pigments especially anthocyanin, mixture of organic acids (malic, citric and tartaric acid), its taste acid tonic, well tolerated by patients with fever Ahmed *et al*., (1998). It has antibacterial, fungal and diuretic activates Caceres *et al*., (1987). Also, Hussein *et al*. (1989) recorded that roselle seeds contain fixed oils (17%) which are easily refundable and have good cooking properties.

Organically- grown agricultural products are considered to be healthier and cause less risk to the environment since their tissues contain lower levels of chemical residues. Also, factors such as escalating N fertilizer costs, soil structural degradation, environmental pollution and sustainable land use have generated a growing interest in natural N fixation as a method of providing plants with their N requirements Subba Rao, (1984).

Bio-fertilizer application improves plant growth, fruit yield and chemical composition, as compared with the untreated plants Abdel-Mouty *et al*., (2001). In this respect, Salah *et al*., (1998) on datura and Kandeel *et al.,* (2002) on *Ocimum basilicum*, recorded appreciable improvement on number of branches as well as fresh and dry weights of vegetative parts due to using N fixer bio-fertilizer.

An explanation was suggested by Lazarovits and Nowak, (1997) who reported that the stimulatory effects of microorganisms may result from indirect action by acting as bio-control agents and reducing diseases, liberation of antibiotic substances that kill noxious bacteria.

Application of NPK with bio-fertilizer resulted in the best growth, total yield of garlic plant characters Ali *et al*., (2001)

Many authors revealed the role of mineral NPK fertilizers in enhancing vegetative growth, flowering parameters, fruits and seeds production and chemical compositions of many medicinal and herbaceous plants such as Abd-Elmalik, (1996) on roselle, Al-Humaid, (2004) on datura, Salah El-Deen, (2005) on fennel and Swaefy Hend *et al*., (2007) on peppermint.

This study aimed to investigate the effect of some chemical and bio-fertilizers on the vegetative growth, yield and chemical composition of roselle plants.

MATERIALS AND METHODS

The current investigation was conducted in field experiment during the two successive growing seasons of 2006 and 2007 at the Experimental Farm, Faculty of Agriculture, Fayoum University to study the effect of chemical and bio-fertilizers on the vegetative growth, yield and chemical composition of roselle plants.

The mechanical and chemical analysis of soil used was carried out according to Olsen and Sommers, (1982) and Page *et al.*, (1982).

Table (1): Physical and chemical characteristics of the studied soil.

Physical properties												
Coarse sand			Fine sand		Silt		Clay		Soil texture			
6.5			13.9		22.7		56.9		Clay			
Chemical properties												
Organic matter %	EC mmhos/cm	pH	Total nitrogen %	Available p mg/g	Calcium carbonate %	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCo_3^{-}	Cl^{-}	So_4^{--}
1.21	1.56	7.63	0.17	23	5.43	5.57	2.35	7.04	0.42	2.05	8.48	4.55

Seeds:-

Seeds of roselle (*Hibiscus sabdariffa* L., var. sabdariffa) were obtained from Medicinal and Aromatic Plant Department, Agriculture Research Center, Ministry of Agriculture, Egypt. Seeds were sown (after mixed with

biofertilizers) in row in the 1st April in the two successive growing seasons. Spaces between rows were 50 cm and between hills were 30 cm. Four seeds were sown in the hill. One month later, the seedlings were thinned to one plant/ hill. Plants were irrigated and hand weeded regularly according to its needs.

Biofertilizers :-

The mixtures of biofertilizers (Rhizobium leguminosarum and Azotobacter chroococcum) were obtained from Agriculture Research Center Ministry of Agriculture, Egypt. Prior to sowing, seeds of roselle were immersed in Arabic Gum solution (16%) as a sticking agent thereafter; the seeds were mixed with the powder of mixed bio-fertilizers. Inoculated seeds were allowed to dry before sowing, according to Allen, (1971).

Treatments :-

1- Control plants received only mineral fertilizer at the rates recommended by the Ministry of Agriculture, which were, 300 Kg/fed. Ammonium nitrate (33.5%N); 150 kg/ fed. Calcium superphosphate (15.5%P_2O_5) and 50 kg/fed. Potassium sulphate (48% K_2O).
2- The mixture of biofertilizer only.
3- 50 % NPK from the rates recommended + biofertilizers
4- 75 % NPK from the rates recommended + biofertilizers.
5- 100 % NPK from the rates recommended + biofertilizers.

Ammonium nitrate was added after sowing in two equal doses: the first dose was added after one month from sowing and the second was added after one month later. Calcium super phosphate and potassium sulphate were added before sowing.

Each experiment included 5 treatments, each with 3 plots (3 × 3.5 m), in a randomized complete blocks design. The results were statistically analyzed using the LSD at probability level 5% for comparisons (Gomez and Gomez, 1983)

Data recorded:-

a) Vegetative growth characters:

1- Morphological characters:-

At the flowering stage (aged 140 days) 10 plants from each plot were randomly chosen to study the following characters: plant height (cm), number of branches/plant, number of leaves/plant, area of 7th leaf (cm^2) from the apex of plant (fully expanded leaf) using an area meter, model Li 3000 from LI C O R E, U S A., dry weight of leaves (g) /plant.(the samples were dried in an electric oven at $70^o \pm 2^o$ C till constant weight and then ground to determine the chemical constituents).

2- Yield and its components: -

During the flowering stage 10 plants from each plot were randomly chosen to study the following characters: number of flowers/plant and fresh and dry weight of sepals (calyx and epicalyx)/plant (g) and yield of dry sepals/fed. (Kg).

b) Chemical composition:

Chlorophylls (a & b) and carotenoids concentrations (mg g^{-1} fresh weight of leaf) were determined using colorimetric method as described by Welburn and Lichtenthaler, (1984). Total carbohydrates were calorimetrically

determined according to the method described by Herbert *et al.,* (1971). Nitrogen % was calorimetrically determined by using the orange G dye according to the method of Hafez and Mikkelsen, (1981). Phosphorus % was determined according to method described by A.O.A.C., (1995). Potassium %was determined by flame-Photometer Parkin-Elmer model 52 with acetylene burner according to Page *et al.,* (1982). Anthocyanin concentration (mg g^{-1}) was determined according to method described by Fahmy, (1970). The acidity (pH) was determined according to Diab*,* (1968).

RESULTS AND DISCUSSION

a) Vegetative growth characters:

Plant height:

Data presented in Table (2) show that, the treated plants with biofertilizers alone significantly decreased plant height as compared to the control. Also, treatment with 50 % NPK in combination with bio-fertilizer slightly decreased plant height of roselle in the first and second seasons. On contrary, a significantly increase of plant height was obtained by the treatment 75 and 100 % NPK in combination with bio-fertilizer as compared to the control plants. The differences between the treatments 75 and 100% NPK in combination with bio-fertilizer were insignificant. These results are in agreement with the findings of Shalan *et al.,* (2001); Rady and El-Sawah (2004) on bean plants; Somida *et al*., (2005) on roselle and Mahfouz and Sharaf-Eldin (2007) on fennel.

Number of branches / plant:

Data in Table (2) indicated that number of branches / plant was markedly decreased by treating plants with bio-fertilizer alone. While, the treatments of 50 % NPK in combination with bio-fertilizer showed a insignificant decrease. On the other side, insignificant increase of number of branches $plant^{-1}$ was observed by the treatments 75 and 100 % NPK in combination with bio-fertilizer as compared to control in the two seasons. It is worthy to mention that there is no great difference between the treatments of 75 and 100% NPK in combination with bio-fertilizer. Shalan *et al*., (2001) on roselle, Mohamed and El-Ganaini, (2003) on broad bean; Rady and El-Sawah (2004) on bean plants and Mahfouz and Sharaf-Eldin, (2007) on fennel, found that the number of branches $plant^{-1}$ was significantly increased by increasing the level of NPK fertilizer (especially, at the treatment 100% NPK) plus bio-fertilizer

Number of leaves / plant:

Data in Table (2) show that the seeds of roselle plants with *Rhizobium* and *Azotobacter* inoculation only as a bio-fertilizer significantly decreased number of leaves $plant^{-1}$ as compared to the control plants in both seasons. While, the treatment of 50 % NPK in combination with bio-fertilizer caused insignificant decrease. The combination between chemical and bio-fertilizers caused an insignificant increase of number of leaves $plant^{-1}$ in the first season and second season as compared to the control. The present results are similar to those obtained by Adam *et al.,* (2002) on cantaloupe; Rady and El-Sawah (2004) on bean plants and Attoa (2008) on *gladiolus*.

Table (2): Effect of bio- and chemical fertilizers on the vegetative growth characters of roselle plants.

Treatments	Plant height (cm)	No. of ranches plant^{-1}	No. of leaves plant^{-1}	Leaf area (cm^2)	D.W. of leaves plant^{-1} (g)	Plant height (cm)	No. of ranches plant^{-1}	No. of leaves plant^{-1}	Leaf area (cm^2)	D.W. of leaves plant^{-1} (g)
	First season (2006)					Second season (2007)				
Control	135.0	18.00	78.00	78.30	58.40	140.74	18.75	81.31	81.63	60.88
Biofertilizer	115.0	10.00	55.00	66.70	42.50	119.92	10.43	57.37	66.54	44.31
50% NPK+ bio	134.0	17.00	75.00	76.40	58.00	139.70	17.73	78.20	79.65	60.47
75% NPK+ bio	140.0	20.00	80.00	80.50	60.00	145.98	20.85	83.41	83.93	62.55
100%NPK+ bio	143.0	22.00	93.00	81.50	63.20	149.10	22.94	96.99	84.97	65.78
LSD 5%	3.54	4.13	7.19	1.92	1.41	3.66	4.33	7.52	1.99	1.48

Leaf area:

Table (2) clearly shows that inoculation roselle seeds with bio-fertilizer alone markedly decreased leaf area of roselle plants as compared to the control plants in both seasons. Also, a slight decrease of leaf area was obtained by treating plants with bio-fertilizer in addition 50 % mineral fertilizer. On the other hand, the highest increase in leaf area was obtained by the combination of mineral fertilizer, especially, at the rates of 75 or 100 % with bio-fertilizer, in the first and second season as compared with the control. Also, it could be noticed that the difference between the treatments 75 and 100% NPK were insignificant. The same trend was observed in the second season. These results are in harmony with those obtained by Mohamed and El – Ganaini, (2003) on broad bean and Attoa, (2008) on *gladiolus*.

Dry weight of leaves / plant:

The data obtained in Table (2) indicated that, 100% mineral fertilizer (control) significantly increases dry weight of leaves plant^{-1} as compared to the treatment with biofertilizer alone. On the other side, slight decrease was obtained by the treatment of 50 % NPK in combination with the mixture of *Rhizobium* and *Azotobacter* in the first and second seasons. On the other hand, the greatest increase was obtained by the combination of mineral fertilizer, especially, at the rates of 75 or 100 % with the mixture of bio-fertilizer, in the first and second seasons as compared with the control. In addition, the difference between the treatments 75 and 100% NPK was significant. The same trend was observed in the second season. The present results agreed with those of Ali *et al*., (2001) who reported that application of NPK with bio-fertilizer gave the best plant growth and dry weight. Attoa, (2008) on *gladiolus* found that interaction between bio-fertilizer and chemical fertilizer gave the highest value for dry weight of leaves plant^{-1} in both seasons.

Number of flowers/plant:

Data recorded in Table (3) show that inoculation roselle seeds with *Rhizobium* and *Azotobacter* without addition of NPK fertilizers significantly decreased number of flowers plant$^{-1.}$ Also, an insignificant decrease was obtained by the treatment of 50% NPK in combination with the mixture of *Rhizobium* and *Azotobacter* in the first and second seasons as compared to

control. On the other side, a slight increase was obtained by the treatment 75% NPK in combination with the mixture of biofertilizers. The greatest increase was obtained by the combination of mineral fertilizer, at the rate of 100 % with the mixture of bio-fertilizer, in the first and second season as compared with the control. Also, significant differences between the treatments 50 or 75 % and 100 % NPK in combination with of biofertilizers were found. These results are in harmony with those obtained by Mohamed and El-Ganaini, (2003) on broad bean as they found that number of pods plant^{-1} was significantly increased by increasing the level of NPK fertilizer (especially at the treatment 100%) with bio-fertilizer.

Table (3): Effect of bio- and chemical fertilizers on yield and its components of roselle plants.

Treatments	No. of flowers plant^{-1}	F.W.of sepals plant^{-1} (g)	D.W.of sepals plant^{-1} (g)	D.W.of sepals yield / fed. (kg)	No. of flowers plant^{-1}	F.W.of sepals plant^{-1} (g)	D.W.of sepals plant^{-1} (g)	D.W.of sepals yield / fed. (kg)
	First season (2006)				Second season (2007)			
Control	25.00	46.70	7.20	216.0	26.06	48.69	7.42	222.6
Biofertilizer	18.00	38.50	6.50	195.0	18.77	40.14	6.69	200.7
50% NPK+ bio	24.50	46.00	7.00	210.0	25.54	47.95	7.21	216.3
75% NPK+ bio	27.50	50.80	8.20	246.0	28.68	52.96	8.47	254.1
100%NPK+ bio	30.00	51.50	8.50	255.0	31.28	53.78	8.78	263.4
LSD 5%	1.82	0.93	0.40	8.8	1.91	1.00	0.42	10.1

Fresh and dry weights of sepals / plant:

Regarding the effect of fertilization treatments on fresh and dry weights of sepals / plant, data presented in Table (3) show that the treated plants with 100 % NPK alone (recommended of Agriculture Ministry, control) significantly increased fresh and dry weights of sepals / plant as compared to the treatment biofertilizer alone. Also, there was a slight decrease obtained by the treatment of 50% NPK in combination with biofertilizer in the first and second seasons, as compared to control. On contrary, plants which treated with high mineral fertilizer levels (75 or 100% NPK) with bio-fertilizer gave the greatest increase in fresh and dry weights of sepals/ plant at the first season as compared to control. Statistically, the different between the treatments 75 and 100% NPK were insignificant in relation to fresh or dry weight of sepals. The same trend was obtained in the second season. Shalan *et al*., (2001) and Somida *et al*., (2005) on roselle.

The stimulatory effect of the interaction between mineral and bio-fertilizer was demonstrated in the previous research which supports our results. Whereas, Ali *et al*., (2001) concluded that the heaviest total yield of garlic plant was recorded by applying NPK with bio-fertilizer. Adam, (2002) found that the interaction between the bio and mineral fertilizer resulted in a significant increase in fruit yield. It could be concluded that the stimulatory influence of both mineral and bio-fertilizer on the vegetative growth of the plants reflected to increase the final product, i.e. fruit yield.

Yield of dry sepals / fed:

Data presented in Table (3) show that the dry yield of sepals/ fed. was greatly decrease by treatment of biofertilizer alone at the first season as compared to control. Also, insignificant decrease was obtained by the treatment of 50 % NPK in combination with biofertilizer in the first and second seasons. On contrary, plants which treated with high mineral fertilizer levels (75 or 100% NPK) with bio-fertilizer caused the significant increase in dry yield of sepals/ fed. at the first season as compared to control. Statistically, the different between the treatments 75 and 100% NPK were significant.

b) Chemical constituents:

Pigments concentration:

Data recorded in Table (4) show that chlorophylls a, b, carotenoids and anthocyanin were significantly decreased by the treatment biofertilizer alone as compared to the control plants. Insignificant decrease of the pigments concentration was obtained by the treatment of 50 % NPK in combination with biofertilizer in the first and second seasons. On the other hand, significant increases of the pigments concentration were obtained by the treatments of 75 or 100 % in combination with biofertilizer in the first and second seasons. But, the different between the treatments 75 and 100% NPK were insignificant at the first season. The same trend was also obtained in the second season. These results are in conformity with the findings reported by Shalan *et al.* (2001); Somida *et al.,* (2005) on roselle and Swaefy Hend *et al.,* (2007) on peppermint.

Total carbohydrates content:

Data recorded in Table (4) indicate that, bio-fertilizer alone or with 50 % NPK significantly decreased total carbohydrates concentration of roselle leaves as compared to the control plants, at the first and second seasons. On the other hand, total carbohydrates concentration was significantly increased by treated plants with treatments of 75 or 100% NPK in combination with biofertilizer as compared to the control plants, at the first and second seasons. Generally, insignificant increase was observed between the treatments 75 and 100% NPK in combination with biofertilizer. The obtained results are in agreement with those reported by Shalan *et al.,* (2001) and Somida *et al.,* (2005) on roselle and Swaefy Hend *et al.,* (2007) on peppermint.

Acidity (pH value):

Table (4) show that in the untreated plants (control) there was an significant increase in acidity (pH) as compared to treatment inoculation roselle seeds with *Rhizobium* and *Azotobacter* alone, while, a slight decrease was obtained by the treatment of 50 % NPK in combination with biofertilizer as compared to control. Also, a slight increase was observed by the treatment of 75 % NPK in combination with biofertilizer. On the other hand, the treatment of 100 % NPK in combination with biofertilizer gave a significant increase in acidity (pH) as compared to control, at the first and second seasons. While, the different between the treatments of 75 and 100% NPK in combination with biofertilizer were insignificant. Similar results were obtained by Shalan *et al.,* (2001) and Somida *et al*., (2005) on roselle.

Table (4): Effect of bio- and chemical fertilizers on some chemical constituents of roselle plants.

Treatments	Chlorophyll a mg/g	Chlorophyll b mg/g	Carotenoids mg /g	Anthocyanin mg /g	Total carbohydrates mg /g	Acidity	Nitrogen %	Phosphorus %	Potassium %
First season (2006)									
Control	1.64	1.03	0.484	20.00	178.10	2.74	4.51	0.16	1.98
Biofertilizer	1.38	0.92	0.402	16.35	151.50	2.55	3.40	0.12	1.77
50% NPK+ bio	1.62	1.00	0.483	19.58	176.30	2.71	4.50	0.15	1.83
75% NPK+ bio	1.68	1.10	0.526	21.15	180.60	2.80	4.56	0.19	2.14
100%NPK+ bio	1.71	1.12	0.530	21.95	180.30	2.82	4.58	0.19	2.15
LSD 5%	0.05	0.04	0.005	1.27	0.62	0.08	0.05	0.02	0.15
Second season (2007)									
Control	1.71	1.07	0.505	20.85	185.67	2.86	4.70	0.17	2.00
Biofertilizer	1.44	0.96	0.419	17.05	157.94	2.66	3.54	0.15	1.87
50% NPK+ bio	1.69	1.04	0.504	20.41	183.79	2.82	4.69	0.19	1.94
75% NPK+ bio	1.75	1.15	0.583	22.05	188.87	2.92	4.74	0.19	2.16
100%NPK+ bio	1.79	1.17	0.584	22.89	189.18	2.94	4.77	0.21	2.27
LSD 5%	0.05	0.04	0.006	1.33	0.71	0.08	0.07	0.03	0.16

Nitrogen, phosphorous and potassium concentrations:

Data tabulated in Table (4) clear that, nitrogen, phosphorous and potassium percentages were generally increased by the treatment control as compared to the inoculation roselle seeds with bio-fertilizer alone. Also, a slight decrease was obtained by the treatment of 50 % NPK in combination with biofertilizer as compared to the control. On the other side, treatments of 75 or 100% NPK in combination with biofertilizer caused the greatest increase in nitrogen, phosphorous and potassium percentages as compared to the control plants, at the first and second seasons. But, the different between the treatments 75 and 100% NPK were insignificant. The previously obtained results are in harmony with those reported by Rady and El-Sawah (2004) on bean plants ; Somida *et al.*, (2005) on roselle, Swaefy Hend *et al.*, (2007) on peppermint and Attoa, (2008) on *gladiolus.*

CONCLUSION

It is clear from the previous results that, the treated roselle plants with biofertilizers alone are not enough to obtain good yield. Also, the enhancement of vegetative growth characteristics, chemical constituents and yield resulted from treating roselle seeds with bio-fertilizer in addition to 75 or 100 % NPK. This effect may be due to that applying biofertilizer increase microorganisms in the soil, which convert the ability of mobilizing the unavailable forms of nutrients elements to available forms (Ishac, 1989). On the other hand, the microorganisms produce growth promoting substances which increase the plant growth. This increase in plant growth may increase the photosynthetic rates leading to an increase of the assimilation rates. Many authors revealed the role of mineral NPK fertilizers in enhancing vegetative growth, flowering parameter, fruits and seeds production and chemical compositions of many medicinal and herbaceous plants such as Abd-Elmalik, (1996) on roselle, Al-Humaid, (2004) on datura, Rady and El-Sawah

(2004) on bean plants , Salah El-Deen, (2005) on fennel and Swaefy Hend *et al.*, (2007) on peppermint.

Recommendation :-

The statistical data cleared that the difference between the treatment of 50 % NPK in combination with biofertilizer and the recommended mineral fertilizers (control) was insignificant. Also, the treatment of 75 % NPK in combination with biofertilizer gave the best results of number of flowers, quality and the dry weight of yield sepals/fed. As compared to control plants. Also, the difference between the treatments of 75 and 100% NPK with biofertilizers were insignificant. So, it could be advised to applying 50 or 75% of the recommended amount of chemical fertilizer (NPK) combined with bio-fertilizer to obtain on safety plant production on human health and environment.

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استجابة نباتات الكركديه للتسميد الكيماوي والحيوي

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أجريت هذه الدراسة في الحقل خلال موسمي ٢٠٠٦ و ٢٠٠٧– لدراسة مدى تأثير بعض الأسمدة الحيوية التي هي عبارة عن خليط من بعض السلالات الميكروبية (الريزوبيم والأزوتوباكتر) سواء منفردة أو متحدة مع السماد الكيماوي (النيتروجين والفوسفور والبوتاسيوم بالمعدلات ٥٠ ، ٧٥ ، ١٠٠ % من الموصي به من وزارة الزراعة) على النمو والمحصول والمكونات الكيماوية لنباتات الكركديه. أظهرت النتائج المتحصل عليها أن :-

- المعاملة بالتسميد الحيوي (بخليط الريزوبيم والأزوتوباكتر) منفردا أدي إلي نقص معنوي في صفات النمو الخضري (مثل ارتفاع النبات وعدد الفروع وعدد الأوراق ومساحة الورقة ووزنها الجاف) والمحصول (مثل عدد الأزهار والوزن الطازج والجاف للسبلات/ نبات ، والوزن الجاف لمحصول السبلات /فدان). أيضا المكونات الكيماوية (مثل تركيز النيتروجين والفوسفور والبوتاسيوم والكلوروفيلات أ و ب والكاروتينيدات والأنثوثيانات والكربوهيدرات الكلية والحموضة بالمقارنة بالكنترول ٠
- من جهة أخري أدت المعاملة ٥٠ % من السماد الكيماوي + السماد الحيوي إلي نقص غير معنوي في الصفات السابقة .
- علي العكس أدت المعاملتين٧٥ و ١٠٠% من السماد الكيماوي + السماد الحيوي إلي زيادة معنوية في الصفات السابقة .
- إحصائيا لا توجد فروق معنوية بين المعاملتين٧٥ و ١٠٠% من السماد الكيماوي + السماد الحيوي علي الصفات السابقة .
- ولذلك تحت ظروف هذه التجربة يمكن التوصية باستخدام التسميد الحيوي مع كميات منخفضة من السماد الكيماوي

(٥٠ أو ٧٥ % من الموصي به) للحصول علي منتج زراعي آمن من نبات الكركدية علي البيئة وصحة الإنسان.