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Impact of bio and mineral fertilizers on growth, yield and its components of roselle plants (*Hibiscus sabdariffa*, L.) grown under different types of soil

Abstract

A field experiment was carried out during the two successive seasons 2007 and 2008 to study the effect of bio fertilizers namely, Azotobacterine (*Azotobacter chroococcum*) and phosphorein (*Bacillus polymyxa*), mineral N, P and K fertilizers at the rates of 25, 50 and 100% for each fertilizer (from the doses recommended by Ministry of Agriculture) on growth (plant height, number of branches and herb fresh and dry weights/plant), yield (dry weight of sepales/plant and feddan and weight of seeds/plant and feddan) of roselle plants (*Hibiscus sabdariffa*, L.) under different soils (clay soil at Dar El-Ramad farm, sandy loam and saline loamy sand soil at Demo farm, Faculty of Agriculture) at El-Fayoum governorate conditions.The data obtained showed that, bio and mineral (NPK) fertilizers increased the above characters of roselle plants under different soils of experiment. The maximum increase of these characters was obtained by the treatment clay soil×100% NPK+bio fertilizers, followed by clay soil×50% NPK+bio fertilizers as compared to saline loamy sand soil×non fertilizer treatment, although, the differences between these treatments and mineral fertilizer at the rate of 100% NPK alone were insignificantly. Therefore, it is economically and environmentally recommended to inoculate roselle seeds with mixture of Azotobacter+Bacillus and fertilize these inoculated plants with 50% improve the vegetative growth and augment the yield components of roselle plants under clay soil were obtained the best results of this work study.

Keywords: roselle, *hibiscus sabdariffa* l, nitrogen, phosphorus, bio fertilization, soil type, salinity, growth, yield

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Introduction

Roselle (*Hibiscus sabdariffa*, L.) belongs to the family Malvaceae. It is now widely cultivated throughout the tropics and sub tropics e.g. Sudan, China, Thailand, Egypt, Mexico, and the west India. Roselle plant is branched, glabrous, annual sub shrub, 0.5-3 m. high, with strong taproot. Roselle is cultivated mainly in Upper Egypt and grows well under different environmental conditions such as high temperature.[1] Plants require specific amount of certain nutrients in specific form at appropriate time, for their growth and development.[2] To determine the rates of N fertilizer application, it is necessary to take into account the inorganic N of the soil and the organic N mineralized during crop growth.[3] Environmental problems caused by irregular application of chemical fertilizers, inappropriate energy production methods and excessive consumption costs have all had harmful effects on biological cycles and destroyed farming stability systems; these factors altogether encourage the application of bio-fertilizers.[4] Nowadays attention to biological fertilizer has been increased due to countries development, prices of chemical fertilizers and attention to sustainable agricultural systems.[5] Nitrogen is required in large quantities for plants growth, since it is the basic constituent of proteins and nucleic acids. Nitrogen is provided in the form of synthetic chemical fertilizer. Excessive use of such chemical fertilizers for increasing crop yield cased health hazard and microbial population problems in soil besides beings quite expensive and making the cost of production high.[6] Bio-as a microbial-based fertilizer composed of different microorganism that has the ability to fix atmospherec N making it available for plant growth which can drastically reduce N-fertilizer input and enhance the yield of wheat. These bacteria can convert the gaseous nitrogen from the air to ammonia at an equivalent rate of 40 kg of N per hectare or higher. It complements the use of chemical fertilizer by 30-50%, an apparent big savings for the farmers. Other results show that Bio-N inoculation, in the presence of 50% the recommended mineral fertilizer, could parallel the yield of fully fertilized corn.[7] Several researchers reported that inoculation of some plants with bio fertilizers (singly or in different combinations with mineral fertilizers) improved plant growth, yield and chemical composition.[8–11] Moreover, several researchers justified the idea that nutrients like N may be taken up through roots and leaves and may spread within the plant.[11,12–15] Therefore, the use of phosphate solubilising microbes along with the applied phosphate can provide a solution to the menace of accumulation of phosphates in the fields and water bodies. Bacillus sp. are well-known rhizobacteria which facilitate the plant growth either by solubilization of minerals like phosphorus or production of metabolites such as siderophores and phytohormones, and are excellent colonizers of the roots.[16] Several researchers justified the idea that nutrients like phosphorus may be taken up through roots and leaves and may spread within the plant.[17–21] Many investigators agreed that application of phosphate dissolving bacteria; *Bacillus megaterium* increased growth characters.[22–26]

The aim of this work was to study the integrated effect of N&P bio fertilizers plus N&P as soil application at different rates on growth and yield of roselle plants.

Material and methods

A field experiment were conducted during the two successive seasons of 2007and 2008 to study the effect of bio, nitrogen and phosphorus fertilizers on growth, yields and its components of roselle plants (*Hibiscus sabdariffa,* L.) under different types of soil at El-Fayoum governorate conditions. Three types of soil in two experimental stations of the Faculty of Agriculture, namely clay soil at the Dar El-Ramad farm, a saline loamy sand and sandy loam soil at Demo farm. Some chemical and physical characteristics of the experimental stations soils are presented in Table 1 & Table 2.

Biofertilizers namely Azotobacterine (*Azotobacter chroococcum)* as nitrogen fixing bacteria and phosphorein (*Bacillus polymyxa*) as a phosphate dissolving bacteria were obtained from Agricultural Research Center, Ministry of Agriculture, Egypt.The seed of roselle cv. Sabahia 17 were obtained from the Research Center of Medicinal and Aromatic Plants, Ministry of Agriculture, Egypt. Seeds were immersed in Arabic gum solution (16%) as a sticking agent, then, the seeds were mixed with the powder of mixed biofertilizers; inoculated seeds were allowed to dry before sowing, according to Allen.[27] Application of N, P and K fertilizers were 100, 50 and 25% for each fertilizer from that recommended doses by the Ministry of Agriculture, 500 kg ammonium sulfate (20.6% N), 150 kg calcium superphosphate (15% P_2O_5) and 50 kg potassium sulfate/fed (48% K_2O). Nitrogen fertilizer was applied in two equal doses, the first dose during sowing and before the first irrigation, and the second dose after one month from sowing. Phosphorus and potassium fertilizers were applied during soil preparation (Table 3).

1- Non fertilizer 2- Biofertilizers 3- 100% NPK 4- (Biofertilizers+100% NPK) 5- (Biofertilizers+50% NPK) 6- (Biofertilizers+25% NPK)

The experimental field was plowed, rolled and divided into 54 plots, each one of 10.5m^2 area (1/400 fed) and contains 5 rows (3 m width and 3.5 m in length). The seeds inoculated were sown on 1st and 2nd May, in the two experimental seasons. Four seeds were sown per hill (50 cm apart) on one side of the ridge. After one month from sowing the seedlings were thinned to one plant per hill. In this regard, each experimental unit (plot) contains 30 plants (6 plants/row) and 12000 plants/fed. All other agricultural practices were followed as recommended in roselle management.

Plant samples

Samples of roselle plants (9 plants) were randomly chosen from each treatment (3 plants for each replicate) in the early morning after 140 days from sowing immediately transferred to the laboratory to study the following morphological characteristics and plant analysis.

i. Average plant height (cm) was measured from the cotyldonary node to plant top of the main stem.

ii. Average number of branches/plant: was estimated by taking the average number of branches of nine plants.

iii. Average fresh weight (g): The samples were stemated by taking the average weight of nine plants.

iv. Average dry weight of herb g/plant: The samples were dried in an electric oven at 70ºC±2 until constant weight was reached almost after 48 hours.

Yield and its components

At the age of 180 days from sowing, roselle plants were harvested (9 plants) from each treatment which randomly chosen to study the following parameters.

i. Dry weight of sepals g/plant: The dry weight of sepals plant (calyx and epicalyx) was recorded after drying in sunny place.

ii. Dry sepals yield (kg/feddan): The capsules were air-dried in suny place .The dry yield of sepals was calculated (kg/fed).

iii. Weight of seeds/plant (g): The capsules were collected and dried on paper sheet in suny open place. After drying, the seeds were separated and its dry weight was recorded.

iv. Weight of seeds (kg/feddan): The weight of seeds/feddan was calculated from the weight of seeds/plot.

Statistical analysis

A split-split plot design was used. Also, all the collected data were reduced to proper format and units and were statistically analyzed using the procedures outlined by Snedecor and Cochran.[28]

Results

A- Growth characters

Data presented in Table 4 clearly indicate that the clay soil gave the highest growth parameters of roselle plant, (i.e. plant height, number of branches, herb fresh weight Kg/plant and herb dry weight g/plant) compared to sandy loam and saline loamy sand soil. The application of mineral fertilization (100% NPK) on roselle growth parameters was significantly increased compared to the non-fertilizer in the first and second seasons. Data also show that bio fertilization treatment significantly increased roselle growth parameters in the first and second seasons, in comparison to non-fertilizer treatment respectively. Seeds inoculation with bio-N&P fertilizer in combination with 25, 50 and 100 % from recommended N&P dose as soil application improved the studied growth parameters of roselle plant, as compared to non-fertilizer treatment. Such trend was true during the two studied seasons. The interaction between mineral fertilizers (NPK) and bio fertilizers significantly affected the roselle growth parameters in the two experimental seasons. All growth parameters for plants received 100% NPK and inoculated with different bacteria strains were increased than those which did not received neither mineral NPK nor bio fertilization treatments. The most effective interaction treatments were 100% NPK+bio fertilizers followed by 50% NPK+bio fertilizers than 25% NPK+bio fertilizers. The interaction of growth parameters between soil type and fertilizer treatments was increased at the treatment (clay soil×Bio+100% NPK) in the first and second seasons, respectively above the lowest values at the treatment (saline loamy sand soil × non fertilizer).

B- yield and its components

Data presented in Table 5 showed that clay soil gave the heaviest yields and its components (Sepals dry weight g/plant, Sepals dry weight kg/fed, Weight of seeds g/plant and Weight of seeds kg/fed) as compared to sandy loam and saline loamy sand soil in the first season and second season, respectively. A significant increment has been recorded on yields and its components by 100% mineral NPK treatment compared to unfertilized plants as listed in Table 5. In regard to bio fertilization, data also show that application of bio fertilization (with two bacteria species) led to significant increase in yields and its components in comparison with non-fertilizer in the experiments of two seasons. The combination between NPK and bio fertilizers significantly affected yields and its components in the experiments of the two seasons. The most effective interaction treatments were 100% NPK + bio fertilization followed by 50% NPK+bio fertilization than 25% NPK+bio fertilization. It was found a slight difference between 100% NPK and Bio+50% NPK treatment. Data tabulated in Table 5 show that the interaction between soil type and fertilizer treatments greatly increased yields and its components at the treatment (clay soil×Bio+100% NPK) above the lowest values, at the treatment (saline loamy sand soil×non fertilizer) in the first and second seasons, respectively.

Table 1 Some physical and chemical properties of the used experimental soils (Dar El-Ramad and Demo farms) through season 2007

Soil properties	**Season 2007**		
	Demo		**Dar El-Ramad**
Physical properties			
Coarse sand %	28.69	30.20	5.14
Fine sand %	37.19	42.33	21.55
Silt %	22.16	15.72	24.43
Clay %	11.96	11.75	48.88
Texture class	**Sandy loam**	**Loamy sand**	**Clay**
Chmical properties			
Organic matter %	0.48	0.41	1.69
$CaCO_3$ %	8.61	7.42	5.82
pH (soil paste)	7.82	7.76	7.89
ECe (paste extract), ds/m	3.12	7.51	1.58
Soluble anions, meq/L*			
CO_3^{--}	….	….	….
HCO_3^-	5.40	4.37	2.24
Cl^-	12.35	38.93	7.12
SO_4^{--}	13.45	31.80	6.44
Soluble cations, meq/L*			
Ca^{++}	8.67	30.75	6.15
Mg^{++}	6.89	17.41	6.80
Na^+	15.03	26.15	2.13
K^+	0.61	0.79	0.72
Available nutrients, ppm**			
N	3.54	4.44	21.02
P	6.87	6.42	12.27
K	54	36	83

*In saturation paste extract

**On dry weight basis

Table 2 Some physical and chemical properties of the used experimental soils (Dar El-Ramad and Demo farms) through season 2008.

Soil properties	Season 2008		
	Demo		**Dar El-Ramad**
Physical properties			
Coarse sand %	22.73	31.05	6.37
Fine sand %	31.66	40.38	19.40
Silt %	31.84	16.04	27.48
Clay %	13.77	12.53	46.75
Texture class	**Sandy loam**	**Loamy sand**	**Clay**
Chmical properties			
Organic matter %	0.38	0.40	1.43
$CaCO_3$ %	7.83	7.69	5.12
pH (soil paste)	7.75	7.81	7.55
ECe (paste extract), ds/m	3.64	7.26	2.10
Soluble anions, meq/L*			
CO_3^{--}	….	….	….
HCO_3^-	4.83	4.96	3.83
Cl^-	15.42	35.43	10.29
SO_4^{--}	16.15	32.21	6.88
Soluble cations, meq/L*			
Ca^{++}	10.25	30.24	7.43
Mg^{++}	7.32	14.39	8.92
Na^+	18.11	27.32	3.80
K^+	0.72	0.65	0.85
Available nutrients, ppm**			
N	3.80	4.96	22.16
P	6.59	6.42	12.27
K	42	24	89

*In saturation paste extract

**On dry weight basis

Citation: Ghabour SSI, Mohamed SA, El-Yazal SAS, et al. Impact of bio and mineral fertilizers on growth, yield and its components of roselle plants (Hibiscus sabdariffa, L.) grown under different types of soil. *Horticult Int J.* 2019;3(5):240–250. DOI: 10.15406/hij.2019.03.00138

Table 3 The experiment included eighteen treatments with three replicates (three different soils × six levels of fertilizers) as following

	N	P	K
Application of mineral fertilization	**Ammonium sulfate (20.6% N)**	**Calcium superphosphate (15% P_2O_5)**	**Potassium sulfate (48% K_2O)**
100%	500 kg/fed	150 kg/fed	50 kg/fed
50%	250 kg/fed	75 kg/fed	25 kg/fed
25%	125 kg/fed	37.5 kg/fed	12.5 kg/fed

Table 4 Effect of bio and mineral fertilization and their interactions on growth parameters (plant height, number of branches, herb fresh weight Kg/plant and herb dry weight g/plant) of roselle plants under clay, sandy loam and saline loamy sand soils during the two successive seasons 2007 and 2008

Treatments	**Plant height (cm)**					
	2007			**2008**		
	Clay	**Sandy loam**	**Saline loam sand**	**Clay**	**Sandy loam**	
Non fertilizer	106.3	97.0	77.3	113.3	94.0	77.3
Biofertilizers	148.0	131.0	118.3	147.7	130.7	118.3
100% NPK	183.7	174.7	128.7	186.3	172.0	128.7
Bio + 25% NPK	174.0	152.0	144.3	175.3	152.0	144.3
Bio + 50% NPK	190.7	175.0	153.7	192.7	176.7	155.3
Bio + 100% NPK	193.0	177.0	161.0	195.3	172.7	166.7
Mean	165.9	151.1	130.6	168.4	149.7	131.8
L.S.D. at 5%	S=27.70 F=8.1 S.F=4.6			S=7.2 F=6.1 S.F=3.5		

Treatments	**Number of branches**					
	2007			**2008**		
	Clay	**Sandy loam**	**Saline loam sand**	**Clay**	**Sandy loam**	**Saline loam sand**
Non fertilizer	10.7	8.3	9.3	11.3	8.0	9.0
Biofertilizers	11.7	11.0	12.3	12.3	11.7	12.8
100% NPK	19.7	18.3	19.2	19.3	18.7	19.5
Bio + 25% NPK	15.0	12.0	13.7	14.7	12.3	14.0
Bio + 50% NPK	19.0	17.3	18.0	18.7	17.7	18.3

Citation: Ghabour SSI, Mohamed SA, El-Yazal SAS, et al. Impact of bio and mineral fertilizers on growth, yield and its components of roselle plants (Hibiscus sabdariffa, L.) grown under different types of soil. *Horticult Int J.* 2019;3(5):240–250. DOI: 10.15406/hij.2019.03.00138

Table continued

Treatments	Number of branches					
	2007			**2008**		
	Clay	**Sandy loam**	**Saline loam sand**	**Clay**	**Sandy loam**	**Saline loam sand**
Bio + 100% NPK	20.3	16.0	16.5	20.7	16.0	17.5
Mean	16.1	13.8	14.8	16.2	14.1	15.2
L.S.D. at 5%	S=3.2 F=3.2 S.F=1.9			S=3.0 F=1.7 S.F=1.0		

Treatments	Herb fresh weight Kg/plant					
	2007			**2008**		
	Clay	**Sandy loam**	**Saline loam sand**	**Clay**	**Sandy loam**	**Saline loam sand**
Non fertilizer	1.40	1.29	1.03	1.37	1.16	0.99
Biofertilizers	1.85	1.56	1.37	1.79	1.48	1.27
100% NPK	2.13	1.95	1.71	2.09	1.89	1.66
Bio + 25% NPK	1.87	1.72	1.47	1.82	1.71	1.40
Bio + 50% NPK	2.17	1.89	1.69	2.12	1.84	1.64
Bio + 100% NPK	2.22	1.99	1.80	2.17	1.94	1.76
Mean	1.94	1.73	1.51	1.89	1.67	1.45
L.S.D. at 5%	S=2.14 F=0.98 S.F=0.57			S=1.22 F=1.2 S.F=0.59		

Treatments	Herb dry weight g/plant					
	2007			**2008**		
	Clay	**Sandy loam**	**Saline loam sand**	**Clay**	**Sandy loam**	**Saline loam sand**
Non fertilizer	312	293	236	305	259	221
Biofertilizers	412	348	313	398	329	284
100% NPK	475	435	389	466	421	370
Bio + 25% NPK	416	383	335	405	381	312
Bio + 50% NPK	482	422	385	471	409	365
Bio + 100% NPK	493	453	411	483	431	393
Mean	432	389	345	421	372	324
L.S.D. at 5%	S=45 F=22 S.F=13			S=25 F=23 S.F=13		

Table 5 Effect of bio and mineral fertilization and their interactions on yields and its components (sepals dry weight g/plant, sepals dry weight kg/fed, weight of seeds g/plant and weight of seeds kg/fed) of roselle plants under clay, sandy loam and saline loamy sand soils during the two successive seasons 2007 and 2008

Treatments	Sepals dry weight g/plant					
	2007			2008		
	Clay	Sandy loam	Clay	Sandy loam	Clay	Sandy loam
Non fertilizer	21.7	17.4	12.9	18.0	15.5	11.6
Biofertilizers	32.2	19.3	14.0	28.6	17.3	12.8
100% NPK	47.7	23.5	20.5	43.6	21.9	19.2
Bio + 25% NPK	36.5	21.5	18.5	34.1	18.6	16.7
Bio + 50% NPK	45.3	23.2	20.4	40.6	20.8	18.5
Bio + 100% NPK	49.4	26.2	23.1	45.1	24.2	20.6
Mean	38.8	21.8	18.2	35.0	19.7	16.6
L.S.D. at 5%	S=3.4 F=2.6 S.F=1.3			S=2.1 F=2.4 S.F=0.9		

Treatments	Sepals dry weight kg/fed					
	2007			2008		
	Clay	Sandy loam	Saline loam sand	Clay	Sandy loam	Saline loam sand
Non fertilizer	261	209	154	216	185	139
Biofertilizers	386	232	168	343	208	154
100% NPK	573	281	246	523	263	230
Bio + 25% NPK	438	258	222	410	223	200
Bio + 50% NPK	543	278	245	487	250	222
Bio + 100% NPK	592	314	278	542	290	248
Mean	465	262	219	420	237	199
L.S.D. at 5%	S=38 F=37 S.F=16			S=16 F=32 S.F=10		

Table continued

Treatments	Weight of seeds g/plant					
	2007			2008		
	Clay	**Sandy loam**	**Saline loam sand**	**Clay**	**Sandy loam**	**Saline loam sand**
Non fertilizer	39.9	18.8	14.8	30.3	13.6	12.6
Biofertilizers	42.4	21.8	21.0	36.4	18.0	17.5
100% NPK	52.2	30.5	28.9	47.1	26.3	25.3
Bio + 25% NPK	49.0	28.5	26.4	41.2	23.9	22.7
Bio + 50% NPK	53.7	28.0	27.3	47.8	23.4	23.6
Bio + 100% NPK	54.1	35.8	32.1	49.5	29.2	28.7
Mean	48.5	27.3	25.1	42.1	22.4	21.7
L.S.D. at 5%	S=16.9	F=4.9	S.F=2.9	S=4.9	F=2.8	S.F=4.9

Treatments	Weight of seeds kg/fed					
	2007			2008		
	Clay	**Sandy loam**	**Saline loam sand**	**Clay**	**Sandy loam**	**Saline loam sand**
Non fertilizer	478	225	177	363	163	151
Biofertilizers	509	262	252	437	216	210
100% NPK	613	367	347	566	315	304
Bio + 25% NPK	577	342	317	494	286	272
Bio + 50% NPK	604	337	328	574	281	283
Bio + 100% NPK	653	430	385	594	351	344
Mean	572	327	301	505	269	261
L.S.D. at 5%	S=140	F=49	S.F=28	S=58	F= 34	S.F=20

Citation: Ghabour SSI, Mohamed SA, El-Yazal SAS, et al. Impact of bio and mineral fertilizers on growth, yield and its components of roselle plants (Hibiscus sabdariffa, L.) grown under different types of soil. *Horticult Int J.* 2019;3(5):240–250. DOI: 10.15406/hij.2019.03.00138

Discussion

Uses of bio-fertilizers containing beneficial microorganisms instead of synthetic chemicals are known to improve plant growth through the supply of plant nutrients and may help to sustain environmental health and soil productivity. In addition, the shortage and high cost of chemical fertilizers and their environmental pollution have been focused attention on uses of bio-fertilizers. The beneficial effect of inoculation of roselle seeds with bio–N &P fertilizer combined with 25, 50 and 100% of the recommended N&P dose from the same nutrient as soil application, resulted in vigorous growth as well as highly productivity of plants with good quality. Moreover, the importance or the superiority for the applications of bio fertilizer was not only taken as a criterion for increasing the income for roselle crop or rationalize of costly mineral-N&P fertilizers, but also for minimizing the possibly adverse fears of both human health and environmental risks resulted from uncontrolled use of mineral-N fertilizers.[29] Thus supplying biological nitrogen fixing (BNF) for plant varieties need an excessive use mineral or chemical fertilizers, especially those of nitrogenous ones. Undoubtedly, the superiority of applied BNF bacteria is more attributed to the role of bacteria strains activity in decomposition of organic substances, which have ability to improve soil properties and, enhancing the released nutrients in mobile or available forms to uptake by plant roots.[30] An increase in each of growth characters (plant height, etc…) was due to many factors such as (a) its ability to release plant promoting substances (mainly IAA, gibberellic acid and cytokinin like substances) which might be stimulated plant growth,[31] (b) synthesis of some vitamins, e.g. B12,[32] (c) increasing the water and mineral uptake from the soil.[33] This could be ascribed to increase in root surface area, root hairs and root elongation as affected by Azotobacter,[34] (d) increasing the ability to convert N_2 to NH_4 and thus make it available to plant[35] and (e) enhancing the production of biologically active fungistatical substances which may change the microflora in the rhizosphere and affect the balance between harmful and beneficial organisms.[36] The increment in the studied growth characters might be attributed to the beneficial effect of bio fertilizers on the nutritional availability and its uptake. Numerous investigators explained the important role of bio fertilizers in reducing pH value by secreting organic acids such as acetic, propionic, fumaric and succinic acids, which brought about the dissolution of nutrients bound to organic materials and render them available for growing plants.[37] The positive effect of inoculation had marked influence on the growth of plant, which was reflected to increase yield. This increase might be due to the effect of N, which was produced by bacteria species, in addition of some growth regulators like IAA and GA_3 which stimulated growth. Some bacteria called Plant Growth Promoting Rhizobacteria (PGPR), stimulate plant growth.[38] The stimulatory effects of microorganisms may result from either direct or indirect action. Direct effects include production of phytohormones,[39] enhancement of availability of some minerals,[38] liberation of phosphates and micronutrients, nonsymbiotic nitrogen fixation and stimulation of disease-resistance mechanisms.[40] Indirect effects arise from (PGPR) altering the root environment and ecology.[41] For example, acting as biocontrol agents and reducing diseases, liberation of antibiotic substances that kill noxious bacteria.[40] In this respect,[35] suggested that addition of biofertilizer increase the ability to convert N_2 to NH_4, and thus make it available to plant. On the other hand, uses of bio-fertilizers combined with 50 and 100 % of the recommended N&P dose from the same nutrient as soil application, resulted in vigorous growth as well as highly productivity of plants with good quality. In many agricultural production systems, nitrogen (N) has been identified as the most deficient essential nutrient. Nutrient inputs into production systems have increased as a result of the need for high yielding crops to sustain the growing population around the world. The optimum dose of nitrogen is very important to obtain the high yield without luxury consumption of nutrients. Improving the nitrogen use efficiency is an economic and environmental request due to the continuous raising fertilizer prices and pollution of soil and water.[42] The present price hike of fertilizers is one of the main constraints to increase the economic yield of crops. Thus efforts are needed to minimize its losses and to enhance its economic use. An increasing the measured growth characters (plant height etc…) was due to that this fertilizer resulting in more availability of nitrogen to be absorbed by the tested plants. The positive effect of mineral-N fertilization on growth characters of plants may be attributed to the encourage role of nitrogen in protoplasm formation , proteins, amino acids, nucleic acids, many enzymes and energy transfer materials.[43] Nitrogen also accelerating both cell division and elongation due to its great action in stimulating nutritional status and the growth parameters. The improving effect of N as foliar application on yield and its components was mainly attributed to its positive action on enhancing growth parameters (Table 5). In this concern[44] concluded that applying N as soil application to wheat plants encouraged growth reproductive organs as well as wheat yield components and this in turn increased grain yield, this may due also to increase in green area intercepting solar radiation. This intern increases the amount of metabolites synthesized by plants.[45] So, the above mentioned results showed that it could be obtained the highest yield with saving about 50 % of mineral nitrogen (through application of bio N&P treatment) and avoiding its undesirable effects. Moreover, the increase of total carbohydrates concentrations in plants sprayed with N may be directly or indirectly due to that the certain enzymes may be activated the anabolic processes leading to the accumulation of these substances. Moreover the positive effect of phosphate dissolving bacteria on growth might be attributed to the effect of these bacteria to encourage plant to produce some growth promoting substances such as auxine , gibberellins and cytokinens[46] which may improve plant growth and stimulate microbial development in the rhizosphere,[47] and their positive action on mineralization and solubilization potential for organic and inorganic phosphorus, respectively.[48] It is well known that the beneficial effects of plant growth-promoting rhizobacteria are attributed to the production of diverse metabolites including siderophores, hydrocyanic acid (HCN), IAA and other associated activities such as good phosphate solubilization and competition in soil and root colonization.[41] Moreover, it was found that the application of phosphate dissolving bacteria as a biofertilizer resulted in a reduction of soil pH which increased the solubility of some nutrients such as P, Fe, Zn, Mn and Cu which in turn increased nutrient uptake by plants.[49]

Finally, from the present results, it could be concluded that the application of bio application of nitrogen and phosphorous greatly increased growth and yield as well as improved quality due to that, these element participate in the different metabolic processes which increased syntheses of carbohydrates and absorption of essential nutrient, so that the use of N&P as bio and soil application could be used for producing plants with high sufficient cellular solutes enable them to overcome salinity of soils, and consequently producing greatest yield with high quality of rosella plants.

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Conflicts of interests

Authors declare no conflict of interest exists.

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