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EFFECT OF BIO-ORGANIC FERTILIZERS ON THE CONTENT OF SOME MACRO-NUTRIENTS IN QUINOA PLANT AS WELL AS ITS PRODUCTIVITY AND QUALITY

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ABSTRACT

Sandy soil is a poor soil which has low of organic matter and nutrition. Not only soil productivity had constrained, but also the environmental deterioration and economic losses were getting worse and worse. Two field experiments were conducted over two consecutive winter seasons 2019-2020 and 2020-2021 in sandy soil of Agricultural Station ARC at Ismalia governorate, Egypt. The experiment was split plot design with three replicates.

The obtained results cleared that the compost and bio-fertilizers application combined with 75 kg fed^{-1} N + 150 kg fed^{-1} P_2O_5 + 50 kg fed^{-1} K_2O increased N, P and K concentrations and uptake in seeds of quinoa plants. The interaction between bio-fertilizers and compost combined with different rates of mineral fertilizers was significant for plant length (cm), weight of seeds /plant, weight of 1000 grains and weight of grains yield (ton fed^{-1}), while the No. of branches was not significant. The highest values of the protein (%), protein yield (kg fed^{-1}), carbohydrates (%), oil (%) and chlorophyll (mg g^{-1} f.w.) contents in quinoa were obtained with compost

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combined with mineral fertilizers at rate (75 N + 150 P_2O_5 + 50 K_2O kg fed^{-1}) as compared with other treatments.

It is recommended the use of integrated bio-fertilizers or compost combined with 75% of the recommended mineral fertilizers for production of quinoa plant grown up on sandy soils.

Key words: quinoa, productivity, macronutrients, quality, bio-fertilizers.

INTRODUCTION

Quinoa (*Chenopodium quinoa* Willd.) is a stress-tolerant plant, its grains have high-protein content with abundance of essential amino acids, and a wide range of vitamins, minerals and saponin and it is a promising worldwide plant for human consumption and nutrition. Quinoa grains have been harvested as 146.7 ton from 173.2 ha farming area with an average crop yield of 847 kg ha^{-1} (FAO 2017). Quinoa seeds (*Chenopodium quinoa*) are very nutritious. Seed contains highest protein content (approx. 14.6%) comparing with other cereals.

The starch content is approximately 60%. lipids in quinoa is about 8% of dry mass and total oil contains 54% of linoleic acid and 20% of oleic acid.

Quinoa is a good source of thiamine, folic acid and vitamin C but has lower content of niacin (B3) in comparison with other cereals. However, they can be mixed with wheat flour in the preparation of bread with high nutritional value (Mansour, 2019). Compost is rich source of nutrients with high organic matter content. Physical and chemical properties of soil can be improved by using compost, which may ultimately increase crop yields. So use of compost is the need of the time. Physical properties like bulk density, porosity, void ratio, water permeability and hydraulic conductivity were significantly improved when FYM (10 t ha^{-1}) was applied in combination with chemical amendments, resulting in enhanced rice and wheat yields in sodic soil (Hussain *et al.*, 2001). The applied cation of composts to soil enhances soil fertility and reduces environmental risk, improves soil texture, retains soil moisture, increases nutrients contents in the soil, stimulates biological activities, encourages vigorous plant rooting system, helps bind nutrients and prevents them from being leached out of the soil, (Chitravadivu *et al*., 2009). Application of compost to the soil had a decreased effect of soil salinity, where its application resulted in a significant increased on wheat yield and yield components i.e. weight of spike/plant (g), weight of grains/spikes (g), weight of 1000 grins (g), straw yield and grains yield (ton fed^{-1}) these increments in yield may be due to the positive effect of added compost on soil properties and fertility (Shaban *et al*., 2019). Compost application to soil increased available soil nutrients and their uptake by the plant. Also, the application of compost led to increase microbial activity, and to improve soil structure and water retention (Duong, 2013).

Soil microbes possess the ability to modify the rhizosphere and thus can ameliorate its deleterious effects on plant growth and development under stressful conditions. The use of Plant-Growth-Promoting Bacteria (PGPB) can be a key factor in reducing salinity stress in plants as they are already introduced in practice (Shilev, 2020).

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The bio-fertilizer and mineral fertilizer have an active role in applying the plant with the necessary nutrients and thus increasing the growth indicators of the plant like weight of grains due to the regularity work of plant hormones when the availability of nutrients K, P and N, which increased the division of cells and increased the number of branch tillers carrying flowering and fertile spikes. The increased vegetative growth of the plant also improves the exploitation of active rays of photosynthesis, especially at the beginning of growth season, which increases the availability of the anabolized substances in support of the emergence plant. Thus, 50% of the mineral fertilizer can be substituted with the biological fertilizer to reduce the risk of contamination and reduce the cost of mineral fertilizer (Kadhum *et al*., 2021). The greatest proportion of biological nitrogen in agricultural soils originates from the activity of symbiotic and free-living nitrogen fixing bacteria living in the relationship with plants. Consequently, it is very important to apply various measures in the plant creation that will increase the number of certain physiological, the total number of soil microorganisms and systematic groups of microorganisms.

Bio-fertilizer is eco-friendly approach for sustainable agriculture providing essential nutrients including N, P, K and antibiotics, hormones such as auxins, cytokinins and vitamins resulting in enrichment of the soil fertility and thus improvement crop productivity compared to other chemical fertilizers as continuous application of these chemicals causes reduction of both soil organic matter content and microbial activity. *Azotobacter* sp. abundance in the soil is a good indicator of all toxicological and degradational changes in the soil (Dawwam *et al*., 2013). The addition of organic amendments increased plant growth, height, fresh biomass, and grain yield in quinoa. The combined use of compost and bio-fertilizer has a significant impact when compared to bio-fertilizer application alone (Gill et al., 2020). The aim of this work was to evaluate the effect of bio-fertilizers and compost application alone or combined with mineral fertilization (NPK) at different rates on productivity and quality of quinoa.

MATERIAL AND METHODS

Two field experiments were carried out in sandy soil of Agriculture Station at Ismalia governorate, ARC, Egypt, during two successive winter seasons 2019/2020 and 2020/2021 to study the effect of organic and bio-fertilizer alone or combined by mineral nitrogen levels on some soil fertility and quinoa (*Chenopodium quinoa*) productivity. The mean values of physical and chemical properties of the soil before planting were determined according to the methods described by (Kulte, 1986), (Page *et al*. 1982) and (Cottenie *et al*. 1982). The obtained data were recorded in Table (1).

Vol. (51); Iss. (1); No. (7); Jan. 2022
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Table (1): Some physical and chemical properties of the used soil before quinoa planting

Sand (%)		**Silt (%)**	**Clay (%)**	**Texture**		**O.M (%)**		**$CaCO_3$ (%)**
88.32		4.56	7.12	Sand		0.57		1.68
pH (1:2.5)	**EC ($dS\ m^{-1}$) in soil past**	**Soluble Cations ($meq\ L^{-1}$)**				**Soluble Anions ($meq\ L^{-1}$)**		
		Ca^{+2}	**Mg^{+2}**	**Na^{+}**	**K^{+}**	**HCO^{-}_{3}**	**Cl^{-}**	**SO^{-2}_{4}**
7.89	1.28	4.55	2.88	4.48	0.87	2.36	5.30	5.14
Available macronutrients ($mg\ kg^{-1}$)			**Available micronutrients ($mg\ kg^{-1}$)**					
N	**P**	**K**	**Fe**			**Mn**	**Zn**	
32.50	4.29	185	1.65			0.65	0.55	

The experiment was carried out in split plot with three replicates. The organic and bio-fertilizers were main plot and mineral nitrogen rates were sub main plot. The compost analysis was done according to the standard methods, as described by (Brunner and Wasmer, 1978).

Table (2): Chemical composition of the compost used in the experiment

EC ($dS\ m^{1}$) (1:5) (Manure: water extr.)	**pH (1:10) ((Manure: water sus.)**	**Moister (%)**	**Bulk density ($kg\ m^{3}$)**	**Water holding capacity (%)**	**O.M (%)**	**O.C (%)**	**C/N ratio**	**Total nutrients (%)**		
								N	**P**	**K**
2.76	7. 50	25	650	160	40.5	25	16.6	1.50	0.88	2.14

EC: Electrical conductivity; O.M: Organic matter;
O.C: Organic carbon; C\N: Carbon/Nitrogen ratio

The area of each experimental unit plot was 10 m length X 5 m width. All farming processes were carried out before planting. On the other hand, the application of compost rate was 5 ton fed^{-1} before 20 days from sowing. Calcium super phosphate (15.5% P_2O_5) was applied at rate 200, 150 and 100 kg fed^{-1} during tillage soil. The experimental plot unite was 50 matter (50*10m).

Azotobacter sp., *Bacillus megaterium*, *bacillus citculans* (PGPR) was applied by coating grains with the gum media carrying the bacteria strain on the same day of sowing. The inoculated grains plots were applied to soil with liquid bacteria strain three times after: 21, 42 and 62 days of planting, as described by Shaban and Omar (2006). The grains of quinoa were obtained from Crop Institute Agriculture Research Center Giza, Egypt. Sowing of quinoa grains (*Chenopodium quinoa*) was on November 2019 and 2020. Two to three of coated grains were sown in hole with 3 cm depth. The distance between each two holes was 15 cm.

After 30 days of sowing, the plants of each hole were thinned to one plant. Urea (46% N) was applied as N fertilizer at rates 100, 75 and 50 kg fed^{1} on three equal doses after 31, 45 and 65 days from planting.

Potassium sulfate (48% K_2O) was applied at rate of 75, 40 and 20 kg fed^{1} on two equal doses after 31, 50 days from quinoa planting. Plant samples of three replicates were taken after 75 days from sowing. Samples of each experiment plot were prepared for some vegetative growth parameters and some physiological determination.

Plant analysis: 0.5 g of each oven dried ground plant sample was digested using H_2SO_4, $HClO_4$ mixture according to the method described by Chapman and Pratt (1961). The plant content of N, P, K, Fe, Mn, Zn and Cu was determined in plant digestion using the methods described by Cottenie *et al.* (1982) and Page *et al*. (1982). Oil seed content was determined using Soxhlet method (AOAC, 1990). Protein percentage of seeds was calculated by multiplying the nitrogen percentage by the factor 5.75. The obtained data were statistically analysis seed using the COSTAT program and L.S.D. test at the probability levels of 5% according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Macronutrients concentrations and uptake in seeds of quinoa:

Data in Table (3) shows that the application of compost and bio-fertilizers with or without mineral NPK fertilizers to sandy soil increased N, P and K concentrations and uptake in seeds of quinoa plants. The highest values of N, P and K concentration and uptake in seeds were obtained with compost combined with (75 +150 + 50 NPK kg fed^{-1}) fertilization as compared to other treatments. All treatments (compost, bio-fertilizers, mineral fertilizers) were significant for K concentration, while the N, P concentrations and N, P and K uptake were not significant.

The application of different rates of mineral fertilizers (NPK) gave significant increase of N, P and K concentrations and uptake in seeds of quinoa plants. Also, the interaction between applied compost and bio-fertilizers combined with or without different rates of mineral fertilizations was significant. On the other hand, the relative increases of mean values were 10.66% for N, 21.43% for P and 27.59% for K concentration in seeds and 54.78% for N, 50.00% for P and 54.78% for K uptake in seeds respectively as affected with application of compost alone as compared without mineral fertilizers. As well as, the relative increases of mean values were 9.02% for N, 28.57% for P and 20.65% for K concentrations in seeds respectively and 35.65% for N, 40.91% for P and 29.57% for K uptake in seeds respectively as affected with bio-fertilizers alone.

Gomaa (2013) showed that the application of nitrogen and phosphate fertilization combined with bio-fertilizers led to increase of N, P and K contents in seeds of quinoa plant compared with control.

Table (3): Macronutrients concentration and uptake in seeds quinoa

Treatments	Macronutrients Concentrations			Macronutrients uptake		
	N%	P%	K%	N-uptake	P-uptake	K-uptake
Fertilizer type						
Control	1.96	0.38	1.86	29.19	5.37	22.87
Compost	2.50	0.46	2.70	47.70	8.56	50.37
Bio-fertilizers	3.35	0.46	2.55	40.15	7.12	41.89
LSD5%	NS	0.05	0.11	0.49	0.15	6.80
Mineral N + P + K rates (kg fed^{-1})						
0+0+0	1.34	0.34	1.69	14.94	3.01	14.73
50+100+25	2.44	0.40	2.47	39.85	6.40	41.02
75+150+50	3.89	0.48	2.58	49.61	9.26	42.82
100+200+75	2.73	0.51	2.74	51.66	9.39	54.91
LSD5%	0.89	NS	0.12	0.34	0.13	5.93
Interaction						
Control X 0+0+0	1.22	0.27	1.44	11.50	2.23	11.50
Control X 50+100+25	1.91	0.35	1.72	26.66	4.90	24.27
Control X 75+150+50	2.23	0.42	1.82	35.88	6.47	12.23
Control X 100+200+75	2.47	0.46	2.47	42.71	7.89	43.46
Compost X 0+0+0	1.41	0.36	1.82	17.84	3.40	17.84
Compost X 50+100+25	2.80	0.46	2.86	50.52	7.90	53.40
Compost X 75+150+50	2.91	0.50	3.08	60.54	11.54	62.84
Compost X 100+200+75	2.88	0.50	3.05	61.90	11.40	67.38
Bio-fertilizers X 0+0+0	1.40	0.39	1.82	15.47	3.41	14.86
Bio-fertilizers X 50+100+25	2.61	0.39	2.82	42.38	6.40	45.40
Bio-fertilizers X 75+150+50	6.53	0.51	2.86	52.40	9.79	53.38
Bio-fertilizers X 100+200+75	2.86	0.56	2.71	50.36	8.89	53.90
LSD5%	1.55	NS	0.21	0.59	0.23	10.27

Vol. (51); Iss. (1); No. (7); Jan. 2022
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Cocking (2003) indicated that nitrogen-fixing bacteria is able to enter into roots from the rhizosphere, particularly at the base of emerging lateral roots, between epidermal cells and through root hairs.

Azorhizobium caulinodans is known to enter the root system of cereal and Arabidopsis, by intercellular invasion between epidermal cells and to internally colonize the plant intercellularly, including the xylem. This raises the possibility that xylem colonization might provide a non-nodular niche for endosymbiotic nitrogen fixation in maize.

Bio-fertilizers and compost fertilizations combined with or without mineral fertilizers on quinoa productivity:

Data presented in Table (4) showed the increase of yield components of quinoa plants, i.e. plant length (cm), no. of branches, weight of seeds /plant, weight of 1000 grains and grains yield (ton fed^{-1}) as affected with all treatments specially soil treated with compost combined with mineral fertilizers. The effect of all treatments were significant of weight 1000 grains quinoa plants while the plant length (cm), no. of branches, weight of seeds/plant, and grains yield (ton fed^{-1}) were not significant.

The mineral fertilizers at different rates were significant for plant length (cm), weight of seeds /plant and weight of 1000 grains, while the no. of branches and grains yield (ton fed^{-1}) were not significant. The interaction between treatments and different rates of mineral fertilizers were significant for plant length (cm), weight of seeds /plant, weight of 1000 grains and weight of grains yield (ton fed^{-1}), while the no. of branches was not significant.

Table (4): Yield and yield component of quinoa after harvest

Treatments	**Plant length (cm)**	**No. of branches**	**Weight of seeds g/plant**	**Weight of 1000 seeds (g)**	**Weight seeds yield (ton fed^{-1})**
Fertilizer type					
Control	79.23	4.63	74.65	4.49	1.40
Compost	84.14	5.83	84.52	5.41	1.79
Bio-fertilizers	68.12	6.00	64.61	5.25	1.52
LSD5%	NS	0.27	NS	0.24	0.27
Mineral N + P + K rates (kg fed^{-1})					
0+0+0	67.01	4.63	51.85	4.17	0.85
50+100+25	82.05	5.30	79.44	5.10	1.69
75+150+50	86.72	5.85	73.32	5.39	1.84
100+200+75	72.87	6.16	93.76	5.55	1.90
LSD5%	13.35	0.20	12.69	0.17	0.19
Interaction					
Control X 0+0+0	65.67	3.67	40.85	3.69	0.79
Control X 50+100+25	77.36	4.52	77.54	4.52	1.42
Control X 75+150+50	85.37	4.80	89.39	4.85	1.63
Control X 100+200+75	88.53	5.52	90.84	4.90	1.77
Compost X 0+0+0	68.45	4.71	58.86	4.54	0.93
Compost X 50+100+25	85.40	5.71	88.40	5.36	1.89
Compost X 75+150+50	89.40	6.40	93.86	5.84	2.10
Compost X 100+200+75	93.29	6.50	96.95	5.90	2.23
Bio-fertilizers X 0+0+0	66.92	5.50	55.85	4.29	0.82
Bio-fertilizers X 50+100+25	83.40	5.68	72.38	5.42	1.77
Bio-fertilizers X 75+150+50	85.39	6.36	36.71	5.47	1.80
Bio-fertilizers X 100+200+75	36.79	6.47	93.50	5.84	1.71
LSD5%	23.12	0.34	21.98	NS	NS

The relative increases of mean values of plant length (cm), no. of branches, weight of seeds /plant, weight of 1000 grains and grains yield (ton fed^{-1}) were 27.44, 34.33, 110.10, 30.68 and 100.00% respectively as affected with mineral fertilizers with different rates as compared without mineral fertilizers. Also, the relative increases of mean values were 27.87% for plant length (cm), 58.04% for no. of branches, 106.85% for weight of seeds /plant, 46.85% for weight of 1000 grains and 124.05 for grains yield (ton fed^{-1}) respectively, as affected with compost alone or combined with different mineral fertilizers compared without mineral fertilizers. As well as, the relative increases of mean values were 24.34, 61.31, 99.00, 43.84 and 92.41% for values plant length (cm), no. of branches, weight of seeds /plant, weight of 1000 grains and grains yield (ton fed^{-1}) respectively, as affected with bio-fertilizers alone or combined mineral fertilizers at different rates as compared without mineral fertilizers. It is worthy to mention that the superiority of quinoa productivity could be arranged as follows:

Compost > mineral > bio-fertilizers > without mineral for plant length (cm) and grains yield (ton fed^{-1}),

Bio-fertilizers > compost > mineral fertilizers > without mineral fertilizers for No. of branches.

Mineral fertilizers > compost > bio-fertilizers > without mineral fertilizers for weight of seeds /plant (g).

Compost > bio-fertilizers > mineral fertilizers > without mineral fertilizers for weight 1000 grains (g).

Bilalis *et al*. (2012) found that the application of compost increased yield quinoa by10%. The yields and components of quinoa plants increased with increasing soil application of compost in comparison with those without application (Fawy *et al*., 2017). Kadhum *et al*. (2021) suggested that the used of bio-fertilizer and mineral fertilizer have an active role in supplying the plant with the necessary nutrients and thus increasing the growth indicators of the plant like weight of grains due to the regularity work of plant hormones when the availability of nutrients K, P and N, which increased the division of cells and increased the number of branch tillers carrying flowering and fertile spikes. The increased vegetative growth of the plant also improves the exploitation of active rays of photosynthesis, especially at the beginning of growth season, which increases the availability of the anabolized substances in support of the emergence plant. The increase of yield components of quinoa plants as affected with bacterial in inoculated compared by without bio-fertilizers treatments may be attributed to the roots excretion of saccharides, organic and amino acids, vitamins, and other substances which stimulate microorganisms as they are the power source to increase their populations. Gomaa (2013) indicated that the bio-fertilizers produce plant growth hormones such as indole acetic acid, gibberellins and cytokinins. The combined inoculation with *Azospirillum brasilense* and *Azotobacter*

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chroococcum and application of chemical fertilizers saved about 60% of recommended mineral nitrogen and phosphate application.

Quinoa quality: Table (5) showed the protein (%), protein yield (kg fed^{-1}), carbohydrates (%), oil (%) and chlorophyll (mg g^{-1} f.w.) contents in quinoa.

Table (5): Quality of quinoa after harvest

Treatments	Protein (%)	Protein yield (kg fed^{1})	Total chlorophyll (mg g^{-1} f.w.)	Carbohydrate (%)	Oil %
Fertilizer type					
Control	11.30	16.54	4.68	64.30	7.68
Compost	11.68	26.47	5.70	72.96	8.66
Bio-fertilizers	13.84	24.94	5.55	70.20	8.51
LSD5%	NS	0.23	0.38	1.13	0.63
Mineral N + P + K rates (kg fed^{-1})					
0+0+0	7.61	6.56	4.32	56.76	7.22
50+100+25	13.70	22.75	5.20	70.49	8.03
75+150+50	12.05	28.29	5.75	73.60	8.71
100+200+75	15.74	33.00	5.98	75.76	9.18
LSD5%	2.53	0.18	0.35	0.57	0.52
Interaction					
Control X 0+0+0	7.17	5.61	3.75	54.47	6.55
Control X 50+100+25	10.96	15.42	4.85	65.44	7.86
Control X 75+150+50	12.84	20.53	4.92	67.00	7.86
Control X 100+200+75	14.24	24.61	5.18	70.29	8.46
Compost X 0+0+0	7.89	7.47	4.59	59.45	7.71
Compost X 50+100+25	15.42	28.47	5.36	74.39	7.85
Compost X 75+150+50	6.86	34.47	6.46	78.46	9.40
Compost X 100+200+75	16.54	35.47	6.40	79.54	9.67
Bio-fertilizers X 0+0+0	7.77	6.60	4.61	56.36	7.39
Bio-fertilizers X 50+100+25	14.72	24.35	5.38	71.64	8.39
Bio-fertilizers X 75+150+50	16.45	29.89	5.86	75.33	8.86
Bio-fertilizers X100+200+75	16.43	38.93	6.36	77.46	9.42
LSD5%	4.37	0.31	NS	0.99	NS

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All contents increased with compost and bio-fertilizers combined with mineral fertilizers at different rates (75 N +150 P_2O_5 + 50 K_2O kg fed^{-1}) as compared with mineral fertilizers of different rates.

The protein yield contents in quinoa gave significant increase as affected by all treatments, while the different rates of mineral fertilizers and combination with compost and bio-fertilizers were significantly increased for protein (%), protein yield (kg fed^{-1}), carbohydrates (%), oil (%) and chlorophyll (mg g^{-1} f.w.) contents in quinoa. The highest values of the protein (%), protein yield (kg fed^{-1}), carbohydrates (%), oil (%) and chlorophyll (mg g^{-1} f.w.) contents in quinoa were obtained with compost combined with mineral fertilizers at different rates (75 N +150 P_2O_5 + 50 K_2O kg fed^{-1}) than other treatments.

The corresponding relative increases of mean values of the protein (%), protein yield (kg fed^{-1}), carbohydrates (%), chlorophyll (mg g^{-1} f.w.) and oil (%) contents in quinoa were 79.63, 262.88, 33.07, 24.78 and 23.55% respectively as affected by different rates of mineral fertilizers as compared without mineral fertilizers; while the 109.02, 353.42, 28.39, 30.44 and 20.52% respectively were obtained with compost combined with different rates of mineral fertilizations as compared with compost alone; As well as, 107.19, 326.00, 27.25, 35.55 and 18.93% respectively, as affected with bio-fertilizers combined by mineral fertilizers than bio-fertilizers alone.

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It is worthy to mention that the superiority of quinoa productivity could be arranged as follows: Compost > bio-fertilizers > mineral fertilizers for the protein (%), protein yield (kg fed^{-1}), carbohydrates (%) and chlorophyll (mg g^{-1} f.w.) contents in quinoa. Mineral fertilizers > compost > bio-fertilizers for oil contents (%).

El-Gamal *et al*. (2020) found that the protein % in seeds of quinoa plants and recorded the highest value (15.75 and 39.06%) in sandy soil compared with control as affected with compost and bio-fertilizers combined with mineral fertilizers. This could be due to better availability of desired and required nutrients in the crop root zone resulting from its solubilization caused by the organic acids produced from the decaying of organic matter and also the increased uptake by quinoa root due to increased availability of nutrients in root zone.

Panayiota *et al*. (2014) found that the application of compost to soil led to higher values of crude protein content in quinoa compared with the other fertilization treatments.

Sakr *et al.* (2014) reported that, compost fertilization treatments, significantly enhanced the seed oil percentage and seed oil yield/plant), and chemical composition of leaves (total chlorophylls, carotenoids and total carbohydrates contents than control. Gomaa (2013) reported that the application of nitrogen and phosphorus increased crude protein and nutrients content in quinoa seeds.

CONCLUSION

The results of this study revealed that the growth characters, seed yield and seeds quality of quinoa plant grown on sandy soil, can be improved by the application of some effective, safe and low cost treatments including bio-fertilizers and compost so that we can use 75 kg ammonium nitrate /fed. plus 150. kg calcium super phosphate /fed. Plus 50 kg fed^{-1} potassium sulfate plus three types of bio-fertilizers. These levels are more safe in quinoa production and economic too. Using bio-fertilizers can minimize the total amount of the mineral fertilizer and its harmful effect on the environment.

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تأثيرالاسمدة الحيوية والعضوية على محتوى نبات الكينوا من بعض العناصر الغذائية الكبرى وانتاجيته وجودته

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المستخلص

الكينوا نبات يتحمل الاجهاد وتحتوى حبوبه على نسبة كبيرة من البروتين مع زياده فى الاحماض الأمينية الاساسية وتحتوى ايضا على الفيتامينات والمعادن والسابونين وهو نبات مفيد للغذاء البشرى. الهدف من الدراسة هو تقيم تأثير التسميد المتكامل من الاسمده الحيوية (NPK) واضافة الكمبوست بمفردهم او متحدين مع معدلات من التسميد المعدنى المتكامل (NPK) على محتوى العناصر الكبرى والانتاجية وكذلك جودة محصول الكينوا. اجريت تجربتين حقليتين بمحطه البحوث الزراعية بالاسماعلية فى الموسم الشتوى ٢٠١٩/٢٠٢٠ و ٢٠٢٠/٢٠٢١ فى ارض رملية. كان التصميم الاحصائى للتجربة منشقة مرة واحدة وثلاث مكررات.

اوضحت النتائج المتحصل عليها ان استخدام الكمبوست والاسمدة الحيوية متحد او غير متحد مع معدلات مختلفة من التسميد المعدنى (٧٥ + ١٥٠ + ٥٠ كجم/فدان) نتروجين – فوسفور – بوتاسيوم على التوالى أدي الي زيادة تركيز وامتصاص العناصر الكبرى N, P and K فى بذور الكينوا. من ناحية اخرى زاد كل من طول النبات (سم)، وزن البذور /نبات (جم)، وزن ١٠٠٠ حبة (جم) ووزن الحبوب (طن/فدان) زياده معنوية نتيجة اضافة التسميد الحيوى والكمبوست متحدين مع معدلات مختلفة من التسميد المعدنى، بينما كان عدد الافرع غير معنوى. زادت نسبة البروتين (%) ومحصول البروتين (كجم/فدان) والنسبة المئوية للكربوهيدات والزيت ومحتوى الكلوروفيل (مللجرام/جرام ماده خضرة) نتيجة تاثرها باضافة الاسمدة المعدنية (٧٥ + ١٥٠ + ٥٠ كجم/فدان) نتروجين – فوسفور – بوتاسيوم على التوالى بالمقارنة بالمعاملات الاخرى المدروسة.

نوصى باستخدام الاسمدة الحيوية المتكاملة او الكمبوست متحدين بنسبة ٧٥% من التسميد المعدنى الموصى به للكينوا تحت ظروف الاراضى الرملية.

الكلمات الدالة: الكينوا، الانتاجية، التسميد، الجودة.