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Influence of Nitrogen Sources and Levels Along with Different Levels of Compost on Quinoa (Chenopedium Quinoa Willd.) Productivity Grown in Newly Reclaimed Soils

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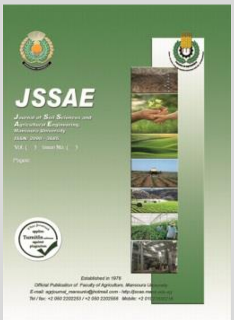

ABSTRACT

Two field experiments were performed during season of 2017 and 2018 at a private farm in newly reclaimed land, Village No 8, El-Minia Governorate, Egypt, to assess the effect of different nitrogen sources [ammonium sulphate, (AS) and ammonium nitrate,(AN) fertilizers] and levels (60 and 90 kg N/fed) as well as different compost levels (5, 10 and 15 t/fed) on growth parameters of quinoa plant, i.e. plant height, dry weight/plant and number of leaves/plant; yield components (number of panciles/plant, 1000-grain weight and grain yield/plant; yield parameters (grain, straw and biological yield); and N, P and K concentration and uptake in both grains and straw as well as nitrogen utilization efficiency (NUtE). The experimental design was a split-split plot design, where compost levels were allocated in main plots and nitrogen sources were arranged in sub plots, while nitrogen levels were applied in sub-sub plots. The results show that all studied growth parameters, yield and yield components as well as N, P and K concentrations and uptake in grains and straw were positively responded to increasing nitrogen and compost levels, except P concentration in grains and straw in both seasons and K concentration in grains in the second season only which did not affect by nitrogen levels. Nitrogen sources were significantly effected the abovementioned traits, except 1000-grain weight and nitrogen concentration in both grains and straw, which the effect of AS fertilizer was more pronounced than AN form. Nitrogen utilization efficiency was negatively affected by compost and nitrogen levels, while nitrogen source was not affect this trait. Combined 15 t/fed compost with 60 kg N/fed had statistically effect on quinoa productivity equal to the effect of 90 kg N/fed.

Keywords: nitrogen sources, levels, quinoa plant, newly reclaimed soils, growth parameters, yield and yield components.

INTRODUCTION

Quinoa (Chenopedium quinoa willd) is a pseudo cereal crop which cultivated in Indian region since thousands years age (Bhargava *et al* 2006). Its grain contain high nutritional value, such as essential amino acids, high protein content (about 15%) which free gluten, important mineral and vitamins, polyphenols and phytosterols (Abugoch James, 2009), and saponins, which constituent of glocosidic triterpenoids with about 80% glucose (Bhargava *et al* 2006). Moreover, Jancurova *et al* (2009) reported that quinoa contain high lysine value as well as Mg, Fe, Mn and vitamin B_2 which important for growth development, metabolism and enzymes functions in plant. In addition, Valencia-Chamorro (2003) mentioned that the quinoa protein improved the human immune system and help in protection from various diseases such as cancer.

Egyptian total area is about one million square kilometer, which most of them is under arid and hyper-arid conditions, therefore, only about 3 percentage is cultivated (El-Ramady *et al* 2013). Quinoa plants can resist the various adverse factors, therefore, Egyptian Ministry of Agricultural encourage the planting quinoa in newly reclaimed land (Adel, 2020). The extent in quinoa cultivation may be reduce the countrỳs dependence on wheat imports. The moderate management resulted in quite low yield of quinoa, while it can be maximized by using proper management such as irrigation, fertilization, organic manure application…….etc (Wang *et al* 2020).

Nitrogen is the most important macronutrients, which it is a major components of various plant substances, such as it comprise from 40 to 50% of the dry matter of protoplasm, amino acids which consider the building blocks of protein, chlorophyll formation (Roy *et al* 2006). Therefore, nitrogen consider the major nutrient for rapid plant growth. Amino acids and proteins formed only from ammonium cation, so nitrate anion must be reduced. Huner and Hopkines (2008) reported that nitrogen transported from roots to plant leaves as NO_3^- or as organic forms, such as amids or amino acids. Many workers have been proved the beneficial effects of nitrogen on quinoa yield such as Fawy *et al* (2017), Kansomjet *et al* (2017), Mahmoud and Sallam (2017), Kakabouki *et al* (2018) and Wang *et al* (2020).

Compost have been widely used in agricultural production at the last years to improve soil properties and fertility, which in turn increased crop growth and productivity. Sadik *et al* (2009) reported that the decomposition of compost in soil resulted in produce organic acids, which have beneficial effect on increasing nutrient availability, beside it supply the plants with various nutrients such as nitrogen, phosphorus and micronutrients. They added that compost increased agricultural productivity, improving soil the activity of microorganisms as well as improving the environmental

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conditions and reducing the ecological risks, especially in sandy soil. Bilalis *et al* (2012), Hirich *et al* (2014), Kakabouki *et al* (2018) and Adel (2020) stated the positive effect of compost application on quality and quantity of quinoa plants.

This study aimed to investigate the response of the quality and quantity of quinoa plants grown in newly reclaimed land to nitrogen sources and levels as well as compost application.

MATERIALS AND METHODS

Two field experiments were conducted at a private farm located in Village No 8 in newly reclaimed land, Minia Governorate, Egypt in two successive seasons of 2017 and 2018 to evaluate the effect of different sources and levels of nitrogen under different levels of compost on quinoa production grown in sand soil. The experimental design was a split-split design in a complete randomized blocks in four replications. The compost levels (5, 10 and 15 t/fed) were located in the main plots, while nitrogen sources (ammonium nitrate, 33.5% N and ammonium sulphate, 20.5% N) were arranged in sub plots. The nitrogen levels (60.0 and 90.0 kg N/fed) were applied in sub-sub plots. The soil was sand in texture, with pH 7.8 and 7.9, EC 2.0 and 2.1, dsm^{-1} and organic matter 0.25 and 0.27% as well as available N 2.1 and 2.7, available P 3.5 and 2.7, and available K 35.1 and 31.2 mg kg^{-1} in both seasons, respectively (according to A.O.A. C,1995).

The chemical composition of the used compost (according to A.O.A. C, 1995) are listed in Table (1).

Table 1. Chemical composition of used compost.

	pH*	EC,dSm^{-1}**	Organic carbon (%)	Organic matter (%)	N%	P%	K%	C:N ratio
2017	8.11	3.62	22.25	38.36	1.52	0.48	1.34	1:15
2018	8.06	3.41	21.86	37.69	1.46	0.50	1.40	1:15

*** in 1:15 compost-water suspension** **** in 1:15 compost-water extraction**

Compost treatments were added before planting during land preparation, while nitrogen treatments were done at equal four doses, the first after thinning and the others after every 15 days later. All treatments received 15.5 kg/fed P2O5 as superphosphate and 24.0 kg/fed K2O as potassium sulphate. Other cultural practices for quinoa production were done as in district.

The grains of quinoa, variety Misr1 (obtained from Agricultural Research Center, Giza, Egypt) were sown at 20 and 25 November in both seasons, respectively in plots (21 m^2). Each plot had ten rows (each row was 6 m^2 long and 3.5 m width). The space between rows were 60 cm and the distance between hills in the row was 20 cm, where lot of seeds were sown in the hill. At harvest (about 120 days) ten plant samples were collected from each plot to measure, growth parameters (plant height, dry weight/plant and number of leaves/plant), yield components (number of panciles/plant, 1000-seed weight (g) and seed yield/plant (g), and yield parameters (grain, straw and biological yields, t/fed). Also, samples from seeds and straw were taken to determine nitrogen, phosphorus and potassium concentration (according to Chapman and Pratt, 1978) and converted to N, P and K uptake, as the following equation:

Nutrient uptake = Nutrient concentration × grains or straw yield

Nitrogen utilization efficiency (NUtE):

The nitrogen utilization efficiency as kg quinoa seeds/kg total absorbed nitrogen was calculated for each treatment as the following formula:

NUtE (kg seed / kg absorbed) = grain yield (kg/fed) / total nitrogen uptake (kg/fed).

The data were subjected to the statistical analysis according to Snedecor and Cochran (1980). L.S.D. values at 0.05 levels were used to compare the differences between means.

RESULTS AND DISCUSSION

Growth parameters

Table 2 clearly show that increasing the level of compost was gradually and significantly increased quinoa plant height, dry weight/plant and number of leaves/plant. Application of 15 t/fed compost increased these parameters by about 23.0, 25.6 and 27.0 % in comparison with 5 t/fed compost treatment respectively in the first season. similar trends were obtained in the second season. The positive effect of compost on growth parameters may be due to, 1- direct effects such as feeding plants with available nutrients, improving soil fertility and quality, increasing soil organic matter, and acting as soil conditioners and 2- indirect effect, by enhancing microorganisms that improving various nutrient availability such as P, S, Mn and micronutrients, also, compost contains various microorganisms that exert many substances and metabolites which act as phytohormones and promoting plant growth (Marschner *et al* 2012). These results are in line with those obtained by El Sabei *et al* (2016) and Adel (2020).

As for nitrogen sources, the data show that growth parameters of quinoa were significantly affected by nitrogen fertilizer forms. Ammonium sulphate (AS) fertilizer had tallest plant height, heaviest dry weight/plant and greatest number of leaves/plant than ammonium nitrate (AN). The superiority of AS fertilizer is mainly due to its physiologically acidic is more efficient than ammonium nitrate, especially in newly reclaimed land which contain high calcium carbonate (Ozturk, 2010). Similar results were obtained by Sarhan and Ismail (2003) for fodder beet plants and Ismail *et al* (2006) for maize plants who reported the superiority of ammonium sulphate than ammonium nitrate in its effect in plant grown in alkaline conditions.

The data reveal that nitrogen levels was significantly affected growth parameters of quinoa. Added 90 kg N/fed increased plant height, dry weight/plant and number of leaves/plant over 60 kg N/fed by about 6.1, 8.4 and 6.5 in the first season and 7.4, 10.1 and 8.8% in the second one, respectively. The increment of growth parameters caused by increasing nitrogen level could be explained by the fact that nitrogen is the important nutrient for chlorophyll formation, which convert the light energy to chemical energy of photosynthetic organs (Zhao *et al* 2005). In this concern, Daughtry *et al* (2000) mentioned that more chlorophyll enhanced photosynthetic active leaf area resulted in better assimilation, in turn improve growth development. These results agree with those obtained by Geren (2015) and Kansomjet *et al* (2017) who stated that increasing nitrogen levels increased growth parameters of quinoa

Table 2. Effect of nitrogen sources and levels under different levels of compost on growth parameters of quinoa plants.

Compost t/fed (A)	Nitrogen sources (B)	Nitrogen levels (kg/fed) (C)																	
		Plant height (cm)						Dry weight/plant (g)						No. of leaves/plant					
		2017			2018			2017			2018			2017			2018		
		60	90	mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean
	AN	31.3	36.6	34.0	34.2	39.1	36.7	22.6	26.7	24.7	26.5	30.5	28.5	109.2	124.1	116.7	112.9	131.5	122.2
5.0	AS	35.5	39.1	37.3	38.7	42.2	40.5	25.3	28.5	26.9	27.5	31.6	29.6	116.5	136.2	126.4	121.2	142.6	131.9
mean		33.4	37.9	35.6	36.5	40.7	38.6	24.0	27.6	25.8	27.0	31.1	29.0	112.9	130.2	121.6	117.1	137.1	127.1
	AN	38.9	41.2	40.1	41.6	46.5	44.1	28.3	31.6	30.0	32.0	36.2	34.1	134.6	142.5	138.6	137.7	149.6	145.7
10.0	AS	42.2	45.3	43.8	45.3	48.1	46.7	30.7	33.2	32.0	33.8	37.6	35.7	147.1	156.9	152.0	141.3	159.2	150.3
mean		40.6	43.3	41.9	43.5	47.3	45.4	29.5	32.4	31.0	32.9	36.9	34.9	140.9	149.7	145.3	139.5	156.4	148.0
	AN	41.8	41.9	41.9	44.6	46.7	45.7	30.6	31.9	31.3	35.8	36.5	35.2	145.1	145.7	145.4	153.7	154.1	153.9
15.0	AS	45.6	45.7	45.7	48.1	48.3	48.2	33.7	33.4	33.6	37.1	37.3	37.2	157.3	157.2	157.3	160.2	160.5	160.4
mean		43.7	43.8	43.8	46.4	47.5	46.9	32.2	32.7	32.4	35.5	36.9	36.2	151.2	151.5	154.4	157.8	157.3	157.6
mean of	AN	37.3	39.9	38.7	40.1	44.1	42.2	27.2	30.1	28.7	31.4	34.4	32.6	129.6	137.4	133.5	134.8	145.1	140.0
sources	AS	41.1	43.4	42.3	44	46.2	45.1	29.9	31.7	30.8	32.8	35.5	34.2	140.3	150.1	145.5	140.9	154.1	147.5
mean of	60		39.2			42.1			28.5			31.8			135.0			138.1	
levels	90		41.6			45.2			30.9			35.0			143.8			150.3	
L.S.D at 0.05																			
A			1.72			1.78			1.01			1.08			7.25			7.02	
B			1.45			1.61			0.95			1.01			6.04			5.36	
C			1.02			1.13			0.91			0.96			6.01			5.12	
AB			N.S			N.S			N.S			N.S			N.S			N.S	
AC			1.92			1.96			1.35			1.39			9.11			8.31	
BC			N.S			N.S			N.S			N.S			N.S			N.S	
ABC			N.S			N.S			N.S			N.S			N.S			N.S	

The data of the interaction reveal that the growth parameters of quinoa were responded to the interaction between compost and nitrogen level treatments, where the differences between the effects of added 60 kg N/fed on growth parameters were statistically equal to the effect of added 90 kg N/fed under the highest level of compost (15 t/fed). These results may be due to highest levels of compost contain nitrogen, which beside 60 kg N/fed is enough to the requirement of quinoa plants from nitrogen. In general, the highest growth parameters of quinoa were achieved for the treatment of 15 t/fed compost + 60 or 90 kg N/fed as ammonium sulphate fertilizer. On the other hand, the treatment of 5 t/fed compost + 60 kg N/fed as ammonium nitrate exhibited the lowest ones.

Yield components

The data in Table 3 reveal that number of panciles/plant, 1000-seed weight and seed yield/plant were significantly responded to compost application. The increasing of compost levels were gradually increased the quinoa yield components in both seasons. Added 15 t/fed compost resulted in increases in these parameters by about 67.7, 20.0 and 29.2 % over 5 t/fed compost, respectively in the first season. similar trends were obtained in the second season. The promotive effect of compost on yield components of quinoa is mainly due to its effect on quinoa growth as mentioned before (Table 2). Also, Ramzani (2017) reported that association of compost led to reduce the pH value by about 0.3 units in soil rhizospher, which improved nutrients availability, consequently increased plant growth and yield and its components. These results are in a good agreement with those obtained by Papastyianou *et al* (2014) and Adel (2020) who reported that compost application enhanced yield components of quinoa plants.

Table 3. Effect of nitrogen sources and levels under different levels of compost on yield components of quinoa.

Compost t/fed (A)	Nitrogen sources (B)	Nitrogen levels (kg/fed) (C)																	
		No. of panicles/plant						1000- seed weight (g)						Seed yield/plant (g)					
		2017			2018			2017			2018			2017			2018		
		60	90	mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean
	AN	7.2	10.2	8.7	7.7	10.9	9.3	3.3	3.6	3.5	3.5	3.7	3.6	13.1	16.4	14.8	13.9	16.8	15.4
5.0	AS	8.1	11.8	10.0	8.5	12.1	10.3	3.3	3.6	3.5	3.6	3.8	3.7	14.6	17.2	15.9	15.3	18.4	16.9
mean		7.7	11.0	9.3	8.1	11.5	9.8	3.3	3.6	3.5	3.6	3.8	3.7	13.9	16.8	15.3	14.6	17.6	16.1
	AN	12.6	14.4	13.5	12.9	14.7	13.8	3.8	4.1	4.0	3.9	4.2	4.1	16.9	18.5	17.7	18.2	21.1	19.7
10.0	AS	14.1	16.5	15.3	14.4	16.8	15.6	3.9	4.2	4.0	3.9	4.3	4.1	18.3	21.7	20.0	20.7	22.7	21.7
mean		13.4	15.5	14.4	13.7	15.8	14.7	3.9	4.2	4.0	3.9	4.3	4.1	17.6	20.1	18.9	19.5	21.9	20.7
	AN	13.9	14.6	14.3	14.2	14.8	14.5	4.2	4.2	4.2	4.2	4.3	4.3	18.1	18.8	18.5	21.1	21.4	21.3
15.0	AS	16.8	16.9	16.9	16.9	16.9	16.9	4.2	4.3	4.3	4.2	4.3	4.3	20.2	21.9	21.1	22.5	22.8	22.7
mean		15.4	15.8	15.6	15.6	15.9	15.7	4.2	4.3	4.2	4.2	4.3	4.3	19.2	20.4	19.8	21.8	22.1	20.8
mean of	AN	11.2	13.1	12.2	11.6	13.5	12.5	3.8	4.0	3.9	3.9	4.1	4.0	16.0	17.9	17.0	17.7	19.8	18.8
sources	AS	13.0	15.1	14.0	13.3	15.3	14.3	3.8	4.0	3.9	3.9	4.1	4.0	17.7	20.3	19.0	19.2	21.3	20.3
mean of	60		12.1			12.4			3.8			3.9			16.9			18.6	
levels	90		14.1			14.4			4.0			4.1			19.1			20.5	
L.S.D at 0.05																			
A			0.95			0.98			0.08			0.09			1.21			1.28	
B			1.13			1.26			N.S			N.S			1.02			1.09	
C			1.16			1.29			0.09			0.09			1.36			1.43	
AB			N.S			N.S			N.S			N.S			N.S			N.S	
AC			1.52			1.70			0.13			0.14			1.65			1.80	
BC			N.S			N.S			N.S			N.S			N.S			N.S	
ABC			N.S			N.S			N.S			N.S			N.S			N.S	

With respect to nitrogen sources, the data clearly indicate that AS fertilizer produced higher values of number of panciles/plant, and seed yield/plant than AN fertilizer, while 1000-seed weight did not affect by nitrogen forms. The superiority of AS over AN fertilizers in these two parameters reached to 14.8 and 11.8% in the first seasons, respectively. Similar trends were obtained in the second season. The augmentation in yield components of quinoa due to AS than AN fertilizer is mainly due to the superiority of the effect of AS fertilizer on the growth parameters as the abovementioned discussed. In this connection, Tisdale and Nelson (1975) mentioned that, due to the accompany SO4-- anion, this source of fertilizer tends to be some what acidic in soil than AN fertilizer, in turn improve soil pH near root zone, which positively increased plant growth. Similar results were obtained by Ismail *et al* (2006) and Hassanien (2009) who reported that ammonium sulphate surpassed ammonium nitrate in its effect on yield components of maize plants.

The nitrogen levels were significantly effected yield components of quinoa. Added 90 kg/fed nitrogen increased number of pancils, 1000-seed weight and seed yield/plant by about 16.5, 5.3 and 13.0% when compared with added 60 kg N/fed, respectively in the first season. The corresponding increases in the second season were 16.1, 5.1 and 10.2%. These increment may be due to increasing nitrogen level enhanced the merestmic activity, vegetative growth and photosynthates accumulation (Allam *et al*, 2001). These results are in harmony with those obtained by Gomaa (2013) and Wang *et al* (2020) who reported that yield components of quinoa increased with increasing nitrogen levels.

As for the interaction, the data indicate that, yield components were responded to the interaction between compost level and nitrogen level (AXC). The increasing nitrogen level from 60 to 90 kg/fed did not statistically induce any changes in yield components in presence of 15 t/fed compost. The highest values of yield components were achieved from the treatment of 15 t/fed compost + 60 or 90 kg N/fed as ammonium sulphate fertilizer. However, the treatment of 5 t/fed compost + 60 kg N/fed as ammonium nitrate exerted the lowest ones.

Yields

The obtained data in Table 4 indicate that yield parameters in term of grain, straw and biological yields were significantly affected by composting. Increasing compost level had a positive effect on yield parameters. The increment in seed, straw and biological yields resulted to added 15 t/fed compost were 38.6, 38.8 and 39.4% over 5 t/fed compost, respectively in the first season. The corresponding increases in the second season were 34.5, 35.6 and 35.5% in the abovementioned respect. The promotive effect of compost may be due to it have several advances, such as: induce balanced slow release nutrients in soil, enhance microorganisms activity, improve root growth caused by better soil structure as well as increased soil organic matter (El-Etr *et al* 2004), consequently increased growth and productivity of plant. Moreover, the positive effect of compost on growth parameters and yield components as mentioned in Tables 2 and 3 is a good explanation to its effect on seed and/or straw yields. These results are in accordance with those obtained by Hirich *et al* (2014), Ramzani *et al* (2017) and Adel (2020) who stated the beneficial effect of compost in quinoa yields.

Table 4. Effect of nitrogen sources and levels under different levels of compost on yields of quinoa.

Compost t/fed (A)	Nitrogen sources (B)	Nitrogen levels (kg/fed) (C) Grain yield (ton/fed) 2017			Grain yield 2018			Straw yield (ton/fed) 2017			Straw yield 2018			Biological yield (ton/fed) 2017			Biological yield 2018		
		60	90	mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean
	AN	0.91	1.00	0.96	0.98	1.12	1.05	1.09	1.20	1.15	1.18	1.32	1.25	2.00	2.20	2.10	2.16	2.44	2.30
5.0	AS	1.00	1.12	1.06	1.10	1.20	1.15	1.19	1.34	1.27	1.32	1.44	1.38	2.19	2.46	2.33	2.42	2.64	2.53
mean		0.96	1.06	1.01	1.04	1.16	1.10	1.14	1.27	1.21	1.25	1.38	1.32	2.10	2.33	2.21	2.29	2.54	2.42
	AN	1.14	1.33	1.24	1.24	1.50	1.37	1.36	1.60	1.48	1.50	1.79	1.65	2.50	2.93	2.72	2.74	3.29	3.02
10.0	AS	1.21	1.47	1.34	1.33	1.51	1.42	1.45	1.75	1.60	1.59	1.80	1.70	2.66	3.22	2.94	2.92	3.31	3.12
mean		1.18	1.40	1.29	1.29	1.51	1.40	1.41	1.68	1.54	1.55	1.80	1.67	2.58	3.08	2.83	2.83	3.30	3.07
	AN	1.33	1.33	1.33	1.41	1.50	1.46	1.60	1.60	1.60	1.78	1.79	1.79	2.93	2.93	2.93	3.19	3.29	3.24
15.0	AS	1.47	1.47	1.47	1.51	1.51	1.51	1.76	1.76	1.76	1.80	1.80	1.80	3.23	3.23	3.23	3.31	3.31	3.31
mean		1.40	1.40	1.40	1.46	1.51	1.48	1.68	1.68	1.68	1.79	1.80	1.79	3.08	3.08	3.08	3.25	3.30	3.28
mean of	AN	1.13	1.22	1.17	1.21	1.37	1.29	1.35	1.47	1.41	1.49	1.63	1.56	2.48	2.69	2.58	2.70	3.01	2.85
sources	AS	1.23	1.35	1.29	1.31	1.41	1.36	1.47	1.62	1.54	1.57	1.68	1.63	2.69	2.97	2.83	2.88	3.09	2.99
mean of	60		1.18			1.26			1.41			1.53			2.59			2.79	
levels	90		1.29			1.39			1.54			1.66			2.83			3.05	
L.S.D at 0.05																			
A			0.11			0.13			0.16			0.17			0.16			0.17	
B			0.07			0.08			0.10			0.12			0.09			0.10	
C			0.07			0.09			0.11			0.11			0.10			0.11	
AB			N.S			N.S			N.S			N.S			N.S			N.S	
AC			0.18			0.21			0.27			0.29			0.25			0.26	
BC			N.S			N.S			N.S			N.S			N.S			N.S	
ABC			N.S			N.S			N.S			N.S			N.S			N.S	

As for nitrogen source, the results show that ammonium sulphate gave yield parameters of quinoa exceeded than ammonium nitrate by about 10.3, 9.2 and 9.7% t/fed in first season and 5.4, 4.5 and 4.9 t/fed in the second one. The superiority of AS over AN fertilizer may be due to AS form reduce soil reaction (Sas *et al* 2003). Bedell *et al* (1999) mentioned that ammonium sulphate form improved lateral roots, pH and total seedling biomass than ammonium nitrate form. Also, Garbin and Dillenburg (2008) and Gendy *et al* (2013) stated that ammonium sulphate fertilizer surpassed ammonium nitrate fertilizer in producing growth and yield of plants.

Considering nitrogen levels, the data reveal that increasing nitrogen level from 60 to 90 kg/fed increased seed, straw and biological yields by about 9.3, 9.2 and 9.3% in the first season and 10.3, 8.5 and 9.3% in the second one. These increases indicated that quinoa plants respond well to increasing nitrogen levels and have high ability to accumulate nitrogen in seed and straw (Razzaghi *et al* 2012). The increment in quinoa yields caused by increasing nitrogen levels may be due to nitrogen fertilizer had positive effect of vegetative growth and yield components (Tables 2 and 3), consequently improved the ability for photosynthesis and photosynthate translocation to grains (Thanapornpoonpong, 2004). Similar results were obtained by Fawy *et al* (2017) and Mahmoud and Sallam (2017) who reported that quinoa plants positively responded to increasing nitrogen levels.

It is obviously to notice that, quinoa yields were significantly responded to the interaction between the levels of both compost and nitrogen (AXC), where under 15 t/fed compost, the yields of quinoa due to 60 kg/fed were statistically equal to that resulted to added 90 kg N/fed. It is worthy to mention that these interaction effects on yields were parallel to the interaction on growth parameters (Table 2) and yield components (Table 3). In general, the quinoa plants supplied with 15 t/fed compost and fertilized with 60 or 90 kg N/fed as ammonium sulphate exhibited the greatest quinoa yields. Whereas, the plants treated with 5 t/fed compost and received 60 kg N/fed as ammonium nitrate exerted the lowest ones.

N,P and K concentration

The data in Tables 5 and 6 represent the effect of compost, and nitrogen sources and levels on N, P and K concentration in both grains and straw. The data show that, the increasing compost amendment in soil led to significant increasing in N, P and K concentration in grains and straw of quinoa plants. Comparing with added 5 t/fed compost, 15 t/fed compost increased N, P and K in grains by about 9.7, 63.8 and 23.6 %, respectively in the first season. Similar trends were obtained for quinoa straw and for the second seasons. The positive effects of compost on N, P and K concentration in grains and straw may be due to its high content of N, P and K (Table 1), therefore the N, P and K content in grains and straw were proportional to the increase in compost levels (Sadik *et al*, 2009). Also, many workers such as Salem *et al* (2004) and Ali *et al* (2009) reported that organic manure amendment led to increase of nutrient content by decreasing soil pH in root zoone during its decomposition, consequently improved nutrients availability. These results are similar to those obtained by El-Quesni *et al* (2010) for Schefflera arboricola L. plants and El Sebai *et al* (2016) for quinoa plants.

Table 5. Effect of nitrogen sources and levels under different levels of compost on N, P and K concentration in grain of quinoa.

Compost t/fed (A)	Nitrogen sources (B)	Nitrogen levels (kg/fed) (C)																	
		N %						P%						K%					
		2017			2018			2017			2018			2017			2018		
		60	90	Mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean
5.0	AN	2.32	2.41	2.37	2.25	2.35	2.30	0.41	0.42	0.42	0.39	0.38	0.39	1.01	1.04	1.03	1.00	1.03	1.02
	AS	2.35	2.42	2.39	2.26	2.35	2.31	0.52	0.52	0.52	0.50	0.51	0.51	1.08	1.11	1.10	1.07	1.10	1.09
mean		2.34	2.42	2.38	2.26	2.35	2.30	0.47	0.47	0.47	0.45	0.45	0.45	1.05	1.08	1.06	1.04	1.07	1.05
10.0	AN	2.47	2.53	2.50	2.38	2.47	2.43	0.56	0.56	0.56	0.53	0.53	0.53	1.13	1.17	1.15	1.11	1.11	1.11
	AS	2.48	2.54	2.51	2.38	2.46	2.42	0.67	0.66	0.67	0.63	0.62	0.63	1.20	1.25	1.23	1.18	1.17	1.18
mean		2.48	2.54	2.51	2.38	2.47	2.42	0.62	0.61	0.61	0.58	0.58	0.58	1.17	1.21	1.19	1.15	1.14	1.14
15.0	AN	2.55	2.66	2.61	2.46	2.53	2.50	0.74	0.75	0.75	0.72	0.73	0.73	1.27	1.31	1.29	1.25	1.23	1.24
	AS	2.56	2.65	2.61	2.45	2.54	2.50	0.79	0.79	0.79	0.77	0.77	0.77	1.30	1.34	1.32	1.27	1.25	1.26
mean		2.56	2.66	2.61	2.46	2.54	2.50	0.77	0.77	0.77	0.75	0.75	0.75	1.29	1.33	1.31	1.26	1.24	1.25
mean of	AN	2.45	2.53	2.49	2.36	2.45	2.41	0.57	0.58	0.57	0.55	0.55	0.55	1.14	1.17	1.16	1.12	1.12	1.12
sources	AS	2.46	2.54	2.50	2.36	2.45	2.41	0.66	0.66	0.66	0.63	0.63	0.63	1.19	1.23	1.21	1.17	1.17	1.17
mean of	60		2.46			2.36			0.62			0.59			1.17			1.15	
levels	90		2.54			2.45			0.62			0.59			1.20			1.15	
L.S.D at 0.05																			
A			0.10			0.08			0.05			0.04			0.06			0.07	
B			N.S			N.S			0.04			0.04			0.03			0.03	
C			0.12			0.10			N.S			N.S			0.02			N.S	
AB			N.S			N.S			N.S			N.S			N.S			N.S	
AC			N.S			N.S			N.S			N.S			N.S			N.S	
BC			N.S			N.S			N.S			N.S			N.S			N.S	
ABC			N.S			N.S			N.S			N.S			N.S			N.S	

Table 6. Effect of nitrogen sources and levels under different levels of compost on N, P and K concentration in straw of quinoa.

Compost t/fed (A)	Nitrogen sources (B)	Nitrogen levels (kg/fed) (C)																	
		N%						P%						K%					
		2017			2018			2017			2018			2017			2018		
		60	90	mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean
	AN	1.09	1.25	1.17	1.03	1.22	1.13	0.14	0.15	0.15	0.13	0.14	0.14	0.56	0.62	0.59	0.54	0.60	0.57
5.0	AS	1.08	1.27	1.18	1.02	1.21	1.12	0.19	0.20	0.20	0.18	0.19	0.19	0.61	0.71	0.66	0.60	0.70	0.65
mean		1.09	1.26	1.17	1.03	1.22	1.12	0.17	0.18	0.17	0.16	0.17	0.16	0.59	0.67	0.63	0.57	0.65	0.61
	AN	1.53	1.87	1.70	1.49	1.81	1.65	0.25	0.25	0.25	0.24	0.24	0.24	0.85	0.92	0.89	0.83	0.90	0.87
10.0	AS	1.54	1.86	1.70	1.50	1.82	1.66	0.31	0.32	0.32	0.30	0.30	0.30	0.96	1.03	1.00	0.93	1.00	0.97
mean		1.54	1.87	1.70	1.50	1.82	1.66	0.28	0.29	0.28	0.27	0.27	0.27	0.91	0.98	0.94	0.88	0.95	0.92
	AN	1.97	2.11	2.04	1.95	2.08	2.02	0.44	0.44	0.44	0.43	0.42	0.43	1.26	1.29	1.28	1.24	1.27	1.26
15.0	AS	1.99	2.10	2.05	1.95	2.09	2.02	0.51	0.52	0.52	0.50	0.51	0.51	1.41	1.46	1.44	1.40	1.45	1.43
mean		1.98	2.11	2.04	1.95	2.09	2.02	0.48	0.48	0.48	0.47	0.47	0.47	1.34	1.38	1.36	1.32	1.36	1.34
mean of	AN	1.53	1.74	1.64	1.49	1.70	1.60	0.28	0.28	0.28	0.27	0.27	0.27	0.89	0.94	0.92	0.87	0.92	0.90
sources	AS	1.54	1.74	1.64	1.49	1.71	1.60	0.34	0.35	0.34	0.33	0.33	0.33	0.99	1.07	1.03	0.98	1.05	1.01
mean of	60		1.53			1.49			0.31			0.30			0.94			0.92	
levels	90		1.74			1.71			0.31			0.30			1.01			0.99	
L.S.D at 0.05																			
A			0.11			0.13			0.07			0.06			0.09			0.08	
B			N.S			N.S			0.04			0.04			0.07			0.05	
C			0.13			0.14			N.S			N.S			0.05			0.04	
AB			N.S			N.S			N.S			N.S			N.S			N.S	
AC			N.S			N.S			N.S			N.S			N.S			N.S	
BC			N.S			N.S			N.S			N.S			N.S			N.S	
ABC			N.S			N.S			N.S			N.S			N.S			N.S	

As shown in Tables 5 and 6 nitrogen fertilizer sources were significantly effected phosphorus and potassium concentration in both grains and straw in both seasons, while nitrogen concentration did not affected. The effect of ammonium sulphate resulted a significantly higher P and K content in grains and straw than ammonium nitrate form. The superiority of AS fertilizer on P and K content is mainly due to its effect on improving its availability due to the positive effect of AS fertilizer on reducing soil reaction (Tisdale and Nelson, 1975). These results are in line with those obtained by Sarhan and Ismail (2003), Ali *et al* (2009) and Hassanein(2009).

Regarding nitrogen levels, the obtained data reveal that N and K concentration were significantly increased as nitrogen level increased, except K content in grains in the first season. Added 90 kg N/fed yielded N and P concentration in grains exceeded that due to added 60 kg N/fed by about 3.3 and 3.6%, respectively in the first season. However, the increment in N and K concentration in quinoa straw due to added 90 kg N/fed reached to 13.7 and 7.4% in the first season and 14.8 and 7.6% in the second one in comparison with added 60 kg N/fed, respectively. Similar results were obtained by Gomaa (2013) and Mahmoud and Sallam (2017) and Wang (2020) who found that N and K concentration in quinoa grains and straw were positively responded to nitrogen levels.

The data of the interaction between any two of the studied factors or among them indicate that N, P and K concentration in both grains or straw did not significantly affect by these interactions. In general, the highest N and K concentration in grains or straw were obtained under the plants received 15 t/fed compost and fertilized with 90 kg N/fed as ammonium sulphate, while the plants supplied with 5 t/fed compost in combined with 60 kg N/fed as ammonium nitrate possessed the lowest ones.

N, P and K uptake

The data in Tables 7,8 and 9 represent the effect of compost application and nitrogen fertilization on N, P and K uptake by grains and/or straw. The data reveal that increasing compost levels was gradually increased N, P and K uptake in grains and straw as well as total uptake. Application of 15 t/fed compost increased total N, P and K by about 85.6, 176.2 and 124.9% in comparison with added 5 t/fed compost, respectively in the first season. The corresponding increasing in the second were 82.3, 175.6 and 116.6 % in the abovementioned order. The increment in nutrient uptake due to increasing compost levels is mainly explained by the effect of compost on quinoa yields (as discussed before in Table 4) and N, P and K concentration in grains and straw (Tables 5 and 6), where nutrient uptake calculated as multiplying grain or straw yields by N, P and K concentrations. These results are in parallel to those obtained by Ali *et al* (2009) on wheat plants and El-Shabrawy (2019) on potato plants and Fawy *et al* (2017) for quinoa plants.

As nitrogen sources, the data clearly indicate that nitrogen sources were significantly affected N, P and K uptake in grains and/or straw, where quinoa plants fertilized with ammonium sulphate absorbed more N, P and K in its grains and straw than that supplied with ammonium nitrate by about 10.1, 28.3 and 19.1%, respectively in first season. Similar trends were obtained in the second season. The superiority of AS than AN fertilizers on nutrient uptake could be explained by the beneficial effect of AS fertilizer than AN on quinoa yields. Moreover, AS fertilizer improved soil pH than AN due to presence of sulphate anion after ammonium absorption by plant, consequently increase nutrient availability near plant roots (Tisdale and Nelson, 1975). These results are similar to those obtained by Hassanein (2009) and Sadik *et al* (2009) for maize plants.

Table 7. Effect of nitrogen sources and levels under different levels of compost on N, P and K uptake in grains of quinoa.

ompost t/fed (A)	Nitrogen sources (B)	Nitrogen levels (Kg/fed) (C)																	
		N (Kg/fed)						P (Kg/fed)						K (Kg/fed)					
		2017			2018			2017			2018			2017			2018		
		60	90	mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean
5.0	AN	21.11	24.10	22.61	22.05	26.32	24.19	3.73	4.20	3.97	3.82	4.26	4.04	9.19	10.40	9.80	9.80	11.54	10.67
	AS	23.50	27.10	25.30	24.86	28.20	26.53	5.20	5.82	5.51	5.50	6.12	5.81	10.80	12.43	11.62	11.77	13.20	12.49
mean		22.31	25.60	23.95	23.46	27.26	25.36	4.47	5.01	4.74	4.66	5.19	4.92	10.00	11.42	10.71	10.79	12.37	11.58
10.0	AN	28.16	33.65	30.90	29.51	37.05	33.28	6.38	7.45	6.92	6.57	7.95	7.26	12.88	15.56	14.22	13.76	16.65	15.21
	AS	30.01	37.34	33.67	31.65	37.15	34.40	8.11	9.70	8.90	8.38	9.36	8.87	14.52	18.38	16.45	15.69	17.67	16.68
mean		29.08	35.49	32.29	30.58	37.10	33.84	7.25	8.58	7.91	7.48	8.66	8.07	13.70	16.97	15.33	14.73	17.16	15.94
15.0	AN	33.92	35.38	34.65	34.69	37.95	36.32	9.84	9.98	9.91	10.15	10.95	10.55	16.89	17.42	17.16	17.63	18.45	18.04
	AS	37.63	38.96	38.29	37.00	38.35	37.67	11.61	11.61	11.61	11.63	11.63	11.63	19.11	19.70	19.40	19.18	18.88	19.03
mean		35.77	37.17	36.47	35.84	38.15	37.00	10.73	10.79	10.76	10.89	11.29	11.09	18.00	18.56	18.28	18.40	18.66	18.53
mean of sources	AN	27.73	31.04	29.39	28.75	33.77	31.26	6.65	7.21	6.93	6.85	7.72	7.28	12.99	14.46	13.72	13.73	15.55	14.64
	AS	30.38	34.47	32.42	31.17	34.57	32.87	8.31	9.04	8.68	8.50	9.04	8.77	14.81	16.84	15.82	15.55	16.58	16.07
mean of levels	60		29.06			29.96			7.48			7.68			13.90			14.64	
	90		32.76			34.17			8.13			8.38			15.65			16.07	
L.S.D at 0.05																			
A			2.01			2.10			0.95			0.97			1.82			1.91	
B			1.56			1.69			0.73			0.77			1.34			1.50	
C			1.79			1.83			0.49			0.53			1.01			1.08	
AB			N.S			N.S			N.S			N.S			N.S			N.S	
AC			2.68			2.74			1.39			1.43			2.40			2.47	
BC			N.S			N.S			N.S			N.S			N.S			N.S	
ABC			N.S			N.S			N.S			N.S			N.S			N.S	

Considering nitrogen levels, the results show that N, P and K uptake in grains, straw and total uptake were increased as nitrogen level increased from 60 to 90 kg N/fed. The relative increasing in total N, P and K due to 90 kg N/fed reached to 17.2, 8.8 and 13.6%, respectively in first season. Similar trends were obtained in the second one. The positive effect of nitrogen level on grain and straw yields (Tables 4 and 5) is a good explanation for its effect on nutrient uptake as mentioned before. These results are in line with those obtained by Fawy *et al* (2017) and Kakabouki *et al* (2018) who stated that nutrients uptake for quinoa plants were linearly correlated with increasing nitrogen levels.

The data of the interaction reveal that the total N, P and K uptake by grains, straw and total uptake were significantly affected by the interaction between compost levels and nitrogen levels (AXC), where in presence of 15 t/fed compost, the effect of 60 kg N/fed on N, P and K uptake by grains and/or straw are statistically equal to the effect of 90 kg N/fed. The finding were parallel to the effect of the interaction between compost and nitrogen levels (AXC) on grain and straw yields (Table 4). In general, the treatment of 15 t/fed compost in combined with 60 or 90 kg N/fed gave the highest values of N, P and K uptake. Whereas, quinoa plants treated with 5 t/fed compost and fertilized with 60 kg N/fed absorbed lowest N, P and K.

Table 8. Effect of nitrogen sources and levels under different levels of compost on N, P and K uptake in straw of quinoa.

Compost t/fed (A)	Nitrogen sources (B)	Nitrogen levels (kg/fed) (C)																	
		N (Kg/fed)						P (Kg/fed)						K (Kg/fed)					
		2017			2018			2017			2018			2017			2018		
		60	90	Mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean
5.0	AN	11.88	15.00	13.44	12.15	16.10	14.13	1.53	1.80	1.66	1.53	1.85	1.69	6.10	7.44	6.77	6.37	7.92	7.15
	AS	12.85	17.02	14.94	13.46	17.42	15.44	2.26	2.68	2.47	2.38	2.74	2.56	7.26	9.51	8.39	7.92	10.08	9.00
mean		12.37	16.01	14.19	12.81	16.76	14.79	1.89	2.24	2.07	1.96	2.29	2.12	6.68	8.48	7.58	7.15	9.00	8.07
10.0	AN	20.81	29.92	25.36	22.35	32.40	27.37	3.40	4.00	3.70	3.60	4.30	3.95	11.56	14.72	13.14	12.45	16.11	14.28
	AS	22.33	32.55	27.44	23.85	32.76	28.31	4.50	5.60	5.05	4.77	5.40	5.09	13.92	18.03	15.97	14.79	18.00	16.39
mean		21.57	31.24	26.40	23.10	32.58	27.84	3.95	4.80	4.37	4.19	4.85	4.52	12.74	16.37	14.56	13.62	17.06	15.34
15.0	AN	31.52	33.76	32.64	34.71	37.23	35.97	7.04	7.04	7.04	7.65	7.52	7.59	20.16	20.64	20.40	22.07	22.73	22.40
	AS	35.02	36.96	35.99	35.10	37.62	36.36	8.98	9.15	9.06	9.00	9.18	9.09	24.82	25.70	25.26	25.20	26.10	25.65
mean		33.27	35.36	34.32	34.91	37.43	36.17	8.01	8.10	8.05	8.33	8.35	8.34	22.49	23.17	22.83	23.64	24.42	24.03
mean of sources	AN	21.40	26.23	23.82	23.07	8.58	25.82	3.99	4.28	4.14	4.26	4.56	4.41	12.61	14.27	13.44	13.63	15.59	14.61
	AS	23.40	28.84	26.12	24.14	29.27	26.70	5.25	5.81	5.53	5.38	5.77	5.58	15.33	17.75	16.54	15.97	18.06	17.02
mean of levels	60		22.40			23.60			4.62			4.82			13.97			14.80	
	90		27.54			28.92			5.05			5.17			16.01			16.82	
L.S.D at 0.05																			
A			1.82			1.86			0.76			0.78			1.41			1.46	
B			1.16			1.25			0.65			0.71			1.25			1.29	
C			1.35			1.39			0.32			0.37			0.92			0.97	
AB			N.S			N.S			N.S			N.S			N.S			N.S	
AC			2.01			2.11			0.95			1.02			1.85			1.89	
BC			N.S			N.S			N.S			N.S			N.S			N.S	
ABC			N.S			N.S			N.S			N.S			N.S			N.S	

Table 9. Effect of nitrogen sources and levels under different levels of compost on total N, P and K uptake of quinoa.

Compost t/fed (A)	Nitrogen sources (B)	Nitrogen levels (kg/fed) (C)																	
		N (Kg/fed)						P (Kg/fed)						K (Kg/fed)					
		2017			2018			2017			2018			2017			2018		
		60	90	Mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean	60	90	mean
5.0	AN	32.99	39.10	36.05	34.20	42.42	38.31	5.26	6.00	5.63	5.35	6.11	5.73	15.29	17.84	16.57	16.17	19.46	17.82
	AS	36.35	44.12	40.24	38.32	45.62	41.97	7.46	8.50	7.98	7.88	8.86	8.37	18.06	21.94	20.00	19.69	23.28	21.49
mean		34.67	41.61	38.14	36.26	44.02	40.14	6.36	7.25	6.81	6.62	7.49	7.05	16.68	19.89	18.28	17.93	21.37	19.65
10.0	AN	48.97	63.57	56.27	51.86	69.45	60.66	9.78	11.45	10.62	10.17	12.25	11.21	24.44	30.28	27.36	26.21	32.76	29.49
	AS	52.34	69.89	61.12	55.50	69.91	62.71	12.61	15.30	13.96	13.15	14.76	13.96	28.44	36.41	32.43	30.48	35.67	33.08
mean		50.66	66.73	58.69	53.68	69.68	61.68	11.20	13.38	12.29	11.66	13.51	12.58	26.44	33.35	29.89	28.35	34.22	31.28
15.0	AN	65.44	69.14	67.29	69.40	75.18	72.29	16.88	17.02	16.95	17.80	18.47	18.14	37.05	38.06	37.56	39.70	41.18	40.44
	AS	72.65	75.92	74.29	72.10	75.97	74.04	20.59	20.76	20.68	20.63	20.81	20.72	43.93	45.40	44.67	44.38	44.98	44.68
mean		69.05	72.53	70.79	70.75	75.58	73.16	18.74	18.89	18.81	19.22	19.64	19.43	40.49	41.73	41.11	42.04	43.08	42.56
mean of sources	AN	49.13	57.27	53.20	51.82	62.35	57.09	10.64	11.49	11.07	11.11	12.28	11.69	25.59	28.73	27.16	27.36	31.13	29.25
	AS	53.78	63.31	58.55	55.31	63.83	59.57	13.55	14.85	14.20	13.89	14.81	14.35	30.14	34.58	32.36	31.52	34.64	33.08
mean of levels	60		51.46			53.56			12.10			12.50			27.87			29.44	
	90		60.29			63.09			13.17			13.54			31.66			32.89	
L.S.D at 0.05																			
A			3.11			3.41			1.55			1.71			2.75			3.81	
B			2.57			2.62			1.13			1.30			2.36			2.44	
C			2.81			2.95			0.92			1.10			2.55			2.71	
AB			N.S			N.S			N.S			N.S			N.S			N.S	
AC			3.91			4.11			2.09			2.25			3.02			3.35	
BC			N.S			N.S			N.S			N.S			N.S			N.S	
ABC			N.S			N.S			N.S			N.S			N.S			N.S	

Nitrogen utilization efficiency (NUtE)

The data in Table 10 represent the affect of calculated nitrogen utilization efficiency by compost and nitrogen treatments. The data show that nitrogen utilization efficiency were decreased by increasing both compost and nitrogen levels. Where increased compost level from 5 to 15 t/fed decreased NUtE by about 25.3 and 26.3% in both seasons, respectively. Also, NUtE decreased by about 7.3 and 7.5 in the two growing seasons, respectively. Owing to increased nitrogen level from 60 to 90 kg N/fed, while nitrogen sources did not effect in this incidence. In this concern, Mahmoud and Sallam (2017) mentioned that nitrogen utilization efficiency was markedly related to genotype of cultivars. Moreover, Razzaghi *et al* (2012) reported that the variation in NUtE may be due to the texture grade of the soil, they added that NUtE of quinoa (CV. Titicaca) grown on sand soil was higher than grown on sandy loam or sandy clay loam. Contrastingly, Erley *et al* (2005) stated that NUtE of studied quinoa cultivar did not respond to nitrogen levels. Similar results were obtained by Mahmoud and Sallam (2017) who found that as nitrogen levels increased the nitrogen utilization efficiency of quinoa decreased. On the other hand, NUtE was not responded to nitrogen sources.

Table 10. Effect of nitrogen sources and levels under different levels of compost on nitrogen utilization efficiency of quinoa.

Compost t/fed (A)	Nitrogen sources (B)	Nitrogen levels (Kg/fed) (C) 2017 60	90	mean	2018 60	90	mean
5.0	AN	27.58	25.58	26.58	28.65	26.40	27.53
	AS	27.51	25.39	26.45	28.71	26.30	27.50
mean		27.55	25.48	26.51	28.68	26.35	27.52
10.0	AN	23.28	20.92	22.10	23.91	21.60	22.75
	AS	23.12	21.03	22.08	23.96	21.60	22.78
mean		23.20	20.98	22.09	23.94	21.60	22.77
15.0	AN	20.32	19.24	19.78	20.32	19.95	20.13
	AS	20.23	19.36	19.80	20.94	19.88	20.41
mean		20.28	19.30	19.79	20.63	19.91	20.27
mean of sources	AN	23.73	21.91	22.82	24.29	22.65	23.47
	AS	23.65	21.93	22.78	24.54	22.59	23.56
mean of levels	60		23.65			24.42	
	90		21.92			22.62	
L.S.D at 0.05							
A			1.01			1.05	
B			N.S			N.S	
C			0.98			0.99	
AB			N.S			N.S	
AC			N.S			N.S	
BC			N.S			N.S	
ABC			1.19			1.22	

CONCLUSION

It could be concluded to fertilized quinoa plants grown in sand soil with 15 t/fed compost in combined with 60 kg N/fed as ammonium sulphate to maximizing quinoa productivity as well as save about 30 kg N/fed.

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تأثير مصادر ومستويات مختلفة من اليتروجين تحت مستويات مختلفة من الكمبوست علي إنتاجية الكينوا النامية تحت ظروف الأراضى الجديدة

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أجريت تجربتان حقليتان في مزرعة خاصة بالقرية الثامنة بالأراضى الجديدة بمحافظة المنيا وذلك خلال موسمي الزراعة 2017 و 2018 م لدراسة تأثير مصادر (كبريتات الأمونيوم ونترات الأمونيوم) ومستويات مختلفة من النيتروجين (60 ،90 كجم/فدان نيتروجين) مع إضافة مستويات مختلفة من الكمبوست (5، 10، 15 طن/فدان) علي إنتاجية نبات الكينوا النامية تحت ظروف الاراضى الجديدة. وقد استخدم تصميم قطع منشقة المنشقة حيث وضعت معاملات الكمبوست في القطع الرئيسية ومصادر النيتروجين في القطع المنشقة، بينما وضعت مستويات النيتروجين في القطع منشقة المنشقة. وتشير أهم النتائج الي:- - أدي زيادة مستويات النيتروجين والكمبوست الي زيادة معنوية في كل من طول النبات ، الوزن الجاف للنبات ، عدد أوراق النبات ، عدد الكيزان للنبات ، وزن ألاف حبة ، محصول الحبوب ،ومحصول القش والمحصول البيولوجي وكذلك تركيز العناصر وإمتصاصها في الحبوب والقش ماعدا تركيز الفوسفور في الحبوب والقش لكلا الموسمين ، وتركيز البوتاسيوم في الحبوب في الموسم الثاني فقط. - أدي أستخدام مصادر مختلفة من التسميد النيتروجيني الي تأثير معنوي علي الصفات السابقة ، ماعدا وزن ألاف حبة وتركيز النيتروجين في الحبوب والقش ، وكان تأثير سماد كبريتات الامونيوم أعلي من تأثير نترات الامونيوم علي تلك الصفات. - أدي زيادة مستويات النيتروجين والكمبوست الي تقليل كفاءة الأستفادة بالنيتروجين ، بينما لم تؤثر مصادر النيتروجين علي ذلك المقياس. - تشير نتائج التداخل أن تأثير معاملة إضافة 15 طن/فدان كمبوست + 60 كجم /فدان نيتروجين مساوية لمعاملة 15 طن/فدان كمبوست + 90 كجم /فدان نيتروجين. ويمكن من نتائج الدراسة التوصية بتسميد نبات الكينوا النامية في الاراضي الجديدة بمعدل 15 طن/فدان كمبوست + 60 كجم /فدان نيتروجين علي صورة كبريتات الامونيوم لتعظيم انتاجيتها وبذلك يتم توفير 30 كجم /فدان نيتروجين .