مجلة المثنى للعلوم الزراعية المجلد (8) العدد(2) لسنة 2021
Al-Muthanna J. For Agric Sci. Print ISSN: 2226-4086 Online ISSN:2572-5149
10.52113/mjas04/8.2/27

مجلة المثنى للعلوم الزراعية
www.mjas.com

The Effect of Nitrogen Fertilizer Levels and Planting Dates on Some Growth Traits and (Yield of the Quinoa Plant (Chenopodium quinoa Wild

Wissam Abdul-llah Jasem AL-asadi and Kefah A. Al-dogagy
Field Crops Department, College of Agriculture, University of Basra, Basra, Iraq.

Article Info.
Received
2020 / 12 / 15
Publication
2021 /1/28

Keywords
Quinoa
Nitrogen
Transplant
Dates

Abstract

Abstract

A field experiment was carried out in Basra governorate, Zubair district, Burjisiya area (20) km southwest of the governorate during the winter agricultural season 2019-2020 with the aim of studying the effect of four levels of nitrogen fertilizer with four dates for agriculture and was as follows in succession (0,60,120,180) kg Nh-1 agriculture date (1/10, 15/10, 1/11and 15/11) and the symbols (D1, D2, D3, D4) applied the experiment in a working-class experiment method using the design of the entire random sectors (R.C.B.D.) and three replications. Black quinoa callana inia 420 seeds were planted in poor and marginal sandy soils irrigated with well water (EC = 9.50ds m-1) and Ph = 7.54. The results showed that the levels of nitrogen fertilization differed morally among themselves in most of the qualities studied, the level (N3) has exceeded the level of the total seed product, the number of days of agriculture to 50% is flower, plant height, leaf area and number of inflorescences in the plant in increments (74.91 days 1011.02 kg h-1, 48.65 cm, 1877.05 cm2, 403.69 seed Inflorescence -1) in sequence compared to the comparison (N0) Agricultural dates have shown moral differences for the qualities studied, as the first date (D1) exceeds most of the qualities studied such as the characteristic of the total seed product, the height of the plant and the leaf area and the number of inflorescences in the plant and increases in the amount of (85.83days, 1139.69 kg h-1,51.33 cm, 3098.43 cm2, 490.05seed inflorescences-1) In succession compared to the rest of the dates, the effect of the overlap between the level of fertilization and the dates morally in most qualities has recorded the combination (N3 x D1) the highest average of the total seed yield and the height of the plant and the leaf area which reached 3264.0.4 kg h-1,61.37 cm, 3264.04 cm2) respectively.

Corresponding author: E-mail( )

Introduction

Quinoa is one of the most promising crops, to feed the world population in light of changing climate challenges (Geren *et al.*, 2015). The scientific name for quinoa is *Chenopodium quinoa* WILD, to the genus Chenopodium, to the Chenopodiaceae family, the quinoa plant of the Ramaceae family. Annual self-pollinating herbaceous plant with a height of 50-200 cm, branched roots help it withstand drought, and quinoa includes a range of varieties, adapted to different agricultural systems and climatic conditions, including salinity and drought, adapts to sandy and marginal soils that are poor and poor in rainwater (Koziol, 1992). Many researchers have indicated that the quinoa plant was great importance, contains high nutritional value, distinguished by its absence of gluten, causes digestive disorders for some people with a wheat allergy, the quinoa seed has multiple uses, after grinding to make bread and pastries, the fresh parts were eaten as fresh vegetables for humans and the other parts as feed for livestock and poultry, due to its high nutritional value and being free from oxalates and nitrates or as fertilizers after turning it over with soil (Galwey, 1993). Quinoa seeds have a wide range of colors, includes black, red, white, pink and yellow, quinoa seeds have been considered one of the best sources of plant protein, because of high in protein levels and also contains all the essential amino acids, rare in seeds and other grains, its richness in magnesium, copper, manganese, fiber, potassium and thiamine, the environment of the region, variety, planting depth and soil moisture are among the most important determinants of its cultivation, quinoa was a short day plant and is able to respond to the length of the day, despite its original habitat in the Andes Mountains at a latitude of 14 m 0 in Lake Titicaca between Bolivia and Peru. However, the genotypes cultivated in September, April and May did not show differences when cultivated in the Brazilian savannah (Rocha, 2008; Santos, 1996). The date of cultivation in Colombia extends from late August to September (Aguilar and Jacobsen, 2003). At Maghreb, it gave lower yields when delaying the date of planting from February to April (Hirich *et al*., 2012). A study in Japan recommended to determine the best timing for several variants of the quinoa crop for different ecological regions, the result was that the best date for transplantation was in March, gave the highest yield in the plains regions (Isobe *et al*., 2016). Nitrogen fertilizers have an important and vital role for the growth of agricultural crops during the vegetative growth stages, affects significantly and clearly the quality and quantity of the outcome, it has an essential role and great importance in obtaining high productivity, involved in the life cycle of plants, especially protein synthesis, the main compound in the protoplasm, included in the synthesis of enzymes, chlorophyll A, B, and some acids in the nucleus and hormones. Purines and pyrimidines were among the most important of these compounds that contain nitrogen, the main compounds in nucleic acids, DNA and RNA, included in the composition of porphyrins, which is found in chlorophyll and cytochrome enzymes, which were necessary for photosynthesis and respiration. Nitrogen is also included in the accompaniments of enzymes necessary for many enzymes, the abundant nitrogen availability promotes active growth (Al-Naimi, 1999). Kaveeta (2006) indicated that nitrogen fertilization rates enhance vegetative growth, reflected in the high yield of quinoa seeds. Sven-Erik (2003) explained that early maturity is one of the important and distinctive characteristics of quinoa cultivation, the growth period for the quinoa crop is 150 days to obtain seeds.

Quinoa is a new crop imported from South America, therefore, its cultivation has spread all over the world, due to its wide environmental diversity and its great and high ability to produce green seeds and fodder under conditions of drought and salinity, it was important to study to increase crop diversity in the area and improve food. The quinoa crop was a promising candidate for its adaptation to the various difficult environmental conditions in the world and Iraq in particular, especially the southern region, especially Basra Governorate, characterized by high nutritional value and high productivity, enable to give a yield in poor, salty and few areas with irrigation water, The aim of his study was to know the best fertilizer combination with the best planting date to give the largest yield and the best quality.

Materials and Methods

This experiment was carried out in Al-Zubair district, 20 km southwest of Basra Governorate, specifically in the Al-Burjisiya area, the coordinates of the site were taken by a GPS device and by a system (UTM 39R 757036-3363358). At one of the farmers' fields during the winter agricultural season 2019-2020, to study the effect of levels of nitrogen fertilization and planting dates on the yield of the quinoa plant, the experiment included two factors:

First: Four levels of nitrogen fertilizer which were 0, 60, 120 and 180 kg N ha^{-1} in the form of urea 46% N, was added in three batches, the first ten days after emergence, the second batch upon elongation and the third batch, the third was at the end of elongation and the beginning of flowering, the following symbols were given to the fertilization treatment N0, N1, N2 and N3, respectively.

Second: Four dates for planting, the first date (1/10/2019), the second date (10/15/2019), the third date (1/11/2019), the fourth date (11/15/2019), the treatment of seedlings dates were given the following symbols D1, D2, D3 and D4 respectively.

Experiment design:

The experiment was applied according to the Factorial Experiments method, Using a Randomized Complete Block Design (R.C.B.D) with three replicates, the different treatments were randomly distributed within each block, total experimental units (4 x 4 x 3 = 48).

Soil analysis:

A random sample of the field soil before planting was taken with a depth of (0-30) cm, blended with each other to homogenize well, air dried, grind, smooth and pass through a sieve with 2 mm holes in diameter, a sample was taken for the conducting some chemical and physical analyzes, the results of which are shown in

Table (1), the analysis took place in the central laboratory, College of Agriculture, University of Basra.

Field operations:
The soil was prepared for cultivation by plowing it two perpendicular to the tipping plow, soften by disc combs, settled by the settlement machine, the earth was divided, a drip irrigation system was installed, divided according to the Randomized Complete Block Design (R.C.B.D), to the experimental units of 48 experimental units. The area of the experimental unit was 12 m^2, contains 4 furrows, 4 m long between furrows, between one mower and another 70 cm, between hill and another 25 cm, each experimental unit contains 64 plants. A seed volume of 5-10 kg ha^{-1} (FAO, 2011). It was irrigated by the drip irrigation system. Phosphate fertilizers were added in the form of calcium superphosphate (P2O5 21%) in an amount of (50) kg ha^{-1}. Potassium fertilizer was added in an amount of (50) kg ha^{-1} by form of potassium sulfate (44% K2O) in one batch before planting (Al-Zoghbi, 2019).

Study traits:

1. The number of days from planting to 50% flowering:
It was calculated when 50% of the floral spike appears in one experimental unit and so on for the rest of the experimental units, after calculating the average of 10 plants taken from the middle furrows of the experimental unit, it was measured in units (day).

2. Plant height:
It was calculated by measuring tape from the soil surface to the highest point of the plant (flowering top) with a rate of 10 plants, it was taken randomly from the two middle furrows of the experimental unit and extracted the mean of it and its unit of measure (cm).

3. Leaf area:
Calculated after randomly selecting 10 from middle furrows plants from each experimental unit, the leaves were completely empty, it was measured with a leafarea meter (Laser Area Meter CL-202), at the laboratory of the Field Crops Department, the mean was extracted for a unit of measurement (cm^2).

4. Number of seeds per cluster:
10 plants were randomly taken from the two middle furrows from each experimental unit, counted the number of clusters and wasted, calculate the number of seeds for each cluster by means of the seed counter, at the laboratory of the field crops Department, the mean was extracted for each plant and its unit was the number of seeds in a cluster. $plant^{-1}$.

5. Seed yield:
1 m^2 was harvested after maturing, then weighed and adjusted on the basis of moisture 14%, and then converted to kg ha^{-1}.

Table (1) Some physical and chemical traits of soil and irrigation water for the experiment field before planting.

Soil field traits	Value
Sand %	82.25
Silt %	11.50
Clay %	6.25
Soil texture: Sandy loam	
pH	8.50
E.C. (ds. M^{-1})	6.90
Total nitrogen %	0.022
Phosphorus (ppm)	0.19
Calcium carbonate %	6.82
Organic Carbon %	0.15
Organic Matter %	0.37
C.E.C (Meq. 100 g soil)	12.30
Irrigation water traits	
E.C (ds. m^{-1})	
pH	
Cl^- (ppm)	
Ca^{++} (ppm)	
Mg^+ (ppm)	
K^+ (ppm)	
Na+ (ppm)	
NO_3^- (ppm)	

The analyzes were carried out in the central laboratory, Department of Soil Sciences and Water Resources, College of Agriculture, University of Basra.

Results and discussion:

1. Number of days from planting to 50% flowering.

Table (2) shows a significant increase in the average of the number of days from planting to 50% flowering with increasing levels of nitrogen fertilization. The treatment (N3) gave the highest average (74.91 days), which significantly outperformed (N0) treatment, gave the lowest average for the number of days of planting to 50% flowering (64.50 days), may be attributed to the important role of nitrogen fertilization in photosynthesis, and physiological processes such as amino acids, nucleic acids, energy compounds, and the formation of chloroplasts, as well as encouraging cell division, expansion and elongation, the formation of good vegetative and root growth, agreed with Muhammad and Ahmad (2018), which study on evaluating the productivity of three introduced varieties of quinoa under conditions of the central highlands of Yemen, and Shehab (2019) in their study on determining the optimal planting date for Chenopodium quinoa Wild in some Syrian regions.

The significant differences between the averages of the number of days from planting to 50% flowering, the implantation date exceeded D1, which gave the highest average for this trait of 85.83 days, which was significantly different from the other dates compared with D4 (55.25 days), the reason may be attributed to the fact that the first date provided it with an ideal period of growth by adapting the temperature and length of the light period, the crop took a longer period to grow in all its different stages (Basra *et al*., 2014; Shehab, 2019).

Table (2) The effect of nitrogen fertilization levels, planting dates, and the interaction on the number of days from planting up to 50% flowering (days).

Planting date	**nitrogen fertilization levels**				**Planting date mean**
	N0	**N1**	**N2**	**N3**	
D1	81.33	84.00	88.00	90.00	85.83
D2	68.66	71.00	73.66	78.00	72.83
D3	57.00	61.33	63.33	70.33	63.00
D4	51.00	52.66	56.00	61.33	55.25
N mean	64.50	67.25	70.25	74.91	
L.S.D $_{0.05}$	**D**	**N**		**Interaction**	
	1.87	1.87		N.S	

2. Plant height (cm):

Table (3) show a significant increase in the averages of the plant height characteristic with an increase in the levels of nitrogen fertilization, the treatment (N3) gave the highest average (48.65 cm), which was significantly superior to all other fertilization levels, while the comparison treatment (N0) gave the lowest average (29.58 cm), may be attributed to the role of nitrogen fertilization in increasing the efficiency of the photosynthesis process, reflected in the improvement of growth characteristics, including the increase in plant elongation through cell division and increasing the distance between nodes, which reflected in the increase in plant height, it was also attributed to the fertilizer level (N3), may provide adequate amounts of nitrogen absorbed into the plant, increased the amounts of protein important in cell division and increased the concentration of oxins and gibberellins, plays an important role in plant cell elongation, meristematic tissue activity and cell division, nitrogen was one of the fast moving elements inside the plant, moves to modern parts, such as the meristems responsible for growth, which increases the elongation of cells, agreed with the findings of (Shames, 2012; Basra *et al*., 2014; Geren, 2015).

It is also noted that there were significant differences between the mean of the plant height trait, the planting date was exceeded D1, which gave the highest mean (51.33 cm), which differed significantly from other dates, and the date D4 scored the lowest average (23.21 cm), due to the role of optimal planting date, giving a longer period for plant growth, which will positively affect the crop, agreed with Shames (2012), Basra et al. (2014), there was a significant effect of the interaction between planting dates and nitrogen fertilization levels for plant height, significant difference, as the combination (N3×D1) gave the highest average (61.37 cm) compared with the combination (N0 × D4), which gave the lowest average (17.13 cm), the reason may be attributed to the fact that this combination provided the necessary nutrients with optimal timing, and to outweigh the constituents of them alone.

Table (3) The effect of nitrogen fertilization levels, planting dates, and the interaction on plant height (cm).

Planting date	**nitrogen fertilization levels**				**Planting date mean**
	N0	**N1**	**N2**	**N3**	
D1	35.05	52.23	56.66	61.37	51.33
D2	32.61	48.56	50.11	54.16	46.36
D3	33.55	41.83	48.05	50.50	43.48
D4	17.13	20.76	26.37	28.57	23.21
N mean	29.58	40.84	45.29	48.65	

	D	N	Interaction
L.S.D $_{0.05}$	1.22	1.22	2.45

3. Leaf area (cm^2):

Table (4) shows a significant increase in the average characteristic of leaf area in the plant with increasing levels of nitrogen fertilization, as the treatment (N3) gave the highest average (1877.05 cm^2), which significantly outperformed the (N0) treatment, which gave the lowest average (694.88 cm^2), due to the fertile levels that helped in cell division, by increasing metabolic processes and photosynthesis, agreed with Kansomjet (2018); Afrin *et al*. (2017). Significant differences between the averages of the leaf area characteristic, the planting date exceeded D1, which gave the highest average (2098.43 cm^2), which differed significantly from the other dates compared with the date D4, which recorded the lowest average (298.83 cm^2), due to the fact that the first date is the best during the longest period of plant survival in the soil

With appropriate environmental conditions during this date, helped to increase the leaf area of the plant, agreed with Awadalla (2017) and Gomaa (2013). There was a significant effect of the interaction between planting dates and nitrogen fertilization levels for leaf area characteristic, the combination (N3 × D1) gave the highest average (3264.04 cm^2), compared with the combination (N0 × D4) which gave the lowest average (109.29 cm^2), the reason may be attributed to the fact that this combination provided the necessary nutrients with the most favorable date than the remaining dates by allowing more time for each stage of plant growth.

Table (4) The effect of nitrogen fertilization levels, planting dates, and the interaction on leaf area (cm^2).

Planting date	nitrogen fertilization levels				Planting date mean
	N0	N1	N2	N3	
D1	1122.56	1747.19	2259.94	3264.04	2098.43
D2	932.45	1122.03	1711.30	2288.70	1513.62
D3	615.24	786.13	1092.25	1392.48	971.52
D4	109.29	194.07	328.99	563.00	298.83

N mean	694.88	962.35	1348.12	1877.05	
L.S.D $_{0.05}$	**D**	**N**		**Interaction**	
	80.74	80.74		161.49	

4. The number of grains in a cluster:

Table (5) shows a significant increase in the average characteristic of the number of seeds per cluster with increasing levels of nitrogen fertilization, the treatment (N3) gave the highest average (403.64 seeds. cluster^{-1}), significantly superior to all other fertilizer levels, while the fertilizers level N0 (comparison treatment) recorded the lowest average (170.16 seed. cluster^{-1}). It was observed that fertilized plants exceeded the level (N3) with an increase of 140.3% compared to non-fertilized plants, the reason for this superiority may be due to the Samadhi level (N3), it was longed seed filling time as well as increased nitrogen supply, which positively affects the formation of a large vegetative group, thus increasing the efficiency of the photosynthesis process, leads to an increase in the nutrients available during the flowering period, reduce competition between floral installations for these materials, thus increasing the number of pollinated flowers, as a number of researchers indicated that the level of nitrogen fertilization increased, leads to an increase in the number of seeds in the cluster (Shoman, 2018; Almadini *et al*., 2019).

The planting date D1, which gave the highest average for this characteristic, (490.05 seed. cluster^{-1}), significantly superior to all other planting dates, the date D4 scored the lowest average (105.97 seed. cluster^{-1}), may be attributed to the superior number of seeds in the cluster, as a result of prolonging the period from planting to flowering, provides suitable climatic conditions of thermal units and a length of light with the completion of growth stages appropriately, it gave a good chance in its superiority in producing dry matter, from planting to flowering, reduced competition between flower bud and stem growth facilities, the formation of primary branches on the photosynthetic products of this date compared with plants cultivated at the fourth date, D4, may be due to the fact that the plants of the first date have grown in favorable environmental conditions of heat, light and humidity, with a higher amount of nitrogen available at this date, contrast to the plants of the last date, which the flowering period coincided with high temperatures at the end of March, led to heat and light stress on the flowering stage, this negatively affected the pollination process and fertilization, so the number of seeds formed in the inflorescences decreased, and this result was in agreement with Ramesh *et al*. (2017) and Saeidi (2020).

There was a significant effect of the interaction between planting dates and levels of nitrogen fertilization for the number of seeds per cluster, the combination (N3 × D1) gave the highest average (745.68 seed. cluster^{-1}), compared with the combination (N0 × D4), which gave the lowest average (52.16 seeds. cluster^{-1}), the reason for this may be due to the superiority of the factors in this characteristic.

Table (5) The effect of nitrogen fertilization levels, planting dates, and the interaction the number of seeds per cluster (seeds. cluster^{-1}).					
Planting date	**nitrogen fertilization levels**				**Planting date mean**
	N0	**N1**	**N2**	**N3**	
D1	230.14	368.10	616.29	745.68	490.05
D2	223.84	327.24	368.91	413.95	333.48
D3	174.49	206.27	226.66	310.07	229.37
D4	52.16	109.69	117.15	144.88	105.97
N mean	170.16	252.83	332.25	403.64	
L.S.D $_{0.05}$	**D**	**N**		**Interaction**	
	23.48	23.48		33.21	

5. Total seed yield (kg. ha^{-1})

Table (6) show that a significant increase in the mean total grain yield with increasing levels of nitrogen fertilization, as the treatment (N3) gave the highest average (1011.03 kg. ha^{-1}), which significantly outperformed all other treatments, with an increase of 521% in the yield, compare with the treatment (N0), which gave the lowest average (195.12 kg. ha^{-1}), due to the nitrogen fertilization, helped cells divide through metabolic processes and photosynthesis, led to an increase in some growth and yield characteristics such as the number of days from planting up to 50% flowering (Table 2), plant height (Table 3), the number of seeds in the cluster (Table 5) and the leaf area, agreed with Schulte *et al.* (2005); Shams (2012); Geren (2015).

The planting date exceeded D1, which gave the highest average (1139.96 kg. ha^{-1}), differed significantly from the other dates compared with the date D4, which recorded the lowest average (147.99 kg. ha^{-1}), due to the better date during the longer period of plant survival in the soil, helped increase the plant's total seeds yield, agreed with Kansomjet *et al*., (2017); Geren (2015). Significant effect of the interaction between planting dates and nitrogen fertilization levels for the total seed yield of the plant, the combination (N3 × D1) gave the highest mean for this characteristic (2124.67 kg. ha^{-1}), compared with the combination (N0 × D4), which gave the lowest average (136.88 kg. ha^{-1}).

Table (6) The effect of nitrogen fertilization levels, planting dates, and the interaction on the total seed yield characteristic (kg. ha^{-1}).

Planting date	nitrogen fertilization levels				Planting date mean
	N0	N1	N2	N3	
D1	294.42	592.66	1548.09	2124.67	1139.96
D2	256.68	542.05	808.19	991.97	649.72
D3	191.57	359.60	431.92	678.14	415.31
D4	37.80	122.95	181.90	249.31	147.99
N mean	195.12	404.32	742.52	1011.02	
L.S.D $_{0.05}$	D	N	Interaction		
	57.54	57.54	115.08		

Conclusions:

The use of fertilizer level N3, which represents 180 kg N ha^{-1} with planting on 1/10, led to a significant increase in most of the studied characteristics of growth and yield.

References

Al-Naimi, SANA, 1999. Fertilizers and soil fertility, Ministry of Higher Education and Scientific Research, University of Mosul.

Al-Zoghbi, RS 2019. The effect of agricultural drainage water on some soil properties, the productivity of the quinoa crop, and determining its water and fertilizer needs. Syrian Journal of Agricultural Research, 6 (3): 306-317.

Shehab, SS 2019. Determining the optimum planting date for Chenopodium quinoa wild in some Syrian regions. Hama Research Center, General Authority for Scientific Agricultural Research, Damascus. Syrian. Syrian Journal of Agricultural Research 6 (4): December 130-143, 2019.

Afrin, S 2018. Influence of fertilizer

levels on growth and yield of Quinoa *(Chenopodium quinoa).* Department of Agronomy, Sher-E-Banngala Agricultural University. Sher-e-Bangla Nagar, Dhaka-1207.

Almadini, A. M., Badran, A. E., and Algosaibi, A. M. Evaluation of Efficiency and Response of Quinoa Plant to Nitrogen Fertilization levels.

Awadalla, A., and Morsy, A. S. 2017. Influence of planting dates and nitrogen fertilization on the performance of quinoa genotypes under Toshka conditions. Department of Agronomy, Faculty of Agriculture Natural and Resources, Aswan University, Aswan 81528, Egypt.. Egyptian Journal of Agronomy, *39*(1), 27-40.

Basra, Shahzad and Iqbal, Shahid and Afzal, Irfan. 2014. Evaluating the Response of Nitrogen Application on Growth, Development and Yield of Quinoa Genotypes. International Journal of Agriculture and Biology. 16. 886-892.

Galwey, N.W. (1993). The potential of quinoa as a multipurpose crop for agricultural diversification. a review. Ind. Crops Prod., 1(1):101–106.

Geren, H.; Y. Kavut; G. Toopcu; S. Ekren; and D. Istlpliler 2015. Effect of different sowing dates on grain yield and some yield components of quinoa (*Chenopodium quinoa* Willd) growth under Mediterranean climatic conditions. Egeuniversitesi ziraat Fakultesi Dergisi. 51 (3): 297-305.

Gomaa, E. F. (2013). Effect of nitrogen, phosphorus and biofertilizers on quinoa plant. Journal of applied sciences research*, 9*(8), 5210-5222.

Isobe, K.; H. Sugiyama; D. Okuda; Y. Murase; H. Harada; M. Miyamoto; S. Koide; M. Higo; and Y. Torigoe 2016. Effects of sowing time on the seed yield of quinoa (*Chenopodium quinoa* Willd) in South Kanto, Japan. Agricultural Sciences. 7: 146-153.

Kaveeta, L., M. Nanakorn, S. Suwanwong and S. Tantiwiwat,2009. Plant Physiology. Kasetsart University Press, Bangkok,Pages: 261.

Kansomjet, P., Thobunluepop, P., Lertmongkol, S., Sarobol, E., Kaewsuwan, P., Junhaeng, P., Ivan, M. 2017. Response of physiological characteristics, seed yield and seed quality of quinoa under difference of nitrogen fertilizer management. *Am J Plant Physiol, 12*, 20-27.

Koziol, M. J., 1992. Chemical composition and nutritional evaluation of quinoa (Chenopodium quinoa Willd.). J. Food Compos. Analysis, 5 (1): 35-68.

Ramesh, K., Devi, K. S., Gopinath, K., and Devi, M. U. 2017. Physiological Indices, Yield and Yield Attributes of Quinoa (*Chenopodium quinoa* Willd.) as Influenced by Dates of Sowing and Varied Crop Geometry. *Int. J. Curr. Microbiol. App. Sci, 6*(7), 1023-1034.

Schulte A.E.G., H.P. Kaul, M. Kruse and W. Aufhammer 2005. Yield and nitrogen utilization efficiency of the pseudocereals amaranth, quinoa, and buckwheat under differing nitrogen fertilization. European Journal of Agronomy. 22 (1): 95-100.

Shams, A. (2012). Response of quinoa to nitrogen fertilizer rates under sandy soil conditions. Paper presented at the Proc. 13th International Conf. Agron., Fac. of Agric., Benha Univ., Egypt.

Sven-Erik, J. (2003). Royal Veterinary and Agricultural University, Department of Agricultural Sciences. Højbakkegaard Alle 9, DK:2630.

Saeidi, S., Siadat, S. A., Moshatati, A., & Sepahvand, N. (2020). Effect of sowing time and nitrogen fertilizer rates on growth, seed yield and nitrogen use efficiency of quinoa (Chenopodium quinoa Willd) in Ahvaz, Iran. *Iranian Journal of Crop Sciences, 21*(4), 354-367.