Annals of Agric. Sci., Moshtohor **ISSN 1110-0419**
Vol. 52(4) (2014), 461–468 **http://annagricmoshj.com**

Effect of sowing dates on quinoa grains and its chemical composition

Shams, A.S.[1] and Wafaa K. Galal[2]

[1] Crop Intensification Research Department, Field Crops Research Institute,
Agricultural Research Center, Giza, Egypt.
[2] Crop Technology Research Departments, Food Technology Research Institute,
Agricultural Research Center, Giza, Egypt.

Abstract

Growing field crops under harsh conditions of arid environment in sandy soils is one of the biggest challenge facing food security especially for small-scale holdings. Quinoa(*Chenopodium quinoa*Willd.),the newly introduced food crop can replenish part of food gap, since; the crop is drought-salinity tolerant and can grow in sandy soil of arid and semi-arid regions and with other most harmful abiotic adverse factors that affect crop production. Field trial was carried out in Ismailia Agricultural Research Station, Agricultural Research Center,Egypt during 2010/2011 and 2011/2012 winter seasons to study the response of Quinoa CV Titicaca to three sowing dates i.e., 15th of November, 1st of December and 15th of December under sandy soil using sprinkler irrigation system.

Results revealed that sowing quinoa on 15th of December resulted in maximum plant height of 57.73 and 61.50 cm, No. of branches/ plant of 11.33 and 12.08, weight of the main head 9.85 and 11.16 g, 1000-grain weight of 2.65 and 2.78 g grain yield /plantof 12.43 and 13.95 g, grain yield /fed of 556 and 622 Kg /fed, and net return of 1,395 and 1,560 LE/fed. in first and second seasons.

Moisture, ether extract, crude protein, crude fiber, ash and carbohydrates contents of quinoa were 9.61, 3.93, 13.97, 10.31, 3.67 and 68.12 %, respectively. In addition, quinoa grains had higher contents of most essential amino acids, especially lysine.Also, quinoa grains had higher contents of minerals especially Zn, Fe, Mg and Ca. Finally, Quinoa grains could be introduced in bakery products to improve its nutritional value. It is a good source of nutrientsespecially for children and also for people who suffer from celiac disease (allergy to gluten), as a gluten-free crop.

Keywords: Quinoa, sowing dates, chemical composition, sandy soils.

Introduction

Quinoa (*Chenopodium quinoa*Willd.) is a very important cultivated food crop in the Peruvian and Bolivian Andes for more than 5000 years. It recently attracts attention because of its high nutritional value and strong growth potential under the extreme harsh conditions of drought and soil salinity. Apart from the high protein content, the grains are also rich in amino acids, minerals and vitamins which, meet or exceed thehuman requirements. The crop has been selected by the **FAO (2003)** as one of the main crops to play a major role in assuring food security in the 21st century because of its high nutritional value and extreme resistance to adverse climatic conditions**(FAO, 2011)**.

Quinoa is the only food crop that contains all the essential amino acids, trace elements and vitamins, and is also gluten-free. Although not a cereal, it is consumed in a similar way to rice and other staple grains. Quinoa also has a high content of all important minerals than maize, rice or wheat (except sodium), and contains large amounts of folate. It is also richer in protein and mono-saturated fatty acids**(FAO, 201**3).

Quinoa the newly introduced food crop can replenish part of food gap, since; the crop is drought and saline tolerant and can grow in sandy soil of arid and semiarid regions and with other most harmful abiotic adverse factors that affect crop production. Also quinoa would provide bread and other products for people who suffer from malnutrition, where quinoa is a highly nutritious food crop, with an outstanding protein quality and a high content of a range of vitamins and essential minerals **(Jacobsen 2003, Jacobsen *et al*, 2003, Ogungbenle, 2003 and Shams, 2010 and 2012)**. Quinoa has enormous potential in the food industry being gluten-free and highly nutritious and suits marginal soils in environments with low rainfall. Hence, quinoa is recommended also as a useful staple food in food industries for baby food formulations **(Ogungbenle, 2003)**. Quinoa has been selected by **FAO** as one of the crops destined to offer food security in the next century **(FAO, 1998; Jacobsen 2003; Jacobsen *et al*, 2003 and Shams, 2010 and 2012)** and ideal candidate crop for NASA Controlled Ecological Life Support System (**CELSS) (NASA, 1993)**. The grains have not been found to contain anti-nutritional factors.

Quinoa grains can be used as a replacement of cereals and have an application in certain diets, because they do not contain gluten **(Caperuto*et al*., 2000)**.

Quinoa grains have high quality proteins and higher levels of energy, calcium, phosphorus, magnesium, iron, fiber, and B-vitamins than barley, oats, rice, corn, or wheat **(Prakash and Pal, 1998; Oshodi*et al*., 1999; Dini *et al*. 2005 and Comai*et al*., 2007**). Quinoa grain lipids appear to be a high quality edible vegetable oil, similar in the fatty-acid composition to soybean oil **(Comai*et al*., 2007).**

Quinoa proteins may be one of the more promising food ingredients, capable of complementing cereal or legume proteins, and there is the potential for the production of protein concentrates from dehulled quinoa grains, which could be used as raw materials in the food industry **(Brinegar*et al*.,1996).** Quinoa grain proteins are rich in amino acids like lysine, threonine and methionine that are deficient in cereals **(Fleming and Galwey, 1995; Jacobsen, 2003 and 2011)**. Furthermore, **FAO/WHO (1990)** stated that the quality of quinoa is equal to the quality of protein of whole dried milk.

The Food and Agriculture Organization **(FAO, 1990)** observed that quinoa grains have high quality proteins and higher levels of energy, calcium, phosphorus, iron, fiber and B-vitamins than barley, oats, rice, corn or wheat **(Koziol, 1992)**.

Quinoa grain is used to make different food products including bread, biscuits, cookies, crepes, muffins, pancakes, and tortillas. More recently, attention has been given to quinoa for people suffering celiac disease (allergy to gluten), as an alternative to wheat, rye and barley, all of which contain gluten **(Fleming and Galwey, 1995 and Jacobsen, 2003 and 2011).**

Quinoa flour can be mixed with maize or wheat flour. Several levels of quinoa flour substitution have been reported, for instance, in bread (10–13% quinoa flour), noodles and pasta (30–40% quinoa flour), and sweet biscuits (60% quinoa flour) **(Valencia-Chamorro 2003 and Bharagava*et al*., 2006).**

Sowing is one of the most important activities of quinoa cropping because the emergence of seedlings impacts plant density and final yield. Seeds are sown, depending on location, variety, soil moisture and sowing depth **(FAO, 2011)**.

In recent years, the cultivation of quinoa has gained rising attention. This study was undertaken to explore the best sowing date for Quinoa CV Titicacaand analyze its grain composition.

Materials and Methods

Field trial was carried out in Ismailia Agricultural Research Station, Agricultural Research Center, Egypt during 2010/2011 and 2011/2012 winter seasons to study the response of Quinoa CV Titicaca to three sowing dates i.e., 15th of November, 1st of December and 15th of December under sandy soil using sprinkler irrigation system.

Data were recorded The experiment included three sowing dates (15th of November, 1st of December and 15th of December) to study their effects on plant height (cm), No. of branches/ plant, weight of the main head (g), 1000-grain weight (g), grain yield /plant (g), grain yield /fed (Kg),total income LE/fed, total costs LE/fed and net return LE/fed. The randomized complete block design (RCBD) with four replications was used. The area of each plot was 24 m^2, 6m in width (15lines40 cm apart) and 4m in length.

Quinoa was grown in hills spaced 20 cm apart then thinned to one plant per hill. Plots were kept free of weeds through hand hoeing twice. Other cultural practices were performed as recommended. Harvesting of quinoa was after 120 days from planting.

The experimental field was finely prepared and calcium super phosphate (15.5% P_2O_5) was applied during soil preparation at the rate of 15.5 Kg P_2O_5/fed. Nitrogen in the form of ammonium nitrate (33.5% N) was applied at the rate of 90 Kg N /fed.in four equal doses, the first after four weeks from planting date and the other doses every two weeks.

Data recorded:

Samples were taken after 110 days from seeding date and consisted of ten plants taken at random from the two inner ridges of each plot to determine plant height (cm) and No. of branches/ plant, while other yield traits i.e., weight of the main head (g), 1000-grain weight (g), Grain yield /plant (g) were determined at harvest except for the grain yield /fed. (Kg) trait which was on plot basis in both seasons.

Chemical composition:

Grain samplesfrom each replicate of best grain yield treatment were taken in the second season after harvesting and mixed together, left for air drying to 15% moisture content and sent to laboratory for chemical analysis.

Moisture, crude protein, crude fat, ash and crude fiber of quinoa were determined according to **AOAC (2005)**.

Minerals content of quinoa (magnesium, sodium, zinc, manganese, iron, calcium, potassium and cupper) were determined using a pyeunicumSp 1900 Atomic absorption spectroscopy technique after dry ashing according to the method described in **AOAC (2005)**. Amino acids content of quinoa was determined according to the method described by **Pellet and Young (1980)**.

Statistical analysis:

Data were analyzed using ANOVA in Randomized Complete Block Design (RCBD) with four replications. **MSTAT-C (1988)** was used for statistical computations.

Soil analysis:

Soil samples from each plot were taken from 0-30 cm depth before planting quinoa mixed together and sent to laboratory for mechanical and chemical analysis in the first and second seasons, respectively. Data are presented in Table (1).

Table 1. Soil mechanical and chemical analysis (Average of two seasons).

Clay(%)		Silt (%)		Sand(%)	SoilTexture		
8.64		0		91.36	Sandy		
pH	EC (dS/m)	OM%	$CaCO_3$ (%)	Macro nutrient N (mg/Kg)	P (mg/Kg)	K (mg/Kg)	
8.45	0.20	0.15	0.64	10	18	84	
Soluble cations (meq/L)				Soluble anions (meq/L)			
K^+	Na^+	Mg^{++}	Ca^{++}	So_4^{--}	Cl^-	HCO_3^-	CO_3^{--}
0.09	0.7	0.9	0.9	1.37	0.78	0.45	-

Data of air temperature of the experimental area are recorded in Table (2).

Table 2. Air temperature averages data of Ismailia during Quinoa growing season (Average of two seasons):

Month	Max. Temp.(C^O)	Min. Temp.(C^O)	Temp. average
November	**26.39**	**15.23**	**20.81**
December	**19.52**	**9.26**	**14.39**
January	**20.31**	**9.14**	**14.72**
February	**21.33**	**9.02**	**15.17**
March	**24.25**	**11.28**	**17.77**
April	**28.95**	**14.02**	**21.49**

Results and Discussion

Agronomic evaluation

Results in table (3) indicated that there were increases in values of plant height, No. of branches/ plant, weight of the main head, 1000-grain weight, grain yield /plant and grain yield /fed with delaying sowing date from 15th of November till 15th of December in both seasons. These results were in agreement with**Bajwa (2011)** who tested four sowing dates of quinoa on 15 October, 15 November, 15 December and 15 January and reported 15 December as more appropriate date.

The increases in plant height and number of branches per plant traits were significant between first and second or first and third sowing dates, but without significant increases between second and third sowing dates, while the significant was among all sowing dates in case of plant height in the first season only. The increases in 1000-grain weight were insignificant among all sowing dates in both seasons.

The differences in case of weight of the main head per plant, grain yield per plant and grain yield per fed were insignificant between first and second or second and third sowing dates, while the significant differences occurred between first and third sowing dates, in both seasons.These results are in accordance with those obtained by**Jacobsen and Bach (1998) andHirich*et al*., (2014).**

Table 3. Effect of sowing dates on Quinoa in 2010/2011 and 2011/2012 winter seasons.

Trait / Sowing date	Plant height (cm)	No. of branches/ plant	Weight of the main head (g)	1000-grain weight (g)	Grain yield plant (g)	Grain yield/fed (Kg)
			2010/2011			
15th Nov.	42.90c	8.98b	7.49b	2.18a	9.33 b	433 b
1st Dec.	52.55b	10.71a	8.70ab	2.45a	11.08 ab	497 ab
15th Dec.	57.73a	11.33a	9.85a	2.65a	12.43a	556 a
			2011/2012			
15th Nov.	48.35 b	9.50b	8.72b	2.20a	9.55 b	467 b
1st Dec.	57.05 a	11.21a	10.40ab	2.50a	11.98 ab	542 ab
15th Dec.	61.50 a	12.08a	11.16a	2.78a	13.95a	622a

Chemical composition of quinoa grains.

Results in Table (4) revealed that quinoa grains contained high amounts of crude protein, crude fiber, ash and carbohydrates (13.97, 10.31, 3.67 and 68.12%, respectively). Results are in agreement with**DeBruin (1964)andLamenca (1979)** who reported that chemical composition of quinoa ranged from 10 to 18%, 4.50 to 8.75%, 2.40 to 3.65% and 2.10 to 4.90%, for protein, crude fat, ash and crude fiber, respectively. **Koziol (1992)** reported that quinoa contains 14.60% protein (on fresh weight). **Bharagava*et al*., (2006)** showed that, the ash content of quinoa (3.4%), is higher than that of rice (0.5%), wheat (1.8%) and other traditional cereals. The chemical composition of quinoa grains varied from 8 to 22%, 2 to 10% and 67 to 74% for protein, fats and carbohydrates, respectively **(Valencia-Chamorro, 2003).**

Jancurová*et al.* (2009) mentioned that quinoa grains contain 16.50% protein, 6.30% fat, 3.8% fiber, 3.8% ash and 69% carbohydrates which is higher on average than that in common cereals such as rice, wheat, and barley.

Table 4. Chemical composition of quinoa grains.

Moisture	Ether extract	Crude protein	Crude fiber	Ash	Carbohydrates*
9.61	3.93	13.97	10.31	3.67	68.12

**Total carbohydrate was calculated by differences.*

Minerals content

Table (5) shows minerals content of quinoa grains. Data revealed that all minerals were higher in quinoa than those found in other cereals**FAO/WHO (1990)**. These results indicated that the content of Mg, Na, Mn and K in quinoa was higher than those found inwheat. While, the content of Zn, Fe and Cu in quinoa was about five times higherthan those found in wheat flour. Furthermore, the content of Ca in quinoa wasabout three times higherthan those found in wheat flour. These results are in agreement with those obtained by **Koziol (1992)and Hareedy*et al.*, (2009). Bharagava*et al.*, (2006)** mentioned that quinoa grains contain large amounts of minerals like Ca, Fe, Zn, Cu and Mn. Calcium and iron are significantly higher than most commonly used cereals. **Ruales and Nair (1992)** reported large amounts of iron (81 ppm) and calcium (874 ppm) in quinoa. It has about 0.26% for magnesium in comparison with 0.16% for wheat and 0.14% for corn.

Quinoa grains are rich in micronutrients such as minerals and vitamins. The main minerals are potassium, phosphorus and magnesium. According to the **National Academy of Sciences (2004)** the magnesium, manganese, copper and iron present in quinoa grains covers the daily needs of infants and adults, while phosphorus and zinc is sufficient for children, but covers 40 to 60% of the daily needs of adults. The potassium content can contribute between 18% and 22% of infant and adult requirements, while the calcium content can contribute 10% of the requirements **(James, 2009).**

Ruales and Nair (1993) found that quinoa contains larger amounts of calcium (874 ppm), magnesium (26 ppm), iron (81 ppm), zinc (36 ppm) and copper (10 ppm) than most of the common cereal grains.

Table 5. Minerals content of quinoa grains (ppm).

Mg	Na	K	Ca	Fe	Zn	Mn	Cu
58.70	151.90	170.10	81.60	149.10	61.10	17.30	5.65

Amino acids content

Results in Table (6) showed that quinoa grains contained high amount of essential amino acids except for isoleucine, leucine and phenylalanine. In addition, quinoa grain contained high amount of aspartic, alanine, glycine, arginine, histidine and total non-essential amino acids percentage (27.54 g/100 g protein). These results are in agreement with those obtained by **Hareedy*et al.* (2009)**. Moreover, **James (2009)** reported that quinoa proteins have higher histidine content than barley, soy, or wheat proteins**.**

Koziol (1992) found that quinoa was rich in histidine and lysine (3.20 and 6.10% of protein composition, respectively). Moreover, the amount of lysine and sulfur amino acids (methionine + cystine) was relatively high. In general, the content of essential amino acids in quinoa is higher than in common cereals **(Ruales and Nair, 1992)**. Amino acid analysis showed that quinoa is an excellent source of lysine, methionine, cystine in addition to other essential amino acids, and it meets or exceeds the recommendations for proper amino acid nutrition **(Abugoch*et al.*, 2009)**.

Economic evaluation

Data in table (7) indicated clearly that there were increases in values of total income, total costs and net return traits with delaying sowing date from 15^{th} of November to 15^{th} of December in both seasons.

Table 6. Amino acids content of quinoa grains.

Essential amino acids	g/100g protein	Non-essential amino acids	g/100g protein
Lysine	4.58	Glutamic	13.15
Methionine+ Cystine	2.41	Aspartic	6.78
Isoleucine	2.83	Proline	4.28
Leucine	4.98	Alanine	3.04
Phenylalanine	3.10	Glycine	4.35
Tyrosine	2.81	Serine	3.18
Threonine	2.72	Arginine	9.21
Valine	4.11	Histidine	3.11
Total essential amino acids	27.54	Total non-essential aminoacids	47.10

Table 7. Effect of sowing dates on total income, total costs and net return (LE /fed) in 2010/2011 and 2011/2012 winter seasons.

Trait / Sowing date	Total income†/fed (LE)	Total costs‡ /fed (LE)	Net return /fed (LE)
		2010/2011	
15th Nov.	**4,550**	**3,464**	**1,086**
1st Dec.	**5,223**	**3,976**	**1,247**
15th Dec.	**5,843**	**4,448**	**1,395**
		2011/2012	
15th Nov.	**4,907**	**3,736**	**1,171**
1st Dec.	**5,695**	**4,336**	**1,359**
15th Dec.	**6,536**	**4,976**	**1,560**

† Price of quinoa grains (US$ 1,469.70 /ton = LE 10,508 /ton), source FAOStat data, 2014.
‡ A kilo cost approximately US$ 1.15 = LE 8/Kg, World Bank, 2014.

The increases in net return of the second and third dates over the first date were 14.83 and 28.45%in the first season and 16.05 and 33.22% in the second season, respectively. These results are in agreement with those recorded by **Jacobsen (2003)**, who reported thatthe economic result for the farmer depends on the yield and the price to be achieved for the cropand add that any improved result will be obtained with either an increased yield or a higher price. **Shams (2012)** found that quinoa can be grown under harsh conditions of sandy soils, arid environment and limited irrigation water of 1850 m^3 /fed with acceptable.

Conclusion

Onthe basis of the results presented here, we may conclude that quinoa can be planted in sandy soils from the 1st to 15th of December (the first half) without significant loses in grain yield. However, more research is needed to fit this crop in the crop rotations prevailing in areas with abiotic stresses.

Quinoa grains is an excellent contribution to the diet according to its protein content and amino acid composition. Quinoa grains had high contents of most essential amino acids, especially lysine. Also, quinoa grains had high contents of minerals especially Zn, Fe, Mg and Ca. Finally, quinoa grainscould be introduced in bakery products to improve its nutritional value in which, it is a good source of nutrient especially for children and people who suffer from celiac disease (allergy to gluten).

References

Abugoch, L.; E. Castro; C. Tapia; M.C. Añón; P. Gajardo and A. Villarroel (2009). Stability of quinoa flour proteins (*Chenopodium quinoa*Willd.) during storage. Inter. J. Food Sci. Tech., 44: 2013-2020.

AOAC (2005). Association of Official of Analytical Chemists, Official Methods of Analysis. 18th Ed., Washington DC, USA.

Bajwa, H.M. (2011). Introduction and assessment of quinoa (*Chenopodium quinoa*Willd) as a potential climate proof grain crop. PhD thesis, Univ. Agric., Faisalabad, Pakistan.

Bharagava, A.; S. Shukla and D. Ohri (2006). Chenopodium quinoa- An Indian perspective. Industrial Crops products. 23:73-87.

Brinegar, C.; B. Sine, and L. Nwokocha (1996). High-Cysteine 2S seed storage proteins from quinoa (*Chenopodium quinoa*). J. Agric. Food Chem., 44:1621–1623.

Caperuto, L.; J. Amaya-Farfan and C. Camargo (2000). Performance of quinoa (*Chenopodiumquinoa*Willd.) flour in the manufacture of gluten-free spaghetti. Food Agri., 8: 95–101.

Comai, S.; A. Bertazzo; L. Bailoni; M. Zancato; C. Costaand G. Allegri (2007). The content of proteic and nonproteic (free and protein-bound) tryptophan in quinoa and cereal flours. Food Chem., 100: 1350–1355.

DeBruin, A. (1964). Investigation of the food value of quinoa and canihue seed. J. Food. Sci., 29: 872-876.

Dini, I.; G.C. Tenore and A. Dini (2005). Nutritional and antinutritional composition of Kancolla seeds: an interesting and underexploited andine food plant. Food Chem., 92: 125–132.

FAO/WHO (1990). Protein quality evaluation in Report of Joint FAO/WHO expert consultation; Food and Agricultural Organization of the United Nations: Rome, 23.

FAO (1998). Under-Utilized Andean Food Crops. Rome, Italy.

FAO (2003). The State of Food Insecurity in the World. Published by the Food and Agriculture Organization of the United Nations VialedelleTerme di Caracalla, 00100 Rome, Italy.

FAO (2011). Quinoa: An ancient crop to contribute to world food security. Vitacura, Santiago de Chile.

FAO (2013). Food outlook: Biannual report on global food markets.

FAO (2014). FAOStat data**.** http://faostat.fao.org

Fleming, J. E. and N.W. Galwey (1995). Quinoa (*Chenopodium quinoa* Willd). In: Williams, J. T. (Eds), Cereals and Pseudocereals. Champman and Hall-London, pp.3-83.

Hareedy, L. A. M.; A.M. Mahafauz and A.S. Kamel (2009). Soybean-quinoa drinks from newly introduced quinoa varieties in Egypt. Egyptian J. Nutr., XXIIII (1): 125-160.

Hirich, A.; R. Choukr-Allah and S.-E. Jacobsen (2014). Quinoa in Morocco – Effect of Sowing Dates on Development and Yield. J. Agron. Crop Sci., 200 (5): 371-377.

Jacobsen, S.E. (2003). The Worldwide Potential for Quinoa (*Chenopodiumquinoa*Willd.). Food Reviews International, 19(1): 167-177.

Jacobsen, S.E. (2011). The situation for quinoa and its production in Southern Bolivila: from Economic Success to Environmental Disaster. J. Agronomy Crop Sci., 10:1439.

Jacobsen, S.E., and A. Bach (1998). The influence of temperature on seed germination rate in quinoa (*Chenopodiumquinoa*Willd.). Seed Sci. Technol. 26, 515–523.

Jacobsen, S.E.; A. Mujica and C.R. Jensen (2003). The resistance of quinoa (*Chenopodiumquinoa*Willd.) to adverse, abiotic factors. Food Reviews International 19: 99–109.

James, L.E.A. (2009). Quinoa (*Chenopodiumquinoa*Willd.): composition, chemistry, nutritional, and functional properties. Advances Food Nutr. Research, 58: 1-31.

Jancurová M.; L.Minarovičová and A.Dandár (2009). Quinoa – a review. Czech J. Food Sci., 27: 71–79.

Koziol, M.J. (1992). Chemical composition and nutritional evaluation of quinoa (*Chenopodiumquinoa*Willd.). Journal of Food Composition and Analysis, 5, 36–68.

Lamenca, M.B. (1979). Composicion de la quinoa cultivada en el altiplano de Puno, Perv. Turrialba, 29: 219.

MSTAT-C (1988). A micro-computer program for the design, management, and analysis of agronomic research experiments. Michigan State Univ., East Lansing, MI.

NASA (1993). Quinoa: An emerging new crop with potential for CELSS. NASA Technical Paper 3422.

National Academy of Sciences (2004). Comprehensive DRI table for vitamins, minerals and macronutrients, organized by age and gender. Institute of Medicine. Food and Nutrition Board, Beltsville, MD.

Ogungbenle, H.N.(2003). Nutritional evaluation and functional properties of quinoa (*Chenopodiumquinoa*Willd.) flour. International Journal of Food Sciences and Nutrition 54, 153 -158.

Oshodi, A.A.; H.N.Ogungbenleand M.O. Oladimeji (1999). Chemical composition, nutritionally valuable minerals and functional properties of benniseed (Sesamumradiatum), pearl millet (Pennisetumtyphoides) and quinoa (*Chenopodium quinoa*) flours. Int. J. Food Sci. Nutr., 50: 325-331.

Pellet, P.L. and V.R. Young (1980). Nutritional evaluation of protein foods, Report of a working group sponsored by the International Union of Nutritional Sciences and the United Nations University World Hunger Programme. The United Nations University.

Prakash, D. and M. Pal (1998). Chenopodium: Seed protein, fractionation and amino acid composition. Int. J. Food Sci. Nutr., 49: 271–275.

Ruales, J. and B.M. Nair (1992). Nutritional quality of the protein in quinoa (*Chenopodium quinoa*, Willd) seeds. Plant Foods Human Nutr., 42(1): 1-11.

Ruales, J. and B.M. Nair (1993). Content of fat, vitamins and minerals in quinoa (*Chenopodium quinoa*, Willd) seeds. Food Chem., 48: 131–136.

Shams, A.S. (2010). Combat degradation in rainfed areas by introducing new drought tolerant crops in Egypt. 4th International Conference on Water Resources and Arid Environments, Riyadh, Saudi Arabia, 5- 8 December, 575-582.

Shams, A.S. (2012). Response of quinoa to nitrogen fertilizer rates under sandy soil conditions. Proc. 13th International Conf. Agron.,Fac.ofAgic., Benha Univ., Egypt, 9-10 September.

Valencia-Chamorro, S. A (2003). Quinoa. In: Caballero B.: Encyclopedia of Food Science and Nutrition. Academic Press, Amsterdam, Vol. 8: pp. 4895–4902.

World Bank (2014). http://www.worldbank.org

تأثير مواعيد الزراعة على حبوب الكينوا و التركيب الكيماوى

عمرو سعد شمس[1] ، وفاء كمال جلال[2]
[1]قسم بحوث التكثيف المحصولى، معهد بحوث المحاصيل الحقلية، مركز البحوث الزراعية، الجيزة، مصر.
[2]قسم بحوث تكنولوجيا المحاصيل، معهد بحوث تكنولوجيا الاغذية، مركز البحوث الزراعية، الجيزة، مصر.

تعد زراعة المحاصيل الحقلية فى البيئة القاحلة والأراضى الرملية من أكبر التهديدات التى تواجه الأمن الغذائى وخاصة لدى صغار المزارعين. محصول الكينوا كمحصول غذائى تم إدخاله حديثا يمكن أن يعالج جزء من الفجوة الغذائية، حيث يتميز المحصول بتحمله للجفاف والملوحة ويمكن أن ينمو في التربة الرملية في المناطق القاحلة وشبه القاحلة ومع العوامل السلبية غير الحيوية الأخرى الأكثر ضررا والتي تؤثر على إنتاج المحاصيل.

أجريت تجربة حقلية بمحطة البحوث الزراعية بالإسماعيلية موسمى 2011/2010 ، 2012/2011 لدراسة إستجابة الكينوا صنف (Titicaca) لمواعيد الزراعة (15 نوفمبر ، 1 ديسمبر ، 15 ديسمبر) تحت ظروف الأراضى الرملية والرى بالرش مع تحليل الحبوب الناتجه لتقييم فوائد المحصول.

أظهرت النتائج ان زراعة الكينوا فى 15 ديسمبر أعطت أعلى ارتفاع للنبات 57.73 ، 61.50سم،عددالفروع/ نبات11.33و12.08، وزنالقنديلالرئيسي11.16،9.85جم،وزن 1000حبة2.65، 2.78جم،محصول الحبوب/ نباتمن12.43و13.95جم،محصول الحبوب/ فدان556، 622كجم/ فدان، وصافى عائد 1.395، 1.560 جنيه/ فدان. فيالموسمالأول والثانيعلى التوالي.

كما احتوت حبوب الكينوا على نسبة 9.61، 3.93، 13.97، 10.31، 3.67و68.12٪من الرطوبة،المستخلص الايثيري، البروتين الخام، الالياف الخام، الرماد والكربوهيدرات علي التوالي. ايضا احتوت حبوب الكينوا على مستويات عالية من الأحماض الأمينية الأساسية و خاصة اللايسين.

كما احتوت الحبوب أيضا على نسبة عالية منالمعادنوخاصةالزنك، الحديد، المغنيسيوم و الكالسيوم. وأخيرا،يمكن إدخالالحبوبالكينوافيالمخبوزاتلتحسينقيمتها الغذائية حيث انها مصدر غذائى جيد بالنسبة للأطفالوأيضا بالنسبة الى الأشخاص الذين يعانون منمرض الاضطرابات الهضمية(حساسية الجلوتين)، كمحصول خالى من الجلوتين.

الكلمات الكشافة : الكينوا ، مواعيد الزراعة ، التركيب الكيماوى ، الأراضى الرملية .