EFFECT OF DIFFERENT NITROGEN FERTILIZER SOURCES AND LEVELS ON GROWTH AND PRODUCTIVITY OF QUINOA PLANT AS A NEW LEAFY VEGETABLE CROP IN EGYPT

By

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ABSTRACT

Heba Mohamed Abd El-Moneim Khater "Effect of Different Nitrogen Fertilizer Sources and Levels on Growth and Productivity of Quinoa Plant as a New Leafy Vegetable Crop in Egypt". Unpublished Ph.D. Thesis, Department of Horticulture, Faculty of Agriculture, Ain Shams University, 2018.

Quinoa (*Chenopodium quinoa* Willd.) is a pseudocereal that has been cultivated in the Andean region for thousands of years. It is considered as a newly non-traditional leafy vegetable crop introduced to Egypt. Nitrogen requirements for quinoa plants as a leafy vegetable crop are not clarified yet. This study was conducted at the Experimental Farm of the Horticulture Department ofthe Faculty of Agriculture, Ain Shams University, Shoubra El-Kheima, Cairo, Egypt, during the two winter seasons of 2015 and 2016, to evaluate the effect of two nitrogen sources as ammonium sulfate 20.6% or calcium nitrate 15.5% used at three rates of 40, 60 or 80 kg N/feddan on vegetative growth, leaf yield and leaf chemical compositions of the two quinoa cultivars of Cica and Hualhuas harvested after 40 days from sowing date. The treatments were laid out in a split plot design, with three replicates. The obtained results showed that Cica cultivar was superior to Hualhuas cultivar concerning all vegetative growth parameters except for leaf area and all measured leaf chemical parameters except for leaf contents of chlorophyll, ash, fats, Ca and Fe in both seasons. However, no significant differences were detected between both cultivars in leaf carbohydrates. Regarding nitrogen rates and sources, quinoa plants which received 80 kg N/feddan from ammonium sulfate or calcium nitrate recorded the highest values of all vegetative growth parameters as well as leaf moisture content without significant differences between the two nitrogen sources. Higher significant leaf yield and Ca content wereattained by ammonium sulfate at 80 kg N/feddan treatment compared to nitrogen treatments. On the other hand, quinoa plants that received 80 kg N/feddan as calcium nitrate gave the highest significant

values of carotenoids, nitrate, proteins, ash, N, K and Fe. Nitrogen treatment of 60 kg N/feddan from calcium nitrate showed the highest significant values of chlorophyll a, b and total chlorophyll during both seasons. However, no significant differences were detected among all nitrogen treatments on the number of leaves/plant and leaf P content. Concerning the interaction effect, the results clearly revealed that cv Cica plants which received calcium nitrate at 80 kg N/feddan gave the highest values of plant length. Furthermore, cv. Cica plants treated with 80 kg N/ feddan either from ammonium sulfate or calcium nitrate recorded significant increases in plant fresh and dry weights, leaf content of carotenoids, nitrate, proteins, ash, N, P, K and Na as well as yield without significant differences between them. On the other hand, the best values of leaf area were detected when cv. Hualhuas plants fertilized by 80 kg N/feddan from ammonium sulfate or calcium nitrate without significant difference between them. While, the best values of chlorophyll a, b and total in both seasons were attained when Hualhuas cultivar plants received 60 kg N/feddan from calcium nitrate. Furthermore, the best values of Zn content were obtained when Cica plants treated with 40 kg N/feddan from ammonium sulfate or 60 kg N/feddan from calcium nitrate without significant differences between them in both seasons.

Given the experimental conditions of this study, it is concluded that Cica cultivar plants received 80 kg N/feddan either from ammonium sulfate or calcium nitrate gave the highest yield of leaves with acceptable quality attributes.

Keywords: *Chenopodium quinoa*, Nitrogen rates, Nitrogen sources, Mineral fertilization, Vegetative growth, Leaf yield, Leaf chemical compositions.

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INTRODUCTION

Quinoa (*Chenopodium quinoa* Willd.), is a member of Amaranthaceae family, cultivated along the Andes, for thousands of years and used as a main staple food until Spanish conquest arrived to Latin America **(Brinegar *et al.*, 1996)**. Quinoa has gained an increased worldwide attention since 1970s, when it has been revived as a new food crop, due to the attractive nutritive value and potential health benefits as well as to its exceptional tolerance to several environmental stresses (**Choukr-Allah *et al.*, 2016**). In this study, quinoa is introduced as a newly vegetable crop for the first time in Egypt. For newly introduced crops, it is necessary to assess the appropriate agricultural practices. Amongst many others, the nutritional requirements of the crop are considered to be the most important factor.

Nitrogen is an essential element for plant growth and development. It is generally the most limiting nutrient factor for the growth of leafy vegetables including quinoa which is characterized by a short-life cycle plant and a considerable high requirement for nitrogen nutrition. Nitrogen is required by all plants in comparatively larger amounts than any other elements (constitutes 2-4% of plant dry matter). It has an important role as a basic element of proteins, amino acids, nucleic acids, enzymes, growth hormones and secondary products **(Madan and Munjal, 2009)**. The excessive application of chemical nitrogen fertilizers leads to groundwater pollution, negative implications on the environment and aggravates the climate change **(Reay *et al.*, 2012)**. In addition to the amount of nitrogen applied, the form of the available nitrogen; ammonia nitrogen (NH_4^+-N) or nitrite nitrogen (NO_3^--N), has a significant effect on the growth, photosynthesis, yield and quality of plants **(Ali *et al.*, 2013)**. Amongst many N sources, ammonium sulfate (20.6% N) and calcium nitrate (15.5% N) are used commonly in Egypt. However, nitrogen requirements for quinoa as a new leafy crop are not clarified yet and the

number of studies is still quite limited because of variability of ecological conditions. Also, little information is available concerning the nutritional value and chemical compositions of quinoa leaves as affected by rates and sources of nitrogen fertilizers.

Therefore, the aim of this work was to investigate the effect of different nitrogen rates and sources on vegetative growth, yield and leaf chemical compositions for young plants harvested after 40 days from sowing date of the two quinoa cultivars (Cica and Hualhuas) as a new leafy vegetable crop in Egypt.

REVIEW OF LITERATURE

In order to have a wide view on the subject of "Effect of different nitrogen fertilizer sources and levels on growth and productivity of quinoa plant as a new leafy vegetable crop in Egypt" the review of literature will be subdivided under the following items:

2.1. Quinoa as a new non-traditional leafy vegetable

As was mentioned earlier, quinoa belongs to the Amaranthaceae family. This family of vegetables is nutritionally low in fat and cholesterol, yet is a rich source of protein and contains all the essential amino acids. It is also a valuable source of vitamin A, C, E, K and iron. These vegetables are also surprisingly high in other minerals such as calcium, magnesium, phosphorus, copper, manganese and potassium. It is considered as a new non-traditional multipurpose crop newly introduced to Egypt **(Eisa *et al.*, 2017)**. In this concern, quinoa leaves have plenty amount of vitamin C (1.2–2.3 g/kg), vitamin E (2.9 mg α-TE/100 g), ash (3.3%), fiber (1.9%), proteins (27–30 g/kg), carotenoids (82–190 mg/kg),Na (289 mg/100 g), abundant moisture (83.92–89.11%), chlorophyll a (0.48–1.82 mg/g), and chlorophyll b (0.25–0.07 mg/g) **(Bhargava *et al.*, 2007; Repo-Carrasco- Valencia, 2011)**. In addition, the leaves are eaten as a leafy vegetable in different parts of the world. Fresh leaves and sprouts of quinoa are edible and may be consumed in salad, and also used as a valuable supplement for functional or complete foods and fortification, due to a high nutritional value, and high antioxidant and anticancer activities **((Mlakar *et al.*, 2010; Świeca *et al.*, 2014; Gawlik-Dziki *et al.*, 2015).** It could support the global food security during this century as reported by FAO which declared 2013 as the *International Year of Quinoa* **(FAO, 2013).** It has a variety of uses in the food, feed, food processing and other non-food/industrial uses **(Bhargava *et al.*, 2006)**.

The nutritive value of quinoa differs significantly between different cultivars. In addition, no saponins could be detected in quinoa leaves, in relative to spinach leaves which contain 0.55% saponins on a fresh weight