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MAXIMIZING SEED YIELD AND QUALITY TRAITS OF SESAME BY USING CHITOSAN NANOPARTICLES AND HYDROGEL UNDER NEWLY RECLAIMED SANDY SOIL

By

NOURHAN NASR ELDEN MOHAMED SAYED
B.Sc. Agric. Sci. (Plant Production), Fac. Agric., Cairo Univ., 2015

THESIS
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APPROVAL SHEET

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Title of Thesis: Maximizing seed yield and quality traits of sesame by using chitosan nanoparticles and hydrogel under newly reclaimed sandy soil
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ABSTRACT

Two field experiment were conducted at the Research and production station of the National Research Centre – Nubaria district (sandy soil) El-Behara Governorate, Egypt during the summer seasons of 2017and 2018 to evaluate the impact of irrigation, hydrogel and Nano fertilizers (chitosan nanoparticles) on growth traits, seed yield and quality traits of sesame (*Sesamum indicum* L.). The experiment was laid out in a split split plot design with 3 replications, consisted of 3 irrigation levels (50, 75 and 100%) of irrigation water regime in main plot, 2 hydrogel levels (with and without) in sub plots and 10 Nano fertilizers levels (F1: Cs NPK 300,50,300 ppm NPs, F2: Cs NPK 300,50,400 ppm NPs, F3: Cs NPK 300,60,300 ppm NPs, F4: Cs NPK 300,60,400 ppm NPs, F5: Cs NPK 500,50,300 ppm NPs, F6: Cs NPK 500,50,400 ppm NPs, F7: Cs NPK 500,60,300 ppm NPs, F8: Cs NPK 500,60,400 ppm NPs, F9: chitosan nano particles (CsNPs), F10: Recommended NPK) in sub sub plots. The obtained results indicated that irrigation with 75% of irrigation requirements of sesame recorded highest values for all growth traits, except hieght of 1st capsule as well as for yield and its components. Irrigation with 100% of irrigation water requirements came in the 2nd order and 50% in the 3rd order. Results indicated that the highest value for water use efficiency for seed and oil resulted form the 50% water regime and gradually decreased with each increase in irrigation water.

Adding hydrogel before sowing significantly increased all studied traits except, height of 1st capsule and harvest index.

Application of NPK chitosan nano fertilizers enhanced allstudied traits, application of chitosan nano particles increased seed yield by 49.6% and biological yield by 36.1% over the control treatment, followed by Cs NPK 300,50,300 ppm NPs foiliar application with note of increase of 45.6% and 31.5% for seed and biological yields respectively. The interaction between all factors was significant.

Key words: Sesame, Water Irrigation, Hydrogel, Nnanoparticles, Chitosan, Yield.

DEDICATION

I dedicate this work to Allah. Also, I dedicate this work to family members especially my mother for all the support she lovely offered along the period of my post-graduation and finaly to my husband and my dear daughter Lareen for their help, patience and encouragement.

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CONTENTS

INTRODUCTION

Oil consumption in Egypt has increased because of increasing high rate of population increase in Egypt. The local production of edible oil amounted to be less than 5 % of the total consumption. This reflects as a vast gap. For this reason, efforts should be directed to increase oil seed production, in order to minimize this gap. Therefore, increasing productivity of oilseed crops is one of the main strategic targets of Egyptian government, this could be achieved either by horizontal expansion in sowing the newly reclaimed lands where desert area represented about 95% from the total area of Egypt, by vertical expansion in using high yielding genotypes and application of the suitable cultural treatments. Egyptian newly reclaimed lands, which characterized as arid and semi arid regions with poor soil nutrients, low organic matter, low water holding capacity, drought and high temperature.

Sesame *Sesamum indicum* L. belongs to the genus *Sesamum*, order Tubiflorae and family pedaliaceae. Its seed has high seed oil content (47-52%), oleic and linoleic fatty acids account about 85% of sesame oil which make the oil to have long shelf-life because these fatty acids have high degree of resistance against oxidative rancidity and the linoleic acid is known to lower cholesterol content in human blood (Khanna, 1990), so it's known as one of the most important oil crops in Egypt. It is suitable for growing successfully in the newly reclaimed lands, which ws expanded on a large scale outside the Nile Valley in Egypt.

Sesame is grown in many governorates as a summer crop and ranks first among the cultivated oilseed crops in Egypt not only for edible oil but mainly in foods processing. Egyptian harvested area was about 28000 ha produced 38000-ton seeds of sesame in 2019 (FAO, 2019).

Water recourses in Egypt are very limited, particularly for irrigation practice, so it's necessary to save irrigation water (Steele *et al*., 2000 and Liao *et al*., 2008). Application of hydrogel is one of the most important practices which improved plant growth by increase water retention and decrease water runoff in sandy soils thus increase its availability to plants in dry regions (Huttermann *et al*., 1999 and Koupai and Sohrab, 2004). Hydrogel is absorbed natural and supplied water 400-500 times their own weight and release it slowly because of root capillary suction mechanism thus preventing water loss in soil by leaching and evaporation.

Hydrogels (super absorbents) absorb and retain water many hundred times their weight, i.e. 400-1500 g water per dry gram of hydrogel (Johnson, 1984 and Bowman and Evans, 1991). Hydrogel polymers have the ability to absorb water hundred times its original weight within short period of time and desorb the absorbed water under stress condition (Zhang *et al*., 2006). They continue being more significant issue in both academic and applicable fields because of their various applications in agricultural sector i.e., drug delivery, water reserve, reduce soil erosion, food additives, tissue culture, as structural materials; produce mulches and creating green–houses (Abobatta, 2018). In agricultural sector hydrogel polymer can be used as soil

conditioners and carriers for slow-release fertilizers and protecting agent, hydrogels may be applied by being mixed with the soil or by spraying on the soil surface (Abobatta, 2018).

Currently, world agriculture faces many challenges such as sustainable use of natural resources and environmental issues like runoff and accumulation of pesticides and fertilizers and increasing food demand. So, it's necessary to use new technologies such as Nanotechnology which can improve life quality through its applications in all food industries, agriculture, medicine, automotive, information and communication technologies, energy, textile, construction, etc. (Cicek and Nadaroglu, 2015). Nanotechnology is the science of very small things, "Nano" means one-billionth of meter (Manjunatha *et al*., 2016). Nanoparticles have high reactivity because of more specific surface area, more density of reactive areas, or increased reactivity of these areas on the particle surfaces (Dhoke *et al*., 2013). Recently, Chitosan has been widely used in many applications due to its biodegradability and nontoxicity (Lubkowski and Grzmil, 2007 and wu and Lu, 2008). It is a natural biodegradable-based polysaccharide with amine groups (Hamid *et al*., 2013). Such unique properties of the chitosan biopolymer can be enhanced by using it in the form of nanoparticles, as in this form it can be used to carry ions of fertilizers to be applied to plants. Because of excellent biological and physico-chemical properties of chitosan, it has the ability to be used as a chelating agent or as slow-release fertilizers to save fertilizer consumption and to minimize environmental pollution by releasing

nutrient contents gradually and to coincide with the nutrient requirement of a plant.

The objectives of this study are:

1. Study the effect of application of hydrogel and water regime on growth and yield of sesame grown in sandy soils aiming to save irrigation water without yield reduction.
2. Study the effect of using NPK nutrients as nano particles on growth and yield of sesame grown in sandy soils compard with foliar and soil application of the traditional NPK fertilizers.

REVIEW OF LITERATURE

The literature of this study will be reviewed under the following topics:

- The importance of sesame crop
- Irrigation water regime effect
- Hydrogel application effect
- NPK chitosan nano particles effect

1. The importance of sesame crop

Sesame (*Sesamum indicum* L.) is an ancient oil yielding crop belongs to the Pedaliaceae family (Mesera and Mitiku, 2015 and Dias *et al*., 2017). Africa can be considered the center of origin due to the large number of Sesamum genus species found there (De Sousa *et al*., 2017). It is considered to have both nutritional and medicinal values (Kafiriti and Mponda, 2010).

Sesame is known as the king of oil seeds due to the high oil content (50% - 60%) of its seed (Abd El-Lattief., 2015; Nadeem *et al*., 2015; Islam *et al*., 2016 and Sarkar *et al*., 2016). Also, the importance of sesame lies in its high content of protein, calcium, iron and methionine (Gupta *et al*., 1998). In addition, the high content of unsaturated fatty acids in the oil and digestive protein in the grains make sesame a food of high quality for human and non-ruminant domestic animals (Kafiriti and Mponda, 2010; Mesera and Mitiku, 2015 and Dias *et al*., 2017).

Sesame oil can be used for cooking and salad oils and margarine, manufacture of soaps, paints, perfumes, pharmaceuticals and insecticides (Nadeem *et al*., 2015 and Dias *et al*., 2017). Its meal, which is left over after the oil is extracted from the seed, has a high

protein content (34 to 50 %) and is used as feed for poultry and livestock (Mesera and Mitiku, 2015).

Sesame, which is usually grown in arid and semi-arid regions of the world, is highly sensitive to environmental factors such as soil moisture, which affect its yield (Ucan *et al*., 2007). It is adaptable to a range of soil types, although it performs well in well-drained, fertile soils of medium texture (typically sandy loam) at neutral pH.

Sesame is a short-day plant that may grow in long-day areas. Depending upon light intensity and day period in various regions, there are different sesame genotypes with different photoperiod requirements (Kafiriti and Mponda, 2010). In addition, Sesame is very sensitive to excess moisture; it is a drought tolerant plant in part due to an extensive root system, though sensitive to drought at germination and seedling stages (Bahrami *et al*., 2012). This crop is usually cultivated in arid and semi-arid regions.

In Egypt, Sesame is considered as one of the most important oilseed crops due to its high seed oil content (47-52%) and it well adapted to Egyptian environmental conditions. It is the most appropriate crop for growing in the newly reclaimed land, which is expanded on a large scale outside the Nile Valley in Egypt (Kassab *et al*., 2005, Tantawy *et al*., 2007 and Pibars and Mansour, 2016).