ROLE OF NANO ZINC IN IMPROVING PRODUCTIVITY OF OIL CROPS: A REVIEW

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ABSTRACT

Micronutrients that comprises zinc, are much of importance in agricultural production in terms of quality and quantity. Despite the availability of various fertilizer sources such as mineral and chelating for these nutrients along with the availability of different addition methods, however, the efficiency of using these fertilizers does not exceed 5% of the additive. It is necessary to reduce the loss of nutrients in the fertilizationprocess and tending to increase the production in crops, by using nanotechnology and nanomaterials, by using alternative fertilizers rather than traditional and environment-friendly one. that is called nano-fertilizers which is very effective. Nanotechnology is one of the modern technologies that have proven its positive effects in many fields, including agriculture, medicine, engineering, and the field of energy, as they deal with materials and structures of dimensions ranging from 1-100 nanometers. Zinc one of the essential micronutrients in plant nutrition plays an important role in building and growing plants through its participation in many vital processes, including photosynthesis and energy production. It was noted that adding nano zinc to oil crops such as (sunflower, sesame, safflower, flax, rapeseed, soybean, groundnut, cotton, mustard, castor) stimulate and accelerate growth and increase the productivity of these crops of seeds and oil.

Keywords: Nano zinc, oil crops, seed yield, oil yield.

دور الزنك النانوي في تحسين انتاجية المحاصيل الزيتية: مقال مراجعة

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المستخلص

تعد المغذيات الصغرى ومنها الزنك مهمة في الانتاج الزراعي من الناحتين الكمية والنوعية. وعلى الرغم من توافر مصادر سمادية مختلفة معدنية ومخلبية لهذه المغذيات وتوافر طرائق اضافة مختلفة الا ان كفاءة استعمال هذه الاسمدة لا تتجاوز 5% من المضاف. ومن الافضل والضروري الحد من فقد المغذيات في التسميد والعمل على زيادة انتاجية المحاصيل من خلال استخدام تكنولوجيا النانو والمواد النانوية، وذلك

باستعمال اسمدة بديلة عن الاسمدة التقليدية وصديقة للبيئة وفعالة جداً تسمى بالأسمدة النانوية. وتعد تقنية النانوتكنولوجي من التقنيات الحديثة التي اثبتت تأثيراتها الايجابية في مجالات عديدة منها الزراعية والطبية والهندسية وفي مجال الطاقة اذ يتم التعامل فيها مع المواد والتراكيب التي تتراوح ابعادها 1-100. ويؤدي الزنك كونه احد العناصر الغذائية الصغرى الضرورية والاساسية في تغذية النبات دوراً هاماً في بناء ونمو النباتات وذلك من خلال اشتراكه في الكثير من العمليات الحيوية منها عملية البناء الضوئي وانتاج الطاقة. ولوحظ ان اضافة الزنك النانوي على المحاصيل الزيتية (زهرة الشمس، السمسم، العصفر، الكتان، السلجم، فول الصويا، فستق الحقل، القطن، الخردل، الخروع) ادى الى تحفيز وتسريع النمو وزيادة انتاجية هذه المحاصيل من البذور والزيت.

الكلمات المفتاحية: الزنك النانوي، المحاصيل الزيتية، حاصل البذور، حاصل الزيت.

INTRODUCTION

Micronutrients, which are a part of agricultural products, are considered important in terms of quality and quantity. In spite of the availability of different fertilizer sources, mineral and chelating, for these nutrients furthermore the availability of different addition methods (in addition to the soil it can be added by spraying it on the leaves or even doing both), nevertheless the efficiency of using these fertilizers does not exceed 5% of the additive. It is better and necessary to reduce the loss of nutrients in fertilization and working to increase the productivity of crops by adopting new methods with the help of nanotechnology and nanomaterials, by using alternative fertilizers rather thanthe traditional, environmentally-friendly, and very effective fertilizers called nano fertilizers, including nano zinc. Nanotechnology is one of the modern technologies that has proven its positive effects in many fields, including agriculture, medicine, engineering, and energy (Monica and Cremonini, 2009), as it deals with materials and structures of dimensions range from 1-100 nanometers (Sharma et al., 2009). It works with the small size of particles of Nano to increase the surface area, activity and chemical reaction in comparison with the large molecules (Ditta and Arshad, 2016) mentioned that the ability to improve plant growth and production increases through improving nutrient absorption efficiency, and eliminating pests and diseases that affect plants (Tripathi et al., 2018). Zinc being one of the essential micro-nutrients in plant nutrition plays an important role in building and growing plants through its participation in many vital processes, including photosynthesis and energy production (Mousavi, 2011). It can activate many enzymes that are associated with the regulation of growth, gene expression, and protein formation. (Gowayed and Kadasa, 2016) indicteded that zinc oxide is used as a source of zinc, whereby it is considered one of the inorganic compounds that has multiple uses (Wang et al., 2012). This article aims to learn about nano zinc, its use in agricultural research, and its role in increasing the productivity of oil crops.

EFFECT OF NANO ZINC ON SUNFLOWER:

Sunflower plant (*Helianthus annuus* L.) is one of the most important oil crops in the world, It gained this importance due to its neutrality of the duration of the lighting, which reflected positively on the assimilation of the crop to a wide environmental range (Al-Subaihi and Al-Ani). It is grown for the purpose of obtaining seeds that contain a high oil content of up to 55%, which is one of the best vegetable oils consumed on the global level, moreover to the sunflower meal that is used as fodder, which is good for farm animals and poultry due to its high protein content of 36%, carbohydrates 20-22%, oil 6% and other nutrients (Al-Awda et al., 2009).

Seghatoleslami and Forutani (2015), in their study using several nano zinc oxide concentrations of (0, 1000, 3000, 6000, 12000 ppm) observed significant differences between concentrations at the 1% probability level, the concentration 3000 ppm had a significant advantage in seed yield. Sedghi et al. (2015) in their study of three concentrations of nano zinc oxide of (0, 0.5, 1 g/l) found that adding nano zinc oxide to the sunflower plant led to a significant increase in seed yield. Singh and Kumar (2017) indicated in their study which included different concentrations of nano zinc sulfide of (100, 200, 300, 400, 500 ppm) that There are significant differences among the concentrations, whereby the concentration of 500 ppm recorded an advantage in the seed yield. Abou-Bakr et al. (2019) showed in their experiment in which they used different concentrations of nanostructured zinc oxide of (0, 200, 300, 400, 500 ppm) that The concentration 200 ppm was significantly higher in the seed yield as shown in table (1). Kolenčík et al. (2020) noted that adding nano zinc oxide to the sunflower plant led to a significant increase in the yield in terms of seeds and oil.

Table 1. Effect of nano zinc on sunflower yield (kg/fadan)

Season	2018		
	Cultivars		
Zinc oxide nanoparticles (ppm)	Giza 102	Sakha 53	Mean
Control	1380.77	1139.72	1260.25
100	1407.81	1308.57	1358.19
200	1665.04	1365.31	1515.18
300	1471.37	1243.76	1357.57
400	1507.68	1194.67	1351.18
500	1468.6	1277.92	1373.26
Mean	1483.55	1254.55	--

EFFECT OF NANO ZINC IN SESAME:

Sesame (*Sesame indicum* L.) is one of the most important oil crops in the world whereby it's planted for the purpose of obtaining its seeds that contain 50-60% oil, 18-20% protein, and 16-18% carbohydrates and minerals such as calcium, phosphorous and vitamins such as Vitamin E (Dasharath et al., 2007). Sesame oil is one of the finest oils, as it is distinguished by its light yellow color that contains a high content of unsaturated fatty acids (Tashiro et al., 1990).

Narendhran et al. (2016) indicated in their study of four concentrations of nano zinc oxide of (0, 0.25, 0.5, 1, and 2 g/l) that the addition of nano zinc oxide improved yield of sesame. Results of Narendhran et al. (2017) also showed that adding nano zinc oxide to sesame plants increased seed yield.

EFFECT OF NANO ZINC IN SAFFLOWER:

Safflower (*Carthamus tinctorius* L.) is an economically and medicinally important oil crop because its oil is suitable for human use. the oil content in it reaches 35-50% (Camas et al., 2007). It is widely used because its oil is bright and its color does not change eventually it is a strong dried oil. It has a Iodine number between 140-152, it is called sweet oil because it contains a high percentage of essential unsaturated fatty acids, of which linoleic acid makes up about 75% (Sun et al., 2004).

Results obtained by Khaghani and Saffari (2016) showed that the addition of nano zinc oxide at a concentration of 600 ppm led to a significant increase in seed yield.

EFFECT OF NANO ZINC IN FLAX:

Flax (*Linum usitatissimum* L.) is a dual-purpose crop that is grown for the purpose of obtaining oil, fiber, or both. The percentage of oil in the seeds ranges between 30-40%. it's a dry oil and is used in the manufacture of dyes, varnishes, soap making, and printing ink. its oil contains a high percentage of linolenic acid of 50%, oleic acid of 23%, and linolenic acid of 20% of the total unsaturated fatty acids (Tayfour and Rashid, 1990).

Results of Sadak and Bakry (2020) in their study of different concentrations of nano zinc oxide of (0, 20, 40, 60 mg/l) showed that the addition of nano zinc at a concentration of (40 mg/l) led to a significant increase in seed yield, while the addition of Nanostructured zinc at a concentration of (60 mg/l) significantly increased oil yield.

EFFECT OF NANO ZINC ON RAPESEED:

Rapeseed (*Brassica napus* L.) Is an important oil crop and ranks third in terms of oil production and consumption after palm and soybean. The oil content ranges between 40-50% and protein 39% (Eskandari and Kazemi, 2012). The rapeseed

seed meal is a rich source of protein, thus it is used in animal feed as it increases milk and meat production for cows (Begna and Angadi, 2016).

Hezaveh et al. (2019), studied three concentrations of nano zinc oxide of (0, 20, 80 mg/l) and they found that adding nano zinc oxide at a concentration of (20 mg/l) improved rapeseed yield.

EFFECT OF NANO ZINC IN SOYBEAN:

Soybean (*Glycine max* (L.) Merrill) is one of the most important protein and oil food crops in the world, as its seeds contain 14-24% oil and 30-50% protein. the seeds contain most of the essential amino acids along with unsaturated fatty acids that play an important role in human health. Soybean occupies the first rank in supplying protein in the animal fodder, thus becomes an industrial food, forage, and fertilizing crop at the same time (Aloda Others, 2009 and Buntin et al., 2007).

Results obtained by Sharifi (2016) in his study, in which four levels of nano zinc oxide were used of (0, 0.3, 0.6, and 0.9 g/l) showed that the concentration of (0.9 g/l) was significant in terms of the seed yield and oil ratio. Kakhki and Goldani (2018) indicated that Significant differences were recorded among nano zinc oxide concentrations of (0, 200, 400 ppm) in seed yield. Dimkpa et al. (2019) observed in their study in which they used three concentrations of nano (Zinc oxide 18nm, copper 40nm, Boron oxide 100nm) that nano zinc oxide was superior In terms of crop yield. Yusefi-Tanha et al. (2020), in their study, in which they used three concentrations of nano-structured zinc oxide (Spherical / 38nm, Floral-likey / 59, Rod-like / >500nm), recorded a significant differences among the nano zinc concentrations in seed yield.

EFFECT OF NANO ZINC IN GROUNDNUT:

Groundnut (*Arachis hypogaea* L.) is an oily-leguminous fodder plant belonging to the Fabaceae family. The seeds of groundnut are high in oil content ranging between 45-50% and protein content between 25-30% (Ahmad and Rahim, 2007) and (Nath and Alam, 2002). The extracted oil is used in human nutrition. The Vegetative Group and the cake/meal resulting from oil extraction provide forage materials with high nutritional value, as they contain a protein content of 51% (Arab Development Organization, 2009).

Prasad et al. (2012), showed when studying different concentrations of nano zinc oxide, that there are significant differences between the concentrations, as the second treatment exceeds pod yield as shown in table (2). A study conducted by Rajiv and Vanathi (2018) to find out the effect of different concentrations of nano zinc on the yield of groundnut showed that Nano zinc oxide at a concentration of 300 ppm led to a significant increase in seed yield and oil yield. Hanumonthappa et al. (2019), indicated, that when they used different concentrations of nano zinc of

(0, 300, 600, 900, 1200, 1500 ppm) showed significant differences between the concentrations. The concentration of (300 ppm) had the superiority in pod yield.

Table 2. Effect of nano zinc on pod yield of groundnut

Treatment	Pod yield (kg/ha)
T1 = NPK (Control)	2391.56 ± 38.40
T2 = NPK + ZnSO4 (Chelated)@30g/15 L	2410.82 ± 72.86
T3 = NPK + ZnO (Nano)@2g/15 L	3121.54** ± 115..23
CD@5%	199.92

EFFECT OF NANO ZINC IN COTTON:

Cotton (*Gossypium hirsutum* L.) is among the main fiber crops in the world. Cotton fibers, which account for about 33% of the weight of cotton blossom, are used in the textile industry, while its seeds form 65% of its weight from which oil is extracted of a percentage in the seeds ranges between 18-26%. The cake/meal obtained after extracting the oil from the seeds contains a high percentage of protein, between 32-36% and is used in animal diets as a main source of protein (Shaker, 1999).

Hussein and Abou-Baker (2018), in their study using three concentrations of nano zinc of (0, 100, 200 ppm) observed significant differences between the concentrations at the probability level of 1% in the blossomed cotton yield. Raj and Chandrashekara (2019) explained in their study of four concentrations of nano zinc oxide of (500, 750, 1000, and 1250 ppm) that the concentration of 1000 ppm was significantly higher in the yield of cotton and the reason was due to the role of nano zinc in improving photosynthesis and other metabolism processes that led to an an increase in cell division and elongation (Hatwar et al., 2003). Results obtained by Gadalla and El-Gedwy (2019) indicated that the effect of four nano zinc concentrations of (0, 100, 200, 300 ppm) during the seasons of 2016 and 2017 indicated a significant differences among the concentrations, as the concentration of 300 ppm recorded an increase in the yield of cotton blossom in both seasons. As shown in table (3), the researcher suggested that the reason for that is due to the role of nano zinc in activating enzymes involved in the manufacture of proteins, fats, and carbohydrates and the metabolism of DNA.

Table 3. Effect of nano zinc on seed yield of cotton

	Season	
Nano zinc concentration (ppm)	2016	2017
Control (Distilled Water)	9.36	10.16
100	11.28	12.47
200	12.68	13.32
300	13.39	13.97
L.S.D at 5%	0.31	0.34

EFFECT OF NANO ZINC IN MUSTARD:

Mustard (*Brassica spp.*), which belongs to the Brassicaceae family, is an important medicinal and oil crop alike. Mustard ranks fifth among oil crops after soybean, sunflower, groundnut, and cotton seeds (Cserhalmi et al., 2001). The proportion of oil in mustard seeds ranges between 24-36%. It is used in the manufacture of soap and others (Tayfour and Rashid, 1990).

Results obtained by Zafar et al. (2020) in their experiment in which they used two types of nan-structured fertilizer (41 nm ZnO (200−600 mg/kg soil)) and 47 nm CuO (12.5−50 mg/kg) soil)) indicated the significant superiority of nano zinc oxide in terms of mustard yield.

EFFECT OF NANO ZINC IN CASTOR:

Castor (*Ricinus communis* L.) is considered of the most important plant of the family called Euphorbiaceae. it is widespread in tropical and subtropical regions (Weiss, 2000 and Dange et al., 2005). The main purpose of cultivating/planting of castor is to obtain its seeds to extract the oil from it. Castor oil can be used in many industries, including the manufacture of soap, dyes, and medicines to treat some skin diseases and other uses,(Tayfour and Rashid, 1990).

Rahbari et al. (2019) showed that adding chelated nano zinc to castor plants led to increase seed and oil yield.

CONCLUSIONS

We conclude from this article that adding nano zinc to oil crops (sunflower, sesame, safflower, flax, rapeseed, soybean, groundnut, cotton, mustard, castor) led to an improvement and increase in the productivity of these crops in terms of seeds and oil.

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