J. Nanostruct., 6(1): 43-48, Winter 2016
DOI: 10.7508/jns.2016.01.00*

ORIGINAL RESEARCH PAPER

Microwave-Assisted Chemical Preparation of ZnO Nanoparticles and Its Application on the Improving Grain Yield, Quantity and Quality of Safflower (*Carthamus Tinctorius* L.)

S. Khaghani *[1], J. Saffari [2]

[1]*Young Researchers and Elite Club, Arak Branch, Islamic Azad University, Arak, Iran.*
[2]*Young Researchers and Elite Club, Zahedan Branch, Islamic Azad University, Zahedan, Iran.*

ARTICLE INFO.

Received 14/10/2015
Accepted 25/12/2015
Published online 01/01/2016

KEYWORDS
Carthamus tinctorius L
Grain Oil
Nanoparticles
Safflower
Zinc Oxide

ABSTRACT

ZnO nanoparticles were synthesized by a microwave-assisted chemical method. ZnO nanostructures were synthesized via a fast reaction between zinc acetate and ammonia at presence citric acid and other effective agents in chemical procedure. Nanostructures were characterized by X-ray diffraction , scanning electron microscopy. Seed yield and seed quality of safflower grown under drought stress. The test includes control treatments priming with distilled water, priming with zinc sulphate in the amount of 300 mg per ml, priming with sulfate of zinc to 600 mg per liter, priming with Nano priming on the amount of 300 mg per liter, with Nano on priming rate of 600 mg per liter, priming with zinc sulphate in the amount of 300 mg/l zinc sulphate along with spraying the amount of 300 mg, zinc sulfate with priming to the amount of 600 mg/l zinc sulphate along with spraying the amount of 600 mg, priming with Nano over the amount of 300 mg per liter plus the foliar application of nano on the amount of 300 mg, priming with Nano over the amount of 600 mg per liter plus the foliar application to nano on 600 mg, zinc sulfate to foliar application with the amount of 300 mg per liter, foliar application with Nano over the amount of 300 Mg/l, respectively.

INTRODUCTION

Safflower (Carthamus tinctorius L.) is a tap-rooted annual crop which can tolerate environmental stresses including salinity and water stress. It ranks eighth in terms of world oilseed production after soybean, groundnut, rapeseed, sunflower, sesame, linseed and castor crops [1-3]. The importance of oil crops such as safflower has increased in recent years, especially with the interest in the production of biofuels. Generally safflower is produced on marginal lands that are relatively dry and relatively deprived the benefit of fertilizer inputs or irrigation. Attempts to improve seed yield and quality by developing new genotypes and agronomic practices are underway throughout the world. The fact that water stress effects on growth and yield are genotype-dependent is well known. In Iran water is a scarce resource due to the high variability of rainfall. The effects of water stress depend on the timing, duration and magnitude of the deficits. Identification of the critical irrigation timing and scheduling of irrigation based on a timely and accurate basis to the crop is the key to conserving water and improving irrigation performance and sustainability of irrigated agriculture [4-6]. The crop yield response was very much dependent on the amount of water applied at different crop development stages than the overall

*Corresponding author
Email address: Sh-khaghani@iau-arak.ac.ir
Tel.: +9834132208

seasonal water applied. This approach may save water with little or no negative impact on the final crop yield. In arid and semi-arid environments, both efficient use of available water and a higher yield and quality of safflower are in demand. Safflower can be a candidate crop in dryland agro-ecosystems due to the potential for growth under water stress and the economic value in terms of both oil and seed. Several studies have been shown that a small amount of nutrients, particularly Zn and Mn applied by foliar spraying can significantly increase the yield of crops. Also, foliar nutrition is an option when nutrient deficiencies cannot be corrected by applications of nutrients to the soil. It is likely therefore, in open-field conditions, where the factors that influence the uptake of the nutrients are very variable, foliar fertilization is a privilege. Among the micronutrients, Zn and Mn nutrition can affect the susceptibility of plants to drought stress.

Zinc plays an important role in the production of biomass. Furthermore, zinc may be required for chlorophyll production, pollen function, fertilization and germination. External application of Zn^{2+} increases photosynthesis, net assimilation, and relative growth and yield. [7-11].

information regarding the effect of foliar application of zinc and manganese on the growth and development of safflower under water deficiency is not available.

Therefore, the purpose of this study is to understand whether application of micronutrients, Zn raises seed yield and quality of safflower. Zinc deficiency is one of the most widespread nutritional problems, affecting nearly one-third of the world population. In addition, it is known that Zn deficiency not only produces yield losses in plants but also causes a low accumulation of Zn in the edible parts and seeds of plants. Low Zn intake in the diet results in Zn deficiency in human populations. Serious nutritional problems have been reported, particularly in developing countries, resulting from the consumption of foods low in Zn [12-15]. Breeding Zn-resistant plant species and varieties and applying Zn-containing fertilizers to correct Zn deficiencies are two approaches to the improvement of Zn concentration in seeds. To obtain genotypes resistant to Zn deficiency through plant breeding requires a long period of Time. However, increases in yield and in the level of Zn in seeds are possible and relatively easy with Zn fertilization. A few studies have investigated the response of safflower to Zn fertilization. Safflower, a multi purposed crop, has been grown for centuries in various regions of the world in view of the orange-red dye obtained from its petals, its many medicinal properties, its feed value and especially its high-quality oil, which is rich in polyunsaturated fatty acids. Interest in this crop has increased in recent years, particularly due to its production in areas with limited rainfall, the preference of consumers for healthy oil, the medicinal uses of the flowers and the extraction of edible dyes from the flowers. Safflower is an important oil crop that is cultivated mainly for its seed, which is used to obtain edible oil and as birdseed, and may potentially be produced under low-input conditions. In this paper, the effects of ZnO application on the soil, on yield and yield components and the accumulation of Zn, Cu and Fe in seed under low-Zn field conditions with different safflower genotypes were studied over two years. Safflower is a valuable and multipurpose oilseed; its oil has been containing high proportion of linoleic acid, high iodine value and characteristic pleasant flavor. Besides, from the oil is also widely used as the cooking and salad oil, hydrogenated fat, margarine, mayonnaise and in several types of processed foods. However the safflower oil is used in significant proportion such as industrial oil, colorless varnishes and paints in the developed world. The oil compositions of seed may be exchange with different causes as a soil structure, breeding regimes for obtaining the desired properties of the seed oil composition. Safflower has a high nutrient value and an alternative production of the crop is being tried. Furthermore, safflower is resistant to arid conditions. It would be adaptable to the climatic and land conditions of the The mono-cultural management of Thrace has caused the increase of phosphorus in soil. Phosphorus fertilizer in large amounts leads to zinc Deficiency. In addition, zinc absorb of the plant falls when pH increases in the land[16-20]. The microwave heating involves two main mechanisms, dipolar polarization and ionic conduction. Microwaves generally heat any material containing mobile electric charges such as polar molecules or conducting ions in a solvent or in a solid. During the microwave heating, polar molecules like glycol molecules try to orientate with the rapidly changing alternating electric field; thus heat is generated by the rotation, friction, and collision of molecules. In the case of ions, any ions present in solution will move through the solution based on the orientation of the electric field, and because this is in constant fluctuation, the ion is moving in constantly changing directions through the solution, causing a local temperature rise due to friction and collision. Semiconducting and conducting samples heat when ions or electrons within them form an electric current and energy is lost due to the electrical resistance of the material.

During the past few years, a variety of synthesis strategies for ZnO nanostructure materials have been described. Recently, microwave method as a simple, effective and novel route has been developed to prepare nanostructures. Microwave method is one of the fastest methods operated under ambient conditions. In this work, various morphologies of ZnO nanoparticles were synthesized by microwave-assisted Chemical method.

MATERIALS AND METHODS

Zinc acetate, Citric acid, oxalic acid, succinic acid, maleic acid and NH_3 were purchased from Merck Company. All the chemicals were used as received without further purifications. X-ray diffraction (XRD) patterns were recorded by a Philips X-ray diffractometer using Ni-filtered CuK_a radiation. A multiwave ultrasonic generator (Bandeline MS 73) equipped with a converter/transducer and titanium oscillator operating at 20 kHz with a maximum power output of 100 W was used for the ultrasonic irradiation. Scanning electron microscopy (SEM) images were obtained using a LEO instrument (Model 1455VP). Prior to taking images, the samples were coated by a very thin layer of Pt (BAL-TEC SCD 005 sputter coater) to make the sample surface conducting obtain better contrast and prevent charge accumulation.

Synthesis of ZnO nanoparticles

At the first step citric acid or maleic acid was dissolved to the ethylene glycol. Then zinc acetate, was dissolved in 15 mL of water. Then ammonia solution was then slowly added to the mentioned solution (pH was adjusted about 9) under microwave radiation (600W , 5s On, 5s Off) for 2 minutes. The white precipitate is then centrifuged and rinsed with distilled water. The product was calcined at 450ºC for 2h. Schematic of various capping agents that were used in chemical method is given in Fig. 1.

RESULTS AND DISCUSSION

The XRD pattern of ZnO nanoparticles is shown in Fig. 2 and is indexed as a tetragonal phase (space group:

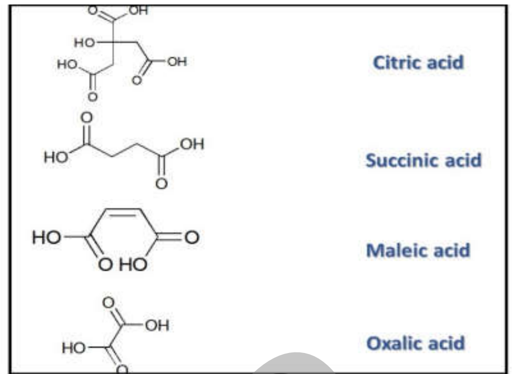

Fig. 1. Schematic of various capping agents

1-42b). The experimental values are very close to the literature (JCPDS No. 80-0075). The crystallite size measurements were carried out using the Scherrer equation (Eq. 1),

$$Dc=0.9\lambda/\beta\cos\theta \quad (1)$$

where β is the width at half maximum intensity of the observed diffraction peak, and λ is the X-ray wavelength (CuK_α radiation, 0.154 nm). The estimated crystallite size is about 13 nm.

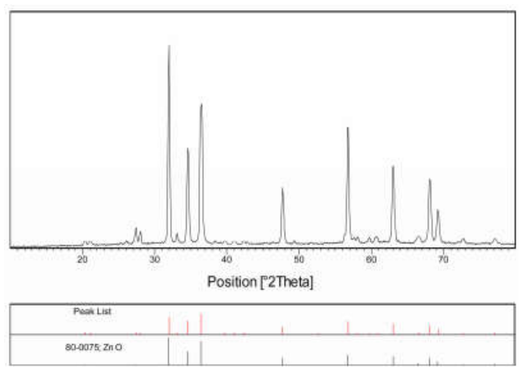

Fig. 2. XRD pattern of zinc oxide nanoparticles

Scanning electron microscopic images of ZnO nanoparticles achieved by citric acid are illustrated in Fig. 3. Nanoparticles with average diameter about 20 nm were synthesized. Citric acid has a suitable interaction with ethylene glycol in formation of sol-gel procedure in preparation of nanostructures [21-25].

Fig. 4 depicts SEM image of nanoparticles synthesized by maleic acid. The agglomeration was observed and it seems nucleation stage overcomes

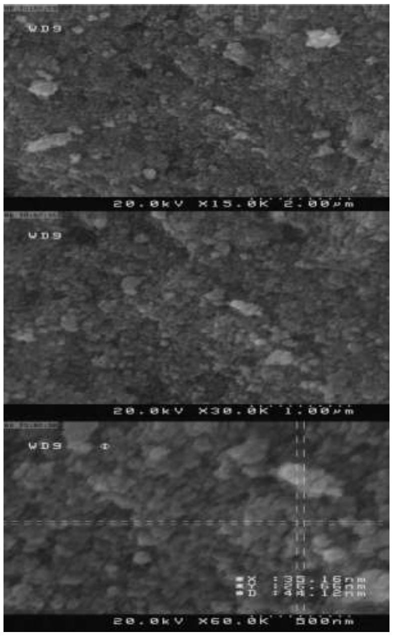

Fig. 3. SEM images of ZnO nanoparticles by citric acid

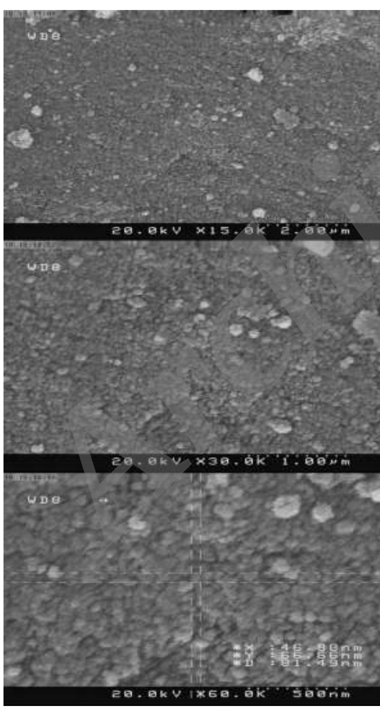

Fig. 4. SEM image of nanoparticles by maleic acid

to growth stage and bigger particles were synthesized. Nanostructures were formed from nanoparticles with average particle size less than 50 nm. Image of our

Fig. 5. Image of our Carthamus tinctorius L

Carthamus tinctorius L is shown in Fig. 5.

To investigate the effect of foliar application and priming sulfate of zinc oxide and zinc nanoparticles on the qualitative and quantitative characteristics of safflower CV. Gol Mehr in 2013-2014 in Islamic Azad University of Arak's research farm in randomized complete block dominates in 3 replications. The test includes control treatments, priming with distilled water, priming with zinc sulphate in the amount of 300 mg per ml, priming with sulfate of zinc to 600 mg per liter, with Nano priming on the amount of 300 mg per liter, with Nano on priming rate of 600 mg per liter, priming with zinc sulphate in the amount of 300 mg/l zinc sulphate along with spraying the amount of 300 mg, zinc sulfate with priming to the amount of 600 mg/l zinc sulphate along with spraying the amount of 600 mg, priming with Nano over the amount of 300 mg per liter plus the foliar application of nano on the amount of 300 mg, priming with Nano over the amount of 600 mg per litre plus the foliar application to nano on 600 mg, zinc sulfate to foliar application with the amount of 300 mg per liter, foliar application with Nano over the amount of 300 Mg/l, respectively. Check the test results showed that the highest grain yield, biological yield 00/4822 kg 42/11324 kg/ha, HA, the highest percentage of 04/41 kg/ha seed oil and the lowest percentage among osteoporosis patients equal to priming % of the seed and the foliar application of 600 ppm on the Nano has gotten the least amount of fertilizer and seed yield of 5/3284 kg/ha obtained from control patients. Some researchers have stated that on the foliar application increases photosynthesis, the plant's rapid growth, nitrogen uptake, increased protein better off and fitted on the performance and cause poor condition fitted up. it appears to be a lack of effect on the seed's weakness reflects the fundamental element in the development of the role of culture and the ability of pollen grain of life is. In this study, as well as on the significant effect on increasing yield and the accumulation of vast likely oil certainty has a direct connection with the application because the increase in yield and yield components.

Chart of comparing means of un-filling and seed yield are shown at Fig. 6 and Fig. 7 respectively.

Control (C), Priming with distilled water (P) Priming with zinc sulfate n the amount of 300 mg/L (PS 300) Priming with zinc sulfate n the amount of 300 mg/L (PS 600) Priming with nano priming the amount of 300 mg/L (PN 300) Priming with nano priming the amount of 300 mg/L (PN 600) foliar application with nano priming the amount of 300 mg/L (PN 300 F) foliar application with nano priming the amount of 600 mg/L (PN 600 F).

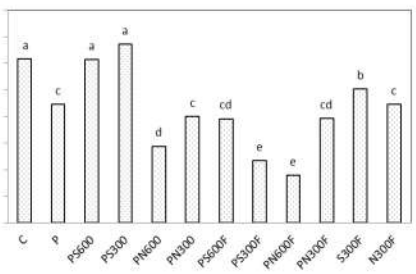

Fig. 6. Chart of comparing means of un-filling

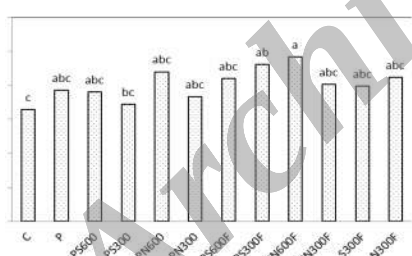

Fig. 7. Chart of comparing means of seed yield

Charts of comparing means of biological yield and harvesting index are shown at Fig. 8 and Fig. 9 respectively.

Simple variance analysis of traits, showed that the percentage of unfilled grain was significantly different ($p<0.01$). Furthermore in the grain seed, biological yield, harvesting index and contain of oil seed there were significant difference ($p<0.05$).

The results of comparison of mean showed that the least average belonged to priming with Nano on priming rate of 600 mg per liter.

The results of Comparison of mean grain yield showed that the most average belonged to priming with Nano on priming rate of 600 mg per literand the least belonged control.

Chart of comparing means of biological yield showed, the most average belonged to priming with Nano on priming rate of 600 mg per liter, which priming with Nano on priming rate of 600 mg per liter was in same group.

The results of Comparison of mean harvesting index trait showed that, the most average belonged to priming with Nano on priming rate of 600 mg per liter. Other traits were in same group with to priming with Nano on priming rate of 600 mg per liter except control and priming with sulfate of zinc to 600 mg per liter.

The results of mean comparison contain of oil seed trait showed that, the most average belonged to priming with Nano on priming rate of 600 mg per liter. Other traits were in same group with to priming with Nano on priming rate of 600 mg per liter except control and priming with distilled water. Charts of comparing means of grain oil are shown at Fig. 10.

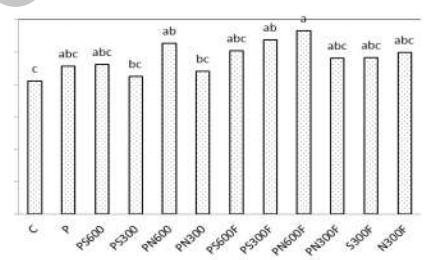

Fig. 8. Chart of comparing means of biological yield

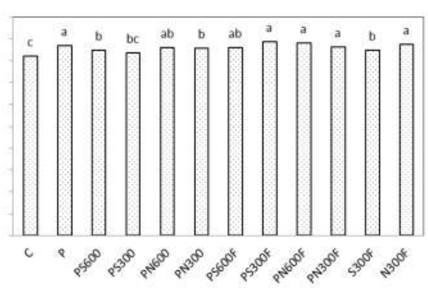

Fig. 9. Chart of comparing means of harvesting index

CONCLUSION

ZnO nanoparticles were prepared by a simple microwave-assisted Chemical process. To investigate

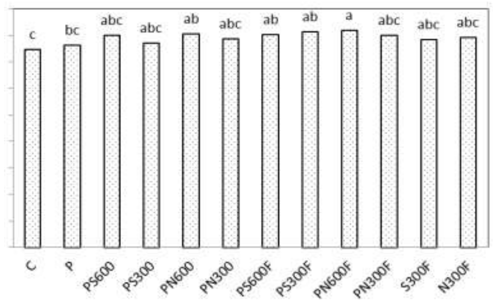

Fig. 10. Chart of comparing means of contain grain oil

the effect of foliar application and priming sulfate of zinc and zinc nanoparticles on the qualitative and quantitative characteristics of safflower CV. Gol Mehr in 2013-2014 in Islamic Azad University of Arak's research farm in randomized complete block dominates in 3 replications. Check the test results showed that the highest grain yield, biological yield 00/4822 kg 42/ 11324 kg/ha, HA, the highest percentage of 04/41 kg/ ha seed oil and the lowest percentage among osteoporosis patients equal to priming % of the seed and the foliar application of 600 ppm on the Nano has gotten the least amount of fertilizer and seed yield of 5/ 3284 kg/ha obtained from control patients. appears to be a lack of effect on the seed's weakness reflects the fundamental element in the development of the role of culture and the ability of pollen grain of life is. In this study, as well as on the significant effect on increasing yield and the accumulation of vast likely oil certainty has a direct connection with the application because the increase in yield and yield components. Nanostructures were formed from nanoparticles with average particle size less than 20 nm.

ACKNOWLEDGEMENT

Authors are grateful to council of Islamic Azad University, Arak branch for providing financial support to undertake this work.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

REFERENCES

[1] M. Movahhedy-Dehnavy, S. A. M. Modarres-Sanavy, A. Mokhtassi-Bidgoli, Industrial Crops and Products, 30 (2009) 82–92
[2] Z. Aytac, N. Gulmezoglu, Z. Sirel, I. Tolay, A. Alkan Torun. Not Bot Horti Agrobo, 42(1) (2014) 202-208
[3] A. ªatana , Turkish J Agricult Nat Sci, 2 (2014) 1757-1760
[4] Anyia, A.O., Herzog, H.,. Eur. J. Agron. 20, (2004) 327–339.
[5] Bannayan, M., Nadjafi, F., Azizi, M., Tabrizi, L., Rastgoo, M., Ind. Crops Prod. 27 (2008)11–16.
[6] Bradford, M.M., Anal. Biochem. 72, (1976) 248–254.
[7] Cakmak, I., Plant Soil 302 (2008) 1–17.
[8] Carvalho, I.S., Miranda, I., Pereira, H., . Ind. Crops Prod. 24, (2006) 75–78.
[9] Crabtree,W.L., Plant Soil 214 (1999) 9–14.
[10] Dordas, C.A., Sioulas, C.,. Ind. Crops Prod. 27, (2008) 75–85.
[11] Dwivedi, S.L., Upadhyaya, H.D., Hegde, D.M., Genet. Resour. Crop Evol. 52, (2005) 821–830.
[12] El Fiel, H.E.A., El Tinay, A.H., Elsheikh, E.A.E.. Food Chem. 76 (2002) 219–223.
[13] Gadallah, M.A.A., J. Arid Environ. 44, (2000) 451–467.
[14] Arslan B Journal of Biological Sciences 7 (2007) 668-672.
[15] Baligar VC, Fageria NK, He, ZL (2001). Communications in Soil Science and Plant Analysis 32:921-950.
[16] Bouis HE (2003). Proc Nutr Soc 62:403-411.
[20] Brennan RF, Holland MDA Australian J Experimental Agriculture 42 (2002). 985-993.
[21] M. Hassanpour, H. Safardoust, D. Ghanbari, M. Salavati-Niasari, J. Mater. Sci. Mater. Electron. 110.1007/s10854-015-4082-0
[22] D. Ghanbari, M. Salavati-Niasari, J Ind Eng Chem, 24 (2015) 284-292.
[23] S. Gholamrezaei, M. Salavati-Niasari, D. Ghanbari, J Indus Eng Chem. 20 (2014) 4000-4007.
[24] D. Ghanbari, M. Salavati-Niasari, Korean J. Chem. Eng. 32(5), (2015) 903-910
[25] A. Esmaeili-Bafghi-Karimabad, D. Ghanbari, M. Salavati-Niasari, L. Nejati-Moghadam, S. Gholamrezaei, J. Mater. Sci. Mater. Electron. 26, (2015) 6970-6978

AUTHOR (S) BIOSKETCHES

Khaghani, S., Ph.D., Assistant Professor, Young Researchers and Elite Club, Arak Branch, Islamic Azad University, Arak, Iran. Email: *shahab.khaghani@gmail.com*

Saffari, J., Ph.D., Assistant Professor, Young Researchers and Elite Club, Zahedan Branch, Islamic Azad University, Zahedan, Iran. Email: *saffari56jilla@yahoo.com*

How to cite this article:
Khaghani S, Saffari J. Microwave-Assisted Chemical Preparation of ZnO Nanoparticles and Its Application on the Improving Grain Yield, Quantity and Quality of Safflower (Carthamus Tinctorius L.). J. Nanostruct. 2016; 6(1):43-48.
DOI: 10.7508/jns.2016.01.00*
URL: http://jns.kashanu.ac.ir/article_13641_2332.html