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Effect of iron nanoparticles and dry yeast extract on the yield and the productivity of corn (*Zea maize* L.)

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Abstract

This work was carried out at the Glass House at the Faculty of Agriculture/ Anbar University in the period between 2016 to 2017 Nano-iron and dry yeast extract were added to evaluate the response of maize productivity. Three concentrations of nano-iron, 0, 50, and 100 mg, were sprayed on the leaves The yeast extract of three concentrations 0, 100 and 150 grams per liter were sprayed on the leaves. The results showed the superiority of the treatments that were sprayed with nanoparticles with the highest rate of chlorophyll, the seed protein ratio and the percentage of seed oil. Significant levels were also recorded when spraying the plants with dry yeast extract. The interactions of 100 mg of nanotube and 150 g / l dry yeast extract characterized by the highest rate of chlorophyll, the oil content in the seeds (%)and the protein rate in the seeds (%)compared to other transactions.

Keywords: Iron, Nanoparticles, Dry Yeast, corn

تاثير الحديد النانوي ومستخلص الخميرة الجافة في حاصل وانتاجية الذرة الصفراء (*Zea maize* L.)

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الخلاصة

تم تنفيذ هذه التجربة في البيت الزجاجي في كلية الزراعة / جامعة الأنبار في الفترة ما بين عام 2016 وحتى عام 2017. حيث تمت إضافة مستخلص الخميرة الجافة و الحديد النانوي لتقييم استجابة الذرة الصفراء إلى ثلاثة تركيز من الحديد النانو ،حيث تم رش 0 و 50 و 100 ملغ على الأوراق ، ومستخلص الخميرة بثلاث تركيز 0 ، 100 و 150 غرام لكل لتر على الأوراق. وأظهرت النتائج تفوق المعاملات التي تم رشها بالحديد النانوي مع أعلى معدل من الكلوروفيل ، نسبة بروتين في البذور والنسبة المئوية للزيت في البذور. كما تم تسجيل ارتفاع في الصفات المدروسة عند رش النباتات بمستخلص الخميرة الجافة. اظهرت نتائج التداخل بين الحديد النانوي ومستخلص الخميرة الجافة تفوقا في الصفات المدروسه حيث اظهر التداخل 100 ملغ من الحديد النانوي و 150 غم / لتر من الخميرة الجافة بأعلى معدل للكلوروفيل ومحتوى الزيت في البذور (٪) ومعدل البروتين في البذور (٪) مقارنة بالمعاملات الأخرى.

Introduction

There is an unprecedented multidisciplinary convergence of scientists dedicated to the study of a world so small,which we can not see it even with a light microscope. That world is the field of nanotechnology, the realm of atoms and nanostructures. Nanotechnology is so new; no one is really sure what will come of it. Even so, predictions range from the ability to reproduce things like

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diamonds and food to the world being devoured by self-replicating nanorobots[1]. Nanotechnology (NT) can increase the quality and quantity of agricultural production, and make it more sustainable by decreasing pollution from agrochemicals, while improving climate resilience (Sustainable Development Goal (SDG). It also has the ability to add valuable nutrients to plants and detect and remediate heavy metals in the soil, and thus contribute to better health (SDG 3: Health and well-being. Furthermore, NT can foster more sustainable agricultural production (SDG 9: Industry, innovation & infrastructure[2]. Conventional nanoparticle synthesis methods like attrition and pyrolysis have drawbacks such as defective surface formation, low production rate, high cost of manufacturing, and large energy requirement[3]. They are some of the most important products of nanotechnology, whose benefits and drawbacks are believed to well exceed those of the industrial revolution. On one hand, some optimists claim that nanotechnology can reverse the harm done by industrialization[4]. On the other hand, in vitro studies, so far, have put a damper on these claims. Investments in nanotechnology are thus increasing rapidly worldwide[5].

Synthesize iron nanoparticles GT-Fe NPs (consisting mainly of iron oxide/oxohydroxide), using green tea extracts. These nanoparticles served as fentonlike catalyst for the degradation of cationic dyes such as methylene blue (MB) and anionic dyes like methyl orange (MO). Almost complete removal of both dyes was achieved in 200 and 350 minutes for MB and MO, respectively. In the case of GT-FeNPs, almost 100% removal of MB and MO was observed at an initial dye concentration of 10 mg/L and 100 mg/L. The efficiency was slightly lower for MB (96.3% for 10 mg/L and 86.6% for 100 mg/L) and significantly lower in the case of MO (61.6% for 10 mg/L and 47.1% for 100 mg/L) when iron nanoparticles were synthesized using the conventional borohydride reduction method[6].

Yeast as a natural source of cytokinins-stimulates cell division and enlargement as well \ nucleic acid and chlorophyll[7]. It is used as a kind of biofertilizer in soil fertilization or in foliar application on the shoots of vegetable crops[8]. This is because It contains many nutrient elements and being productive compounds of semi growth regulator compound like auxins. [9], reported that inclusion the foliar application of yeast to organic fertilization significantly increased potato yield in comparison with either the positive control or the corresponding treatments.

The aim of this work is to show and probe the effect of iron nanoparticles and dry yeast extract on the yield and the productivity of corn. The plant growth parameters (chlorophyll, carbohydrate, and protein contents) were investigated in this work.

MATERIALS AND METHODS

This work was carried out in Glass House at the Faculty of Agriculture/ Anbar University in the period between 2016 and 2017. The study involves the use of nano particles of spherical shape (ranged from 10 to 30 nm, average 20 nm). The size of the nanoparticles and its morphology were characterized by UV spectral analysis. The nano-iron and dry yeast extract addition on maize by spraying on the leaves was done in three concentrations for both nano-iron (0, 50 and 100) mg, and dry yeast extract (0, 50 and 100) grams per liter Iron nanoparticles were added daily in different concentrations (0, 25, 50, 75 and 100 ppm) for each test plant. Each concentration was prepared in three replicates. Chlorophyll A, chlorophyll B and carotenoid pigments were accomplished based on the method of Minoiu et al.[10], oil content in the seeds (%)was measured according to Nelson[11] and to Somogyi [12]. Protein content was measured according to Lowry et al.[13].

Statistical analysis of the treatments were conducted with three replicates and the results were presented as mean ± SD (standard deviation). Each of the experimental values was compared to its corresponding control. The results were analyzed by one way Anova with used Statistical Package for Social Sciences (SPSS) Version 11.5.

Preparation of yeast extract: The Yeast extract was prepared using a technique which allowed yeast cells (pure dry yeast) to be grown and multiplied efficiently during conducive aerobic and nutritional conditions that allowed to produce denovo beneficial bioconstituent, (carbohydrates, sugars, proteins, amino acids, fatty acids, hormones, etc.) These constituents could release out yeast cells in readily form by two cycles of freezing and thawing for disruption of yeast cells and releasing their content. Such technique for yeast preparation was modified after (Spencer et al, 1983). Chemical analysis of yeast extract after Mahmoued (2001) is presented in Table-1 Yeast extract was used at two concentrations, 25 and 50 ml /l. Zinc chelated (%13) was also used at two concentrations, 75 and 150 ppm.

I Iron nanoparticles were characterized by UV–Visible Spectrum, iron nanoparticles absorption spectra is at 400 nm. According to the manufacturer, the nanoparticle sizes ranged from 10 to 30 nm (average 20 nm). The absorption spectra are due to plasmon excitations of particles[14]. Distribution and particle sizes mainly depends upon spectral analysis[15]. The concentrations of iron nanoparticles were chosen in the range 0,100 and 150 ppm according to other studies[16].

Results And Discussion

The rate of chlorophyll in the leaves

Effect of iron nanoparticles on chlorophyll content (total chlorophyll) of corn (Zea mays) showed significant ($P < 0.05$) increase above the control values as shown in Table-2. At 50 ppm concentration of nano-iron chlorophyll A and chlorophyll B increased by 49% and 33% compared to the control in common bean (Phaseolus vulgaris). In corn (Zea mays) treated crop, the chlorophyll A and B increased by 46% and 26% compared to control, respectively. The results of the study indicate the morphological effect of nano-iron spraying on maize, while showing the superiority of the treatment when sprayed at the highest level of nano-iron with the highest ratio for chlorophyll in the leaves reaching **28.23 (mg^{-1})** but it recorded the lowest rate of chlorophyll when compared with the treatment that has not been sprayed with iron nano-iron may be attributed this moral rise at a rate of chlorophyll That the good influence of iron nanoparticles to raise the rate of chlorophyll in the leaves thus it will work to increase the process of photosynthesis this increase will increase the process of transporting manufactured materials from the source to the downstream. This is supported by the results of Liu and Lal [17] . They pointed out that the fertilizer nanoparticles are the best types of fertilizer as they stay longer around the perimeter of the root increasing the chance of absorption of these elements.

The addition of dried yeast extract to the leaves resulted in a clear increase in the chlorophyll rate in the leaves. The highest rate of chlorophyll was recorded in the plants that were treated with the highest rate of dry yeast (**16.51 mg^{-1}**) while the lowest chlorophyll was recorded in plants that were not sprayed with dried yeast extract (control). Previous studies have shown that dry yeast contains many growth catalysts such as algebra, oxyin and others, which lead to increased growth and activity of the plant cells[18].These results are consistent with the results of the dry yeast extractwhich has led to a clear rise in the rate of chlorophyll in the leaves. This effect is characterized by very important qualities, which depend on the ability of the plant to grow, build and produce.

The interaction between the experiments factors resulted in a clear significant effect on the chlorophyll rate in the leaves. The interaction between the nano-iron and the dry yeast extract gave the highest rate of chlorophyll (40.08 mg-1) while the lowest chlorophyll rate was recorded in the leaves when the plants were not treated with nano-iron fertilizer and dry yeast extracts, which gave a significant decrease from the rest of the treatments.The addition of manure makes the roots highly capable of intercepting and absorbing the nutrients from the soil solution [19]. The mass flow of ions plays a role in this field as the elements are transported to the surface of the roots with the water movement. This mechanism helps the roots to absorb the largest amount of nutrients. The availability of water helps to increase the movement of elements to the roots in a manner of flow and spread. The addition of dry yeast extract has increased the the ability of the cell
to divide and stimulate the growth and construction process[20].

Table 1-Effect of Nano -iron concentration (ppm) and dry yeast extract levels on total leaf chlorophyll content (mg^{-1}).

dry yeast extract levels	Nano-iron concentration (ppm)					Average
	0	25	50	75	100	
150 g	16.51	22.45	28.34	36.23	40.08	**28.72**
100 g	14.12	19.85	23.11	32.34	36.54	**25.19**
0 g	13.45	15.43	18.33	24.43	28.23	**19.97**
Average	**14.69**	**19.24**	**23.26**	**31**	**34.95**	
LSD (0.05)	**Nano-iron concentration (ppm)= 1.726 Dry yeast extractlevels= 0.281 Nano-iron concentration (ppm)×Dry yeast extractlevels= 3.859**					

Oil content in the seeds (%)

The results of the statistical analysis showed the response of the maize to the nano-iron and dry yeast extract. Significant results were recorded.

The plants that were sprayed with nano-iron were characterized by the highest rate of oil content in the seeds (2.8%) ; significantly different compared with the plants which were not treated with nano-fertilizer (control) where the lowest rate of oil content in the seeds (%)(1.8%) was recorded that is significantly lower than the rest of the treatments. This increase may be due to the effect of iron in the direct nano formula in raising the rate of carbohydrates in the seeds. This may be due to the fact that nanoparticles provide a larger surface area for different metabolic reactions in the plant, which increases the rate of photosynthesis and also preserves the plant from various stresses.

The results in Table-2 shows the superiority of the treatment of Spraying with dry yeast extract on the rate of oil content in the seeds (%). The highest rate of oil content in the seeds (%) was recorded in the plants that were sprayed with the highest rate of dry yeast extract which was significantly different from other treatments While the lowest rate of oil content in the seeds (%)was recorded in the plants that were not treated with dry yeast extract (control) which was significantly lower compared with the rest treatments that were processed with dry yeast extract.Dry yeast is a source of natural cytokinein, which contributes to the increased division and expansion of cells and the manufacture of routine, as well as nucleic acids and chlorophyll, hence the possibility of using yeast as a safe fertilizer for the plant[21].

The results of Table-2 shows that the interaction between the nano-iron and the dry yeast extract was higher than that of the other oil content in the seeds (%), while the lowest oil content in the seeds (%) was recorded in plants that were not treated with dry yeast extract (control) where the oil content in the seeds (%)rate was (1.8%) significantly lower than the other parameters that were not processed with the nano-iron and dry yeast extract.The iron is targeted the cell wall and increases the efficiency of biochemical conversion, facilitating the permeability of nutrients into the plant. This helps to increase cell division, thus providing a continuous demand for the nutrients that the plant takes from the soil[22].

Spraying of dry yeast has a resulted in increased vegetable growth, which has been positively reflected on root crops to provide a strong root mass capable of absorbing nutrients from the soil and delivering them to the plant. Therefore, plant growth or nitrogen effect is stimulated to produce abundant vegetative growth through its photosynthetic process and processes other protoplasmic construction[23].

Table 2-Effect of Nano-iron concentration (ppm) and Sprayed dry yeast extract levels on oil content in the seeds (%).

Dry yeast extract levels	Nano-iron concentration (ppm)					Average
	0	25	50	75	100	
100 g	2.8	4.4	4.9	5.5	6.1	**4.74**
50 g	2.1	4.2	4.5	5.3	5.7	**4.36**
0 g	1.8	3.9	4.2	5.0	5.5	**4.08**
Average	**2.23**	**4.16**	**4.53**	**5.26**	**5.76**	
LSD (0.05)	**Nano-iron concentration (ppm)= 0.219 Dry yeast extract levels = 0.473 Nano-iron concentration (ppm)×Dry yeast extract levels = 0.490**					

Protein rate in seeds (%)

The results of the statistical analysis showed the response of the maize to the nano-iron and dry yeast extract where significant results were recorded. The plants that were sprayed with nano-iron were characterized by the highest rate of protein (9.9 %) significantly different from those that were not treated with the nano-fertilizer (control), it recorded the lowest rate of protein rates (5.6) % significantly lower compared with the rest of the treatments. This may be due to the close connection between the breathing and nutrient uptake, as the process of respiration is the basis of energy in the process of absorption, the iron is the decisive factor in this. Iron also activates a number of enzymes and contributes to the building of nucleic acids in the plant cell and improves the performance of optical systems in the plant also urges the process of opening and closing the gaps in the leaves, which increases the process of transpiration thus increases the absorption at the roots.

The results in Table-3 shows the clear superiority of the treatments that are of spraying with the dry yeast extract to raise the protein rate in the seeds. The highest rate of protein was recorded in the plants that were sprayed with the highest rate of dry yeast extract by a significant difference from the rest of the other treatments. Lowest protein was recorded in comparison with treatments that were not treated with dry yeast.

Al-Shaheen et al.[24]stressed that dry yeast leads to the construction of a radical root, capable of absorbing the main nutrients and meeting the requirements of vegetative growth of water and nutrients. Saito cayenne works to stimulate cell division and prolongation and stimulate the representation of protein, nucleic acids and chlorophyll delayed aging of leaves.The lowest rate of protein was recorded in the leaves when the plants were not treated with yeast (control), significantly lower compared with the rest treatments that were treated with dry yeast extract.

The interaction between the experimental factors has a clear effect on the rate of protein in the seeds. The interaction between the nano-iron and dry yeast extract gave the highest rate of protein in the seeds (9.9%), while the lowest rate of protein in the seeds was recorded in plants that were not treated with nano-iron and dry yeast extract,which showed a significant decrease compared with the other treatments.

Table 3-Effect of nano-iron concentration (ppm) and sprayed dry yeast extract levels on percentage of protein in the seeds (%)

dry yeast extract levels	**Nano-iron concentration (ppm)**					**Average**
	0	**25**	**50**	**75**	**100**	
0 g	6.8	8.5	8.9	9.7	9.9	**8.76**
100 g	6.5	8.1	8.5	9.1	9.4	**8.32**
150 g	5.6	7.4	8.0	8.4	8.9	**7.66**
Average	**6.3**	**8**	**8.46**	**9.06**	**9.4**	
LSD (0.05)	**Dry yeast extractlevels = 0.214** **Nano-iron concentration (ppm)= 0.367** **Dry yeast extractlevels× Nano-iron concentration = 0.478**					

Conclusion

The addition of nano-iron resulted in a clear increase in all studied traits, increase of plant growth rate and productivity The use of dry yeast extract gave positive effects All the plants that have been sprayed with dry yeast extract yielded the highest rate of all the studied parameters. The interaction between the iron nanoparticles and dry yeast extract has given significant differences in the studied parameters.

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