Growth and productivity of Onion (Allium cepa L.) as influenced by set size and spraying with Nanocarbon.

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Abstract. A field study was conducted in Diwaniyah city at the winter season 2017-2018 for studying the effect of the set size and Nanocarbon compounds on the growth and yield of onion plant Allium cepa L. Three set sizes (small, medium and large) and two Nanocarbon concentrations (0 and 500 mg/L) were used in the experiment. A range of vegetative traits including plant height and number of leaves, total leaf area, chlorophyll rate and number of roots were studied. In addition to yield characteristics that includes number of bulbs, fresh and dry weight and productivity. The results showed that set size and Nanocarbon compounds significantly affected the vegetative growth of the studied plants. Plants planted with large sets and treated by 500 mg/L Nanocarbon scored the best results for plant height, chlorophyll rate and leaf area. In which, it recorded the highest plant height (70.1 cm), and the maximum chlorophyll content (80.18 mg/ml), and the maximum leaf area (5.21 cm²), compared to control treatment which scored (26.5 cm), (47.59 mg/ml), (2.21 cm²) for the same parameters above. The number of leaves/plants increased with the increase in set size while it decreased when treated by all Nanocarbon concentration. The large set gave the highest number of leaves/plants when not treated by Nanocarbon as it reached 8.5 leaves, in comparison with those treated by Nanocarbon and the comparison treatment which reached 7.1 and 7.5 respectively. The plants planted with medium sets and treated by (500 mg/L) of Nanocarbon gave the largest number of roots/plant reached 90.1 root, compared to control plants, which have 68 root only. Large set plants treated by 500mg/L, carbon nanotubes increased the number of double bulbs, fresh weight, dry weight and productivity increased to 7.9, 31.01g, 9.0 g and 70.017 respectively in comparison to control plants which scored 1.8, 27.59g, 2.531g and 64.636 for the same parameters respectively.

Key words: onion, Allium cepa, set size, multiwalled carbon nanotubes, Nanocarbon.

1. Introduction

Onion, Allium cepa L. that belongs to the family Amaryllidaceae, are an economically and nutritional important vegetable crop, on both local and international level. In Iraq, It is one of the most consumed vegetables and it comes at the fourth place in terms of consumption, after tomatoes, potatoes and cucumbers (USAID-Inma, 2012). Its nutritional importance came from the presence of phosphor and calcium and a group of vitamins containing vitamins C and B and folic acid and others (Elhassaneen, and Sanad, 2009). Many studies demonstrated that onions also have positive medical effects (negi, 2012; Edith, et. al., 2018; Dini, et.al., 2008).
Despite the great importance of this crop, it is clear that Iraq's onion production has been steadily deteriorating over the last decade. Statistics from the World Food and Agriculture Organization indicated a significant decrease in Iraq's onion production. Which has gradually decreased from 170.157 kg / ha in 2011 to 101.810 kg / ha in 2015 to 56.659 kg / ha in 2017 (FAOSTAT, 2018).

In addition, Onion production in Iraq often involves many fungal infections either in the field, during harvest or during storage. Which decrease production and Causes significant economic losses (Lahmood and Manher, 2016). While Iraq's production from onion is dropping off, according to the latest statistics of the World Food and Agriculture Organization (Shown above), the need for it and its consumption rate is increasing. Iraq needs 535,000 Kg of onions annually, and Imports for onions from Iran and Syria are almost 65% of the country's needing. On the other hand, Market prices for onions have shown an upward trend since 2009, following changes in foreign policy toward Iran and Syria which significantly reduced support and subsidies for onion cultivation in Iraq (USAID-Inma, 2012).

Due to all of the aforementioned issues, it is necessary to use the best methods and modern technologies that can lead to increase the productivity and improve the quality of cultivated onion. Nanotechnology is among these promising technologies that promise to improve agricultural processes and increase productivity at an optimal level (Taha, 2016). Nanotechnology, the use of nanoparticles ranging in sizes from 100-1.1 nanometers (Husen and Siddiqi, 2014), showed positive effects in wide areas of science such as medicine, engineering, agriculture, and food (Mousavi and Rezaei, 2011; Klaine, et.al., 2008).

Yassin and others (2016) noted in their study on Sunflower (Helianthus annuus L.) that the use of nanoparticles with three concentrations (0, 25 and 50 ml/ L) showed positive effects on average number of leaves, number of branches and leaf contents of carbohydrate. Yaseen and mejbel (2017) experimented different concentrations of different nanoparticles on the yiel of sweet peper Capsicum annum L. and confirmed that the use of nanoparticles caused significant increase in fruit yield.

The uptake of carbon nanotubes by plants has shown a very recent area of nanoscale farming. Nanotubes are able to interact with biological molecules and create functional nanomaterials for the transfer of other substances within cells that lead to the interaction between nanotubes and other compounds at the morphological, cellular and even molecular levels (Khodakovskaya et al., 2011). Al-Rekaby (2018) explained that the treatment of Karkade Hibiscus sabdariffa L. with carbon nanotubes caused a significant increase in the characteristics of vegetative growth as well as quantitative and qualitative changes in their secondary metabolites. marhon and others, (2018) found that spraying Vinga unguiculatal with nanocarbon spray and yeast suspension led to significant increase in vegetative growth characters, quantitative and qualitative characters yield.

The set size used in agriculture is an important factor in increasing the productivity of many vegetables. Large-sized sets are often packed with nutrients that feed the embryo for longer periods of time, helping to produce strong growth crops capable of withstanding environmental conditions (Michael et.al., 2012). Yassen and Kadim (2013) found that the use of large sized onion sets significantly enhanced most vegetative growth characteristics and productivity of onion plants, it also increase the percentage of carbohydrates , vitamin C and quercetin compared to the use of small set.

Due to the lack of studies on the effect of carbon nanotubes and the set size on the growth and yield of onion plants, this experiment came to study the effect of the addition of nano-carbon compounds on the growth and production of onion plant grown in the city of Diwaniyah.
2. Materials and Methods

A field experiment was conducted in the Department of biology - colleg of Science - University of Al-Qadisiyah, to study the effect of the set size and the concentration of multi-layer carbon nanotubes on the growth and yield of white onions grown in the city of Diwaniyah. The experiment was carried out with the design of complete random blocks (RCBD) with a factorial organization, using three set sizes (small, medium, large) and two concentrations of multi-layer carbon nanotubes (0 and 500 mg / L) with three replicates per treatment.

The white onion plantations were planted on / 2017 in pits within lines the distance between a pit and another was 30 cm while the distance between one line and another was 75 cm. Multi-layer carbon nanotubes were added to spray on plant and soil leaves until the total wetness and with concentrations of 0 and 0.200 mg / L on 2/1/2018. fertilization were carried out according to the recommendations of the onion crop. Compos was used at 280 kg / ha after laying the seeds directly in the soil. Urea fertilizer was used at 240 kg / ha, after 40 days of planting. The bush was removed in a hand-held manner several times. Irrigation was done according to the need of plants and stopped before a week from harvesting to preserve the crop from damage. After completion of the experiment (26/2/2016) several growth indicators were measured includes Plant height (cm), Number of leaves per plant, total leaf area (cm. Plants), The number of leaves per plant, fresh and Dry weight, Number of roots (root of plant), Roots fresh weight, Number of double bulbs and Productivity.

The obtained data were analyzed by two way analysis of variance test and The significance of the differences were compared by using Duncan multiple range test (p<0.05).

3. Results and Discussion

According to the results of analysis of variance, significant interaction between set size and Nano carbon application was observed in all evaluated parameters.

Figure (1) shows the effect of study factors and their interference in some vegetative growth characteristics. It is noticed from the figure that the height of the onion plant increased significantly by the addition of the nanoparticles to all the set sizes used in transplanting. The increase in plant height was highest when adding 500 mg /L To the large sets of onions plants as the plant height increases from 26.5 to 70.1% cm.

![Figure 1: Influence of nanocarbon and set size on plant height (cm) of onion. (Treatments having the same letters are not different significantly according to DMRT at p<0.05)](image-url)
Chlorophyll significantly increased in response to the addition of 500 mg L of nanoparticles in all the set sizes used in the study, maximum chlorophyll content was with the large sets as it reached 80.18 mg /L in comparison with the control treatment 47.59 mg/L (figure2).

Onions planted with large sets and treated by 500 mg/L Nano-carbon scored the best results for leaf area(figure3). In which, it recorded the maximum leaf area 5.21 cm² compared to control treatment 2.21cm². figure(4) showed that The number of leaves/plants increased with the increase in set size while it decreased when treated by Nano-carbon. The large set gave the highest number of leaves/plants when not treated by Nano carbon. as it reached 8.5 leaves, in comparison with those treated by Nano carbon and the comparison treatment which reached 7.1 and 7.5 respectively.

**Figure (2):** Influence of carbon nanotubes and set size on chlorophyll content (mg/L) of onion (Treatments having the same letters are not different significantly according to DMRT at p<0.05)

**Figure (3):** Influence of carbon nanotubes and set size on leaf area (cm²) of onion (Treatments having the same letters are not different significantly according to DMRT at p<0.05)
The number of roots increased significantly with the addition of nano-carbon compounds at a concentration of 500 mg /L. onions planted with medium sets and treated by (500 mg/L) of Nano-carbon gave the largest number of roots/plant as it reached 90.1 root, compared to control plants, which have 68 root only, and with those planted with small and large sets which have 75 and 85.7 roots respectively.

![Figure (4): Influence of carbon nanotubes and set size on No. Leaf/plant of onion](image1)

*Figure (4): Influence of carbon nanotubes and set size on No. Leaf/plant of onion (Treatments having the same letters are not different significantly according to DMRT at p<0.05)*

![Figure (5): Influence of carbon nanotubes and set size on No.root/plant of onion](image2)

*Figure (5): Influence of carbon nanotubes and set size on No.root/plant of onion (Treatments having the same letters are not different significantly according to DMRT at p<0.05)*

These results are consistent with the findings of Canas et al. (2008) on a range of vegetable plants, which included onion and other plants. Khodakouskaya, 2009 and 2011 also obtained similar results on potato plants.

These increases in growth parameters, is due to the growth promoting effects of Nanocarbon. Multi-walled Nanocarbon tubes can be considered as growth requirements because of its role in activating cell division, wall formation, water transport, nutrient uptake from soil. Nanocarbon can Increase
nitrogen and phosphorus uptake in the soil, in contrast, reduces sodium concentrations in which increases different growth activities (Rico, et.al.,2011; Khodorkovsky, et al., 2012).

Yield characteristics of onion responded positively to the treatment with nano-carbon compounds and the increase in set size. It is noted from the figure (6) that the number of bulbs of the study plants increased significantly when treated by 500 mg/L nano-carbon with all the set sizes used in the study, with the maximum number of bulbs 8.9 referred to plants planted with large sets

![Figure 6](image)

**Figure (6):** Effect of Nano-carbon compounds and set size on no. bulbs of onion (Treatments having the same letters are not different significantly according to DMRT at p<0.05)

Fresh weight and dry weight also responded positively to the addition of carbon nanotubes. As shown in figure (7) below, Fresh weight increased by 4.67% , 6.93% and 9.52% for small, medium and large sets respectively.

![Figure 7](image)

**Figure (7):** Effect of nano-carbon compounds and set size on fresh weight (cm) of onion (Treatments having the same letters are not different significantly according to DMRT at p<0.05)

dry weight at the same time increased by 31.21% , 48.11% and 36.93% for small, medium and large sets respectively (figure 8).
Figure (8): Effect of nano-carbon compounds and set size on Dry weight (cm) of onion (Treatments having the same letters are not different significantly according to DMRT at p<0.05)

Figure (9) emphasize that the increase in plant growth and weight has achieved an actual increase in the plant productivity. Productivity of onions planted with all studied set sizes significantly increased due to the treatment with Nanocarbon. In which the maximum productivity reached 70.17 (kg/m²) for those planted with large sets and treated by 500 mg/L Nanocarbon, while it reached 64.636 (kg/m²) for the control plants.

Figure (9): Effect of nano-carbon compounds and set size on productivity (kg/m²) of onion (Treatments having the same letters are not different significantly according to DMRT at p<0.05)

These results are similar to those reached by Marhoon et.al (2018) where they found that the use of nanocarbon spray led to significant increase in quantitative and qualitative characters of Vinga unguiculatal yield.

The effects of nanoparticles on the growth and yield of the studied plant are due to the small sizes of carbon nanotubes of (8-15 nm) associated with an increase in surface area, due to their being multi-walled, which make it work as transport systems. Heydari (2013) points out that the permeability and interaction of Nanocarbon tubes with plant systems cause a range of functional changes that eventually
lead to increased biomass. Nanocarbon permeability is due to its tubular form that regulates and facilitates the passage of water through tissue as it increases transport efficiency and that ensures easy access through leaf surfaces. Thus, the treatment of plants by multi-walled nanocarbon tubes increases the absorption of water, changes the lipid composition, stiffness and permeability of cellular membranes and activates the Co2 assimilation. all above-mentioned activities lead at the end to changing the growth and development of plants.

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