



Effect of Foliar Spray of Nano Silver and Organic Fertilizer (Algastar) and Salicylic Acid on Some Morphological Characteristics and Carbohydrate Content in (*Helianthus annuus* L.)

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted to check the effect of foliar spray of nano and organic fertilizers and a growth regulator on vegetative growth of sunflower crop. Sunflower (*Helianthus annuus* L.), Spanish class (Viki) was cultivated from march 2013 to June 2013 at College of Agriculture, University of Wasit, Iraq. Three levels of nano silver viz., control, 25 and 50 mL/L; three levels of organic fertilizer (Algastar) viz., control, 0.75 and 1.5 g/L and three levels of salicylic acid viz., control 60 and 120 mg/L were foliar sprayed at 65 days old sunflower crop. Results showed that foliar spray of 50 mL/L of nano silver, 1.5 g/L of organic fertilizer (Algastar) and 120 mg/L of

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salicylic acid have a positive effects on average number of leaves, number of branches and leaf contents of carbohydrate. There was no significant interaction among nano silver, organic fertilizers and salicylic acid on all studied traits of sunflower.

Keywords: Nano silver; Algastar; carbohydrate.

1. INTRODUCTION

Sunflower is a native of western North America and introduced in Europe and Russia in sixteenth century and has spread in the tropical and temperate countries including Russia, Argentina, the combined European Union, Turkey, and South Africa. Its cultivation has increased recently which is due to the growing demand for monounsaturated sunflower oil although the intrinsic demand remains for polyunsaturated oil. Monounsaturated oil needs to contain more than 85% oleic acid [1]. Sunflower crop is an important for the production of oils after peanut (*Arachis hypogaea* L.) and soybean (*Glycine max* L.) and the global production of sunflower seeds has increased from 26-31 million tons between 2004-2006 [2,3]. Particularly, we must use the best methods and new technologies to improve the production of sunflower in developing countries especially in Iraq. Among these technologies is the one that is provided by technical science "technologies minor" or Nanotechnology, in which nano materials are used in sizes ranging from 1-100 nm [4].

Generally, nano materials refer to a colloidal particulate system, with size ranging from 10 to 1000 nm, possessing unique properties, such as size dependent qualities, high surface to volume ratio, and promising optical properties [5]. Nano silver particles have a positive effects on plant growth and development. Recently, on one hand, biosynthesized AgNPs have shown a significant effect on seed germination and induced the synthesis of protein and carbohydrate, also AgNPs have enhanced seed germination and seedling growth. AgNPs have increased plant growth profile (shoot and root length, leaf area) and biochemical attributes (chlorophyll, carbohydrate and protein contents) [6]. On other hand, organic fertilizer (Algastar) also is regarded as an organic, natural fertilizer that extracted from marine extracts which is amino acids in nature and natural hormones and it consists of nitrogen (1%), potassium (18%) alginic acid more than 10%, sulfur 1.3%, plant growth regulators and organic matter 45%. It contributes to increase in proportion of germination and it is

able to produce strong seedlings, and increases the productivity and fruit quality, and it is suitable for all types of crops. Salicylic acid (SA) or ortho-hydroxy benzoic acid is known as one which can affect various physiological growth of plants and may play as a key role in regulating their growth and productivity. Salicylic acid is considered to be an endogenous growth regulator of phenolic compound work to stimulate morphological growth of plants [7]. Thus, the aim of this study is to find the effect of foliar spray of nano silver, organic fertilizer and salicylic acid alone and in combinations on improving the vegetative growth including some morphological characteristics and carbohydrate contents (*Helianthus annuus* L.).

2. MATERIALS AND METHODS

This study was conducted in fields of Wasit Governorate in 2013, College of Agriculture, University of Wasit, Iraq. The soil was sandy loam in texture with pH 7.5, EC2.98 dS m⁻¹, organic carbon 37.52 mg/kg, available P 68 mg/kg, available N 13 mg/kg and available K 143 mg/kg. Soil samples were taken to a depth of 30 cm and soil types occurred in simple patterns. The area of field was 364 m² (40.5 m length × 9 m width). It was divided into three blocks and the area of each block was 121.5 m² (40.5 m length × 3 m width) and every block was further divided into 27 panels with a total of 81 panels, the area of each plate was (1.5 m × 3 m) in which one panel contained 20 seeds. The treatments were foliar sprayed at 65 days old plants. The levels of nano silver were 25 and 50 mL/L and 0.75 and 1.5 g/L of Algastar and 60 and 120 mg/L of salicylic acid in addition to the control. The average number of leaves, number of branches and leaves content of carbohydrate in leaves [8] was determined after 14 days of foliar treatments.

2.1 Statistical Analysis

The experiment was RCBD with three factors factorial in triplicates of each treatment. Statistical analysis was carried out using SPSS of three-way ANOVA test. Less significant difference ($p < 0.05$) values are calculated for comparisons of treatment means [9].

3. RESULTS AND DISCUSSION

3.1 Average Number of Leaves

The results showed that nano silver had a significant effect on average number of leaves, (see Table 1). The average number of leaves increased steadily which was due to the increase in the concentrations of particles of nano silver from 25 mL/L to 50 mL/L and the average number of leaves increased from 21.93 to 24.15. The highest number of leaves were recorded in plants that were sprayed with 50 mL/L of nano silver particles. The organic fertilizer (Algastar) had also a significant effect on the average number of leaves. Similarly, the average number of leaves increased steadily because of the increase in the level of organic fertilizers. Maximum number of leaves was counted with 1.5 g/L (23.52) of organic fertilizer in comparison to 0.75 g/L (21.37) and control (17.41) respectively. Besides, the use of salicylic

acid at different levels resulted in high average number of leaves. The maximum number of leaves (22.81) was recorded with 120 mg/L of salicylic acid in comparing with 60 mg/L salicylic acid and control that showed 21.11 and 18.37 leaves respectively.

The interaction effect between nano silver particles and organic fertilizer (Algastar) was found significant on the average number of leaves (see Table 1). The maximum number of leaves was recorded in crop sprayed with 50 mL/L nano silver and 1.5 g/L organic fertilizer followed by 50 mL/L nano silver and 0.75 g/L organic fertilizer (24.67); minimum number of leaves (14.11) was recorded in control plots. The interaction effect between the nano silver particles and salicylic acid on the average number of leaves was non-significant. The combination contained 50 mL/L nano silver particles and 120 mg/L of salicylic acid, which produced the highest number of leaves

Table 1. Represents the effect of nano silver (mL/L), organic fertilizer (Algastar) (g/L) and salicylic acid (mg/L) and their two and three way interactions on average number of leaves

Nanosilver (N)	Organic fertilizer (Algastar) (O)	Salicylic acid (S)			N × O means
		0	60	120	
0	0	13.33 i	13.67 h	15.33 h	14.11 g
	0.75	14.33 h	16.67 g	18.00 g	16.33 f
	1.5	16.00 e	18.67 f	20.00 f	18.22 e
25	0	15.33 f	19.33 e	20.00 f	18.22 e
	0.75	20.67 c	24.00 c	24.67 d	23.11 c
	1.5	21.33 b	25.00 b	27.00 b	24.44 b
50	0	17.67 d	20.33 d	21.67 e	19.89 d
	0.75	23.00 a	24.33 c	26.67 c	24.67 b
	1.5	23.67 a	28.00 a	32.00 a	27.89 a
Means salicylic acid		18.37	21.11	22.81	
LSD 0.05%			5.17		0.89
Nanosilver (N)	S means			N means	
	0	60	120		
0	14.56 c	16.33 c	17.78 c	16.22 c	
25	19.11 b	22.78 b	23.89 b	21.93 b	
50	21.44 a	24.22 a	26.78 a	24.15 a	
		0.89		5.17	
Organic fertilizer (O)	S means			O means	
	0	60	120		
0	15.44 c	17.78 c	19.00 c	17.41 c	
0.75	19.33 b	21.67 b	23.11 b	21.37 b	
1.5	20.33 a	23.89 a	26.33 a	23.52 a	
		0.89		5.17	

Alphabets showed the significant based on means comparison tests

(26.78) that was significantly different from the combination of 50 mL/L of nano silver with 60 mg/L of salicylic acid (24.22). The interaction between the concentrations of organic fertilizers and salicylic acid also showed the significant effect on number of leaves. The combinations of organic fertilizer (0.75 and 1.5 g/L) with salicylic acid (60 and 120 mg/L) produced average number of leaves significantly more higher than the control treatment amounting to 15.44 or with the use of 60 or 120 mg/L of salicylic acid without organic fertilizer 17.78 and 19.00 respectively.

3.2 Number of Branches

The effect of nano silver, algastar and salicylic acid and along with their interactions was significant for the number of branches in sunflower plants. Nano silver resulted in increasing in the number of branches 11.50 as the rate reached to the concentration of 50 mL/L, which differed significantly from the use of 25 mL/L concentration (8.15), compared with control (3.63). Organic fertilizer also achieved a significant increase in the number of branches

when using a different concentration of 1.5 g/L (9.59), that was significantly different from the use of 0.75 g/L (7.67) compared with control (5.78). Spraying with salicylic acid showed a high number of branches (9.30) when treated with 120 mg/L in comparison to control (5.89) and also it differed significantly when sprayed with 60 mg/L salicylic acid (7.85) respectively. The interaction effect between nano silver and organic fertilizer showed no significant impact, while the interaction effect between the nano silver particles and salicylic acid had a significant effect on number of branches. The combinations contained nano silver with 60 and 120 mg/L salicylic acid which recorded a significant increase in the number of branches compared with other treatments that didn't include nano silver particles. The interaction effect between the concentrations of organic fertilizers and salicylic acid also showed that all combinations of organic fertilizer (0.75 and 1.5 g/L) with concentrations of salicylic acid (60 and 120 mg/L) resulted in more number of branches than the control (4.44) or with the use of 60 or 120 mg/L of salicylic acid without organic fertilizer was 5.67 and 7.22 respectively. There was no interactive effect

Table 2. Represents the effect of nano silver (mL/L), organic fertilizer (Algastar) (g/L) and salicylic acid (mg/L) and their two and three way interactions on number of branches

Nanosilver (N)	Organic fertilizer (Algastar) (O)	Salicylic acid (S)			N × O Means
		0	60	120	
0	0	1.67 g	2.00 h	2.67 i	2.11 h
	0.75	2.33 f	3.67 g	4.33 h	3.44 g
	1.5	3.33 e	6.00 f	6.67 g	5.33 f
25	0	5.00 d	6.00 f	8.00 f	6.33 e
	0.75	6.33 c	8.33 e	9.67 e	8.11 d
	1.5	7.33 b	10.33 c	12.33 c	10.00 c
50	0	6.67 c	9.00 d	11.00 d	8.89 d
	0.75	10.00 a	11.00 b	13.33 b	11.44 b
	1.5	10.33 a	14.33 a	15.67 a	13.44 a
Means salicylic acid (mg/L)		5.89	7.85	9.30	
LSD 0.05%		5.18			N.S
Nanosilver (N)		S Means			N Means
		0	60	120	
0		2.44 c	3.89 c	4.56 c	3.63 c
25		6.22 b	8.22 b	10.00 b	8.15 b
50		9.00 a	11.44 a	13.33 a	11.26 a
		0.89			5.18
Organic fertilizer (O)		S Means			O Means
		0	60	120	
0		4.44 c	5.67 c	7.22 c	5.78 c
0.75		6.22 b	7.67 b	9.11 b	7.67 b
1.5		7.00 a	10.22 a	11.56 a	9.59 a
		0.89			5.18

Alphabets showed the significant based on means comparison tests

among Nano silver particles, organic fertilizers and salicylic acid on number of branches in sunflower.

3.3 Carbohydrate Contents in Leaves (%)

Results in Table 3 showed the carbohydrate in leaves which increased significantly with successive increase in the concentrations of nano silver particles as it reached to 46.78 % when it treated with 50 mL /L, which was significantly different from the concentration of 25 mL/L (42.59%) and the treatment of control up to 36.89% respectively. The use of organic fertilizer (Algastar) showed the effect of carbohydrate on leaves reached to 44.67% when using 1.5 g/L, which differed from the less concentration of 0.75 g/L, and it gave 43.04%. Salicylic acid with 120 mg/L achieved a high proportion in leaves content of carbohydrates (44.56%), which was significantly different from the use of 60 mg/L as it gave 42.44% and it differed from the control treatment 39.26%.

On one side, the three way interactive effect of nano silver particles and organic fertilizer, and the two way interactive effect of salicylic acid and

the organic fertilizer were non-significant for carbohydrate contents in leaves. This can be explained by the impact of nano silver or organic fertilizer or salicylic acid as single or combined to disrupt the main ingredient in morphological characters especially number of leaves and number of branches. In this study, the impact of the factors which resulted in increasing in the average number of leaves and it is shown in Tables 1 and 2 which may possibly due to the use of AgNPs and it acted as inhibitors of ethylene perception. Besides, it could represent the effect of nano silver (mL/L), organic fertilizer (Algastar) (g/L) and salicylic acid (mg/L) (see Table 3) and their two and three way interactions on carbohydrates contents in leaves (%)interfere with ethylene biosynthesis which increased the plant growth especially the average number of leaves and branches of leaves [10]. The application of organic fertilizer increased the cell division and elongation without hampering the nutrient uptake process and it provided better results which was due to the better nutrition. Therefore, it improved the morphology of plants especially the average number of leaves and number of branches [11,12,13].

Table 3. Represents the effect of nano silver (mL/L), organic fertilizer (Algastar) (g/L) and salicylic acid (mg/L) and their two and three way interactions on carbohydrates contents in leaves

Nanosilver (N)	Organic fertilizer (Algastar) (O)	Salicylic acid (S)			N × O Means
		0	60	120	
0	0	30.33 h	32.33 i	35.67 h	32.78 h
	0.75	34.67 g	38.33 h	40.67 g	37.89 g
	1.5	36.33 f	41.00 f	42.67 f	40.00 f
25	0	37.67 e	39.33 g	43.00 e	40.00 f
	0.75	40.67 d	44.00 e	46.00 c	43.56 d
	1.5	41.67 c	46.00 c	45.00 d	44.22 c
50	0	40.00 d	43.33 d	45.33 d	42.89 e
	0.75	45.67 b	47.67 b	49.67 b	47.67 b
	1.5	46.33 a	50.00 a	53.00 a	49.78 a
Means salicylic acid (S)		39.26	42.44	44.56	
LSD 0.05%		0.984			N.S
Nanosilver (N)		S Means			N Means
		0	60	120	
0		33.78 c	37.22 c	39.67 c	36.89 c
25		40.00 b	43.11 b	44.67 b	42.59 b
50		44.00 a	47.00 a	49.33 a	46.78 a
		N.S			0.984
Organic fertilizer (O)		S Means			O Means
		0	60	120	
0		36.00 c	38.33 c	41.33 c	38.56 c
0.75		40.33 b	43.33 b	45.44 b	43.04 b
1.5		41.44 a	45.67 a	46.89 a	44.67 a
		N.S			0.984

Alphabets showed the significant based on means comparison tests

Moreover, SA as shown in Tables 1 and 2 is of phenolic in nature, which participates in the regulation of physiological processes in plants as well as the foliar application of SA may play a significant role in plant water relations, photosynthesis, growth rate and stomata regulation, as well as ion uptake and transport, membrane permeability, raising indoleacetic acid content and enhancing of cell division and extension of shoot cells [14,15]. The impact of the factors in this study which resulted in increasing in the carbohydrate of leaves is shown in Table 3 may possibly be in accordance with the photosynthetic pigments for corresponding AgNPs treatment as well as low concentrations of nano silver caused increasing soluble sugar [10,16]. This improvement in the total carbohydrates content as a result of foliar organic fertilizer could be attributed to the mode of action in the macro and micro elements to enhance photosynthetic activity and enzymes of carbohydrates transformation [17,18].

SA application might activate the metabolic consumption of soluble sugars to form new cell constituents as a mechanism to stimulate the growth of sunflower plants. Photosynthetic pigments were increased in response to salicylic acid treatments and thus they enhance biosynthesis of total carbohydrates significantly (Table 3) which are utilized in growth of sunflower plants. These results are in line with the findings of Dawood et al. [19].

4. CONCLUSIONS

Nano silver, algastar and salicylic acid have a positive impact on the growth of sunflower either in alone or in combination. The high concentrations of foliar sprayed nano, organic and growth bioregulator have increased the number of leaves and number of branches in sunflower while 50 mL/L of nano silver with 1.5 g/L of organic fertilizer have increased carbohydrate contents in leaves as compared with other interactions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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