



Evaluation of Spraying Nano Sea Algae Extract on Growth and Yield of *Cucurbita pepo* L.

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Abstract: This study was conducted in Kufa, Najaf province, during the 2019-2020 season to examine the effect of spraying nano sea algae extract (no spraying, 0.5, and 1 ml L⁻¹) on the growth and yield of two cultivars of *Cucurbita pepo* L. c. v. (Domestic and Fadwa). The experiment was set up in a split-plot layout, where the cultivars were the main plots and the concentrations were in subplots with three replicates. Fadwa cultivar excelled the domestic cultivar in vegetative growth, including plant length, total number of leaves, and fresh and dry weight. Spraying with nano sea algae extract at 0.5 ml L⁻¹ concentration significantly improved vegetative growth for both cultivars compared to the control treatment (spraying with water only). The interaction between cultivars and sea algae extract was also significant, as Fadwa + spraying 0.5 ml L⁻¹ of sea algae extract recorded higher vegetative growth and yield traits of *Cucurbita pepo* compared to Domestic + spraying with water only.

Keywords: *Cucurbita pepo*, Cucurbit cultivar, Nano application, Sea algae extract

Summer squash (*Cucurbita pepo* L.) belongs to the Cucurbitaceae family and is commonly cultivated in highlands with mid-altitude agroecosystems ranging from approximately 1,000 to over 2,000 meters in Central and North America, specifically in central Mexico and the southwestern United States (Kates et al., 2017). The Central Organization of Statistics in Iraq (2020) indicate that the production of the area unit of summer squash in 2020 decreased to 9.68 tons per hectare compared to the average production of some of the world's crop-producing countries in the same year (47,322, 58,679, and 66,725 tons per hectare in Spain, Indonesia, and the Netherlands, respectively) (FAO 2020). Hence, there is a need to increase production per unit area, with the use of high-productive cultivars, keeping in increase in demand due to an increase in the population. The plant cultivar is very important in the productivity as genetic characters determine the growth and development of the cultivar, which affects the quantity and quality of the yield. Adaptation to the environment is another factor that determines yield. Moreover, Al-Foliar nutrition uptake also affects the growth and yield (Kostadinov and Kostadinova 2014, Stojanov et al., 2016).

Nanotechnology is a new technology that can help increase the productivity and economic value of crops (Ghormade et al., 2011). Nano Sea algae extract is a new approach for higher productivity. Researchers have found that spraying plants with algae extracts improves metabolism inside the leaves by increasing photosynthesis, as it contains cytokinins, auxins, and many nutrients (Yokoya et al., 2010), and delays plant aging and prevents the fall of leaves, flowers, and fruits. Al-Zubaidy and Al-Hamzawy (2016)

mentioned that the spraying of herb extract (Basfolior Kelp) at 6 ml L⁻¹ concentration on *Capsicum annum* increased both the vegetative and yield traits., Al-Aqaeshi and Al-Sahaf (2017) found a significant increase in yield when spraying okra plants two times every 30 days with 3 ml L⁻¹ of sea algae extract. Spraying eggplants with 1.5 3 ml L⁻¹ of Agazone and Atonik resulted in the highest average vegetative growth (Taien and Mathkor 2018). The current study aims to examine the effect of spraying nano sea algae extract on the growth and yield of two cultivars of *Cucurbita pepo* L. c.v. (Domestic and Fadwa).

MATERIAL AND METHODS

This experiment was carried out in Kufa, Najaf province (latitude: 32° 03' 4.10" N; longitude: 44° 26' 24.61" E) in the 2019-2020 season. Ten samples of the field soil were taken randomly from 0-30 cm depth before planting and were analyzed using the Walkley and Black method described by Jackson (1958) to measure chemical and physical characteristics (Table 1).

The field was prepared by tilling and levelling, and the area was divided into three lines, each 35 m long and with a row-to-row spacing of 1.5 m. Sowing was performed on September 15, 2018, with a plant-to-plant spacing of 0.5 m. The recommended agronomic practices were followed (Jasim et al 2015). The concentrations of nano sea algae extract provided in Table 2, and the foliar application was repeated three times at 15-day intervals (Alhasnawi et al 2020). The experiment was in a split-plot arrangement in a randomized complete block with three replicates (Montgomery, 2020). Cultivars were set up in the main plots,

and concentrations were set up in the subplots. The plot size was 3.75 m² (2.5 m length × 1.5 m width) with nine plants per plot. Means were compared using the least significant difference (LSD) at 5% level of significance ($P > 0.05$). The VSN International GenStat 12th Edition (Payne et al., 2009) was used for the two-way analysis of variance

Vegetative traits: Vegetative traits were estimated from 5 plants randomly selected from each experimental unit at the end of the autumn season on January 8, 2020.

Plant length (cm) was measured from the soil surface to the top of the plant, and the means were calculated. The total number of leaves (leaf plant⁻¹) was calculated on the main stem and branches. Dry weight of total vegetative (g plant⁻¹) was estimated at the end of the season from five plants randomly selected from each experimental unit. After removing the roots, the plants were weighed before drying. Afterward, 100 g of fresh weight was dried in an electric oven at 75°C until its weight was fixed.

Yield traits: The number of fruits per plant (fruit plant⁻¹) was recorded for each experimental unit. 2- Yield per plant (kg plant⁻¹) was calculated from the first harvest to the end of the season. (November 6 2019 to January 4, 2020).

RESULTS AND DISCUSSION

Vegetative traits: The vegetative traits of *Cucurbita pepo* L.

varied significantly among the different cultivars. The Fadwa cultivar (C₂) treatment excelled in all traits, with maximum plant length (129.87 cm), leaf number (21.25 leaves plant⁻¹), and dry weight of total vegetative (133.84 g plant⁻¹) as compared to the Domestic cultivar (C₁) (Table 3). The differences were due to the better adaptation of the Fadwa cultivar (C₂) to the environment of Najaf province compared to the domestic cultivar. There was a significant effect of spraying nano sea algae extract on the average vegetative growth (plant length, leaf number, and total dry weight). The 0.5 ml L⁻¹ gave the highest plant height (129.13 cm), leaves per plant (19.57), and dry weight (130.40 g plant⁻¹), while the lowest average of traits was in E₀ (spraying with water only). Al-Bayati et al. (2020) also observed similar trend. The

Table 2. Treatment of the studied factors

Treatments and their interaction	
Concentrations of nano sea algae extract (ml L ⁻¹)	Cultivar
E ₀ = Distilled water	Domestic cultivar C ₁
E ₁ = 0.5	
E ₂ = 1.0	
E ₀ = Distilled water	Fadwa cultivar C ₂
E ₁ = 0.5	
E ₂ = 1.0	

Table 1. Chemical and physical characteristics of the field soil before planting

Soil texture	Sand (g kg ⁻¹)	Silt (g kg ⁻¹)	Clay (g kg ⁻¹)	Organic material (%)	Electric conductivity (dS m ⁻¹)	Soil pH
Sandy	670	190	140	1.2	4.0	7.2

Table 3. Effect of cultivar and spraying with nano sea algae extract on vegetative and yield traits of *Cucurbita pepo*

Treatments		Plant length (cm)	Leaf number (leaves plant ⁻¹)	Total dry weight of shoot (g plant ⁻¹)	Fruit number (fruit plant ⁻¹)	Total yield (ton h ⁻¹)	
Cultivars	C ₁	110.70	10.83	110.93	7.19	8.51	
	C ₂	129.87	21.25	133.84	12.35	9.73	
LSD (p=0.05)		6.51	5.77	3.79	1.02	0.65	
Spraying concentrations (ml L ⁻¹)	E ₀	114.01	12.67	116.20	8.16	8.21	
	E ₁	129.18	19.57	130.40	11.56	10.07	
	E ₂	117.72	15.87	120.57	9.60	9.08	
LSD (p=0.05)		2.44	4.50	2.47	0.79	0.47	
Cultivars *	C ₁	E ₀	107.49	8.11	106.63	6.29	7.52
		E ₁	113.25	14.78	113.88	8.47	9.33
Concentrations	C ₂	E ₂	111.36	9.59	112.29	6.81	8.68
		E ₀	120.52	17.23	125.76	10.03	8.90
		E ₁	145.00	24.36	146.91	14.65	10.81
		E ₂	124.08	22.15	128.85	12.38	9.47
LSD (p=0.05)		12.70	8.07	4.31	1.80	0.92	

increase in vegetative growth may occur due to nutrients that form nano sea algae extract, such as nitrogen and phosphorus, which form proteins, enzymes, and nucleic acids (DNA, RNA) (Al-Hurmazy 2011). The interaction between cultivars and spraying concentrations treatments showed a significant effect on vegetative growth (plant length, leaf number, and total dry weight of vegetative) when the treatment C2E1 achieved higher plant height of 145.00 cm, 24.36 leaves plant⁻¹, and 146.91 g plant⁻¹, respectively, compared to the control treatment (Table 3).

Yield and related traits: There were significant differences in the yield traits of the different cultivars. Fadwa gave the highest average of fruit number, and total yield of 12, 35 fruit plant⁻¹, and 9.73-ton h⁻¹ respectively, in comparison with the lowest average of 7.19 fruit plant⁻¹ and 8.51-ton h⁻¹ in the Domestic cultivar (Table 3). There was significant effect of spraying nano sea algae extract on the yield traits. E1 (0.5 ml L⁻¹) provided the highest fruits per plant (11.56), and yield (10.07 ton h⁻¹) in comparison with the lowest average in E0 (8.16 fruit plant⁻¹), and yield (8.21 ton h⁻¹). The improvement in yield traits may be due to the nutrients in nano sea algae, which play a significant role in increasing biological processes (Nejatzadeh-Barandozi et al., 2014). There was significant interaction between cultivars and spraying concentrations on yield traits. The treatment C2E1 provided the highest number of fruits (14.65 fruits plant⁻¹) and total yield (10.81 ton h⁻¹), in comparison with the treatment (C1E0), which gave the lowest averages of fruit number (6.29 fruit plant⁻¹) and yield (7.52 ton h⁻¹).

CONCLUSION

Fadwa cultivar with 0.5 ml L⁻¹ concentration of nano sea algae extract gave the higher vegetative growth and yield traits of *Cucurbita pepo* plants.

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