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Response of Snake Cucumber Plant to Spraying with Roselle Extract and Nano-Potassium on Growth Characteristics

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Abstract: This study was carried out in one of the unheated greenhouses located in the Najaf Agriculture Directorate, Nurseries Department, during the spring of the 2021 agricultural season, and aimed to study the effect of foliar spraying with different concentrations of the Roselle extract and Nano-potassium on the growth and yield characteristics of the Snake cucumber plant. An experiment was carried out as a factorial experiment using a Randomized Complete Block Design (R.C.B.D) with two factors and three replications, the first factor was foliar fertilization of the Roselle extract with three concentrations of (0, 5, and 10) ml.L-1. The second factor was spraying Nano-potassium with four concentrations (0, 1, 2, and 3) g.L-1. Results indicated that the spraying of Roselle extract was significantly superior at a concentration of 10ml.L-1 in the total number of leaves reached 59.52 leaves and shoot dry weight reached 29.47gm, fruit content of total soluble carbohydrates to 11.14mg.g-1 dry matter, percentage of calcium to 1.232 and the percentage of fiber to 1.041% in the fruits average fruit length increased to 17.78 cm, average fruit weight to 84.77g, the yield of one plant to 7.69kg compared with the unsprayed plants, which gave the lowest values. Meanwhile spraying of Roselle extract was significantly superior at a concentration of 5ml.L-1increased significantly total chlorophyll to 47.84 g.100g-1 fresh weight in leaves. Spraying at the concentration of 3g.L-1 with Nano-potassium increased significantly the content of total chlorophyll in the leaves was 48.98g.100g-1 fresh weight and the fruit content of total soluble carbohydrates was 11.42mg.g-1 dry weight and gave the highest average fruit weight of 86.48g, and the highest yield per plant amounted to 8.59kg. The superiority of spraying with Nano-potassium at a concentration of 2g.L-1, registered 53.97 for the number of total leaves for one plant, and 28.58g for shoot dry, with 1.228% percentage of calcium and 1.086% fiber in the fruits compared with the control treatment, which gave the lowest values. The interaction treatment between the spraying of Roselle extract at a concentration of 10ml.L-1 and Nano-potassium at a concentration of 3g.L-1 recorded a significant increase in the shoot dry weight achieving 33.16g, and the highest number of fruits pre-plant was 119.17, the highest yield per plant was 10.26kg compared to the comparison treatment, which gave the lowest values.

Keywords: Snake cucumber, Roselle extract, Nano-potassium, plant nutrition

INTRODUCTION

Cucumis melo var *flexuosus* is a plant belonging to the Cucurbitaceae family. Its fruits are consumed fresh or in appetizers and pickles. It is herbaceous, annual, runner plant with lobed leaves, small yellow flowers and long fruits somewhat similar to cucumbers (Matlob et al., 1989). Foliar fertilization is one of the most efficient ways to add nutrients to the plant in small quantities, which leads to reducing fertilization costs, and the quantities of fertilizers used (Wojcik, 2004). This type of fertilization is effective, especially in soils with problems of loss by washing and fixing nutrients, which leads to a lack of readiness of nutrients necessary for plant growth, especially in alkaline soils. In general, foliar feeding is a supplement to plant nutrition through the soil and is not a substitute for it (Tisdale et al., 1999). Studies have shown that there are many plant extracts that have an encouraging effect on the vegetative and flowering growth of the plant because they contain many natural chemical compounds that differ according to the parts of the plant extracted from them and the environmental conditions to which the plants are exposed. One of these extracts is the extract of the sepals leaves of the Hibiscus sabdariffa L. Important medicinal, economic and food plants. The plant is a herbaceous plant whose cultivation and use is widespread in many regions of the world, especially the Arab region (Osuntogun and Aboaba, 2004). Different parts of the roselle plant contain many different chemicals as the sepals are rich in their content of important active chemicals, including proteins, carbohydrates, fiber, thymine, riboflavin, niacin and vitamin (Aacorbic acid) Mahadevan et al. (2009).

It also contains important nutrients (phosphorous, potassium, iron, zinc, calcium and manganese) and amino acids, including the amino acid Aspartic acid and organic acids such as tartaric acid, malic acid, citric acid De-Costa-Rocha (and others, 2014). It was indicated by Atallah et al. (2019) that spraying of cucumber plants, cultivar Omega, grown in the greenhouse with the nutrients Biomin 221 and Folicist, increased the number of total leaves, shoot dry weight, the average fruit length and weight, and plant yield. Abbass et al. (2016) also reported that spraying roselle extract on the clove plant Dianthus caryophllus L. at a concentration of 10 g. L-1 led to a significant increase in plant height, number of branches, plant dry weight, and leaf content of total chlorophyll.

The applications of Nanotechnology have expanded to include the customization of Nanostructured materials in various specialized fields. It was noted that Nanotechnology has benefits in agricultural systems, as it can be used to arrange agricultural inputs (especially chemical fertilizers) and regulate them to increase the effectiveness of active materials and reduce their added quantities, as well as reduce pollution in the environment (Ghorbanpour, et al., 2017). Nanofertilizers are nutrient carriers with sizes of 1-100 nm and with a large surface area (Prasad et al., 2014). Studies (Cui et al. (2010) indicate that Nano-fertilizers are environmentally friendly and of great importance to promote sustainable agricultural development. Potassium is an effective and important element for the vital processes within the plant, as it plays a major role in the respiration process and the effectiveness of enzymes, and therefore it affects the improvement of the qualitative characteristics of the crop and has a role Important in increasing the efficiency of the plant photosynthesis process, as it activates more than 60 enzymes inside the plant for various vital processes (Taiz and (2010, Zeiger).

In the study of Kasemi (2013) on cucumber plants, it was found that the foliar spraying of potassium in the form of potassium nitrate (200 and 100 mg.l-1) had a significant effect on the number of total leaves, the dry weight of the plant, the percentage of chlorophyll in the leaves, the average weight of the fruit, the length of the fruit and the total yield of the plant. Gerdini (2016) demonstrated in his experiment that spraying Cucurbita pepo with Nano potassium in three concentrations of 0, .1.5 and .2.5 ml. L-1 caused a significant increase in vegetative growth indicators and total yield, especially at a concentration of 2.5 ml. liter 1-. Similar results were found when fertilizing cucumber plants with potassium nitrate (K46.6) (KNO), which led to an increase in the number of leaves, the content of leaves from total chlorophyll, the length of the fruit and the yield of one plant (Hamid, 2020). In order to improve the growth and production of cucumber and to improve its quality, this study was conducted with the aim of studying the effects of spraying plant extracts (the sepals extract of roselle), Nano-potassium and its effect on cucumber growth indicators and yield components.

MATERIALS AND METHODS

The experiment was carried out during the spring growing season (2021-2022) in the nurseries of the Najaf Agriculture Directorate. Ten samples of field soil were taken before planting for the purpose of analyzing some chemical and physical characteristics, and the specifications of the irrigation water used (Table 1) were also analyzed.

A factorial experiment was carried out using Randomized Complete Block Design (R.C.B.D) with three replications and two factors: the first was the aqueous extract of the aniseed leaves of the roselle plant (Table 2) at three levels (0,5 and 10) g.l-1, and the second factor was Nano-potassium at four concentrations (0, 1, 2 and 3) mg.L^{-1}. Three cucumber plants were planted at the beginning and end of each sector and considered as guard plants, and the number of experimental units in each sector was 12, containing 5 plants each (the two side plants were considered as guard plants for each experimental unit). The total number of experimental units was 36, and the length of the experimental unit is 80 cm. The comparison between the treatments means was performed according to Duncan's multiple range test at the level of significance 0, 0.5 (Al-Rawi and Khalaf-Alla, 2000).

Table1. Chemical and physical properties of field soil and water used in the study

<table>
<tr><td colspan="2" rowspan="2">Electrical Conductivity (DS. M^{-1})</td><td>Soil</td><td>Well water</td></tr>
<tr><td>1.558</td><td>2.180</td></tr>
<tr><td rowspan="2">positive ions (mmol charge. $Liter^{-1}$)</td><td>K</td><td>193.00</td><td>16.13</td></tr>
<tr><td>OM</td><td>2.01</td><td></td></tr>
<tr><td rowspan="2">Ready-made macro elements (mg.kg^{-1})</td><td>N</td><td>34.672</td><td>6.940</td></tr>
<tr><td>P</td><td>16.667</td><td>4.688</td></tr>
<tr><td rowspan="3">Soil particles g.Kg^{-1}</td><td>Clay</td><td>860</td><td></td></tr>
<tr><td>Silt</td><td>100</td><td></td></tr>
<tr><td>Sand</td><td>40</td><td></td></tr>
<tr><td colspan="2">Soil texture</td><td>Sandy-loam</td><td></td></tr>
</table>

Table 2. Components of the calyx leaves extract of the roselle plant

No.	Element/compound	Measurement unit
1	nitrogen	%3
2	Calcium	655g
3	potassium	1%
4	magnesium	85g
5	Iron	2.1g
6	zinc	8.8g
7	polyphenol	377g
8	flavonoids	217g
9	tannin	293g

At the end of the experiment on 1/1/2021, the total number of leaves was measured (leaf.$Plant^{-1}$), the plants were uprooted and the vegetative system was separated from the root, then weighed with a sensitive scale. Then the vegetative samples were placed inside perforated paper bags and dried in an electric oven at a temperature of 70 °C, and until the weight was stable, the dry weight was measured. The total chlorophyll content of leaves (mg.100gm softgel-1) was determined by the acetone method (Goodwin, 1976). The total soluble carbohydrate content of fruits (mg.g-1 dry weight) was estimated using perchloric acid, concentrated sulfuric acid and using a spectrophotometer (Duboies et al., 1956). The percentage of calcium (Ca) in fruits was measured (Olsen and Sommers (1982) and the determination of calcium in fruits using Spectrophotometer VIS - UV at a wavelength of 620 nm, and the content of fruits of fiber (mg. g-1) The fibers were estimated according to the method by Cataldo et al. (1975).

Regarding the average length of the fruit (cm), ten fruits were randomly selected for the first five fairies and the length of each fruit was measured with a tape measure. The average weight of the fruit (gm) based on the first five harvests (dividing the yield of the experimental unit of three plants by the number of fruits), and a plant yield (g) as an average of the first eight harvests.

RESULTS AND DISCUSSION

It is noted from Table (3) that spraying cucumber plants with sepals extract of roselle plant had a significant effect on the growth indicators under study. Where the spray treatment at 10 g.L-1 recorded the highest number of total leaves, the highest shoot dry weight, the fruit content of total soluble carbohydrates, calcium (%), and fibers (%) compared to the control treatment sprayed with DW, which recorded the lowest values with a significant difference. It was also observed that spraying the cucumber plants with roselle extract had a significant effect on leaf content of total chlorophyll compared to the non-sprayed plants, which gave the lowest value.

Spraying cucumber plant with Nano-potassium, especially at the concentration of 2 $g.L^{-1}$, had a significant effect in increasing the growth indicators under study with a significant difference from the non-treated plants (control). Also, spraying cucumber plants with roselle extract significantly affected the average fruit length, the average fruit weight, and the largest yield per plant, compared to the control (Table4).

In general, among all the treatments, the interaction of spraying with roselle extract at 10 $g.L^{-1}$ and Nano-potassium 2 $g.L^{-1}$ led to the highest average number of total leaves, the highest leaf content

Table3. The effect of spraying Roselle calyces extracts and Nano-potassium on the growth characteristics of Snake cucumber.

Treatments		Total number of the leaves (Leaf. $plant^{-1}$)	Shoot dry weight (gm)	Total chlorophyll content of leaves ($mg.100g^{-1}$) fresh weight	Total fruit content of soluble carbohydrates ($mg.\ g^{-1}$ dry weight	Calcium in fruit (%)	Fiber in fruit (%)
Roselle extract (g.L-1)	**0**	**43.34**	**23.38**	**43.10**	**10.46**	**1.229**	**0.997**
	5	**45.29**	**25.62**	**48.03**	**11.21**	**1.183**	**1.002**
	10	**59.52**	**29.47**	**47.84**	**11.41**	**1.232**	**1.041**
L.S.D 0.05		**02.42**	**02.30**	**02.64**	**00.87**	**1.205**	**0.219**
Nano-potassium ($mg.L^{-1}$)	**0**	**42.67**	**22.70**	**48.56**	**10.09**	**0.047**	**0.940**
	1	**46.77**	**25.31**	**48.19**	**12.21**	**1.202**	**0.960**
	2	**53.97**	**28.58**	**39.56**	**10.39**	**1.228**	**1.086**
	3	**53.07**	**27.94**	**48.98**	**11.41**	**1.225**	**1.068**

L.S.D 0.05			01.44	01.42	03.06	00.60	0.055	0.253
Roselle extract × Nano-potassium	0	0	32.01	20.21	33.47	8.94	1.233	0.954
		1	37.72	23.64	45.47	10.80	1.239	0.845
		2	46.61	25.64	38.04	11.51	1.234	1.298
		3	57.02	23.74	55.42	10.59	1.219	0.983
	5	0	43.30	22.45	41.73	10.50	1.207	0.867
		1	47.41	24.65	34.67	13.78	1.115	1.079
		2	44.84	28.64	58.59	9.57	1.194	1.059
		3	45.61	26.93	57.13	10.99	1.216	1.006
	10	0	52.70	25.43	55.07	10.83	1.184	1.001
		1	55.20	27.65	40.52	12.05	1.252	0.957
		2	70.53	31.64	45.98	10.0	1.256	0.902
		3	56.62	33.16	49.79	12.66	1.239	1.304
L.S.D 0.05			05.81	02.10	06.64	00.98	0.095	0.438

of chlorophyll, fruit content of total soluble carbohydrates, and the percentage of fibers. Whereas, the interaction treatment (spray with roselle extract 10 g.L^{-1} and Nano potassium 3 g.L^{-1}) gave significantly the highest shoot dry weight, and the highest percentage of fruit content of fibers compared to all other treatments and the control treatment (Table3), and the highest fruit length and yield per plant (Table4).

The results showed that spraying with roselle extract significantly increased the number of total leaves, the shoot dry weight, and the leaf content of chlorophyll and carbohydrates. This increase may be attributed to the roselle extract content of nutrients, phenols and flavonoids important for plant growth and added as a spray on the leaves. As the availability of the necessary nutrients, whether major or minor, has a major role in the process of photosynthesis and respiration, as some of them, such as nitrogen, magnesium, iron and zinc, are included in the composition of amino and nucleic acids necessary for cell division, which increases the number of internodes and then increases plant length (Taiz and Zeiger, 2003).

Table4. The effect of spraying Roselle extracts and Nano-potassium on the yield characteristics of Snake cucumber

Treatments		Average fruit length (cm)	Average fruit weight (g)	Plant yield (kg)
Roselle extract (g.L-1)	0	14.56	75.89	6.83
	5	17.78	82.74	7.30
	10	17.78	84.77	7.69
L.S.D 0.05		0.53	2.02	0.48
Nano-potassium (mg.L^{-1})	0	16.64	80.18	4.92
	1	16.48	75.58	7.56
	2	17.49	82.31	8.02
	3	16.22	86.48	8.59
L.S.D 0.05		0.45	5.18	0.55
	0	17.14	63.12	3.62

Roselle extract × Nano-potassium	**0**	**1**	**13.81**	**80.88**	**8.00**
		2	**14.62**	**70.42**	**8.28**
		3	**12.68**	**89.15**	**7.32**
	5	**0**	**14.92**	**87.36**	**4.90**
		1	**16.95**	**69.12**	**8.02**
		2	**19.56**	**90.36**	**8.09**
		3	**19.69**	**84.14**	**8.19**
	10	**0**	**17.78**	**90.06**	**4.92**
		1	**18.69**	**76.75**	**7.55**
		2	**18.29**	**86.15**	**8.02**
		3	**16.29**	**86.14**	**10.26**
L.S.D 0.05			**1.28**	6.48	0.99

Likewise, the zinc present in the roselle extract has an activating role for enzymes and the formation of nucleic acids and participates in the formation of the amino acid tryptophan, which is the basic material for the manufacture of IAA Acid Acetic Indole, an auxin hormone important for the elongation and growth of cells (Cakmak et al., 1998). (Simonetti et al., 2000), as well as the nitrogen element that enters nitrogen in the formation of chlorophyll in addition to the formation of amino and nucleic acids and participates in the porphyrine groups involved in the composition of chlorophyll and cytochromes important in the processes of photosynthesis and respiration (Al-Mosili, 2013).

In addition to the extract content of magnesium, which participates in the synthesis of chlorophyll, as it constitutes 2.7% of the weight of the chlorophyll molecule. And the presence of iron, which enters the enzymatic system of Hemes and Hematin, which are important in the process of respiration and enters the composition of chloroplasts and chloroplasts (Al-Mosili, 2013).

The spraying of roselle extract contributed to an increase in vegetative growth and thus to an increase in the efficiency of carbon metabolism and then an increase in the carbohydrate content, thus increasing the length of the fruit, the average weight of the fruits and the yield of the plant. The roselle extract also contributed to an increase in the materials synthesized in the plant, which increase female flowers fruit formation, thus reducing the percentage of flower dropping and then increasing fruit forming rate (Simonetti et al., 2000). This ultimately led to an increase in the average fruit weight and an improvement in the yield characteristics (Smirnoff and Wheeler, 2000; Atallah et al., 2019).

The spraying with potassium Nanoparticles also resulted in a clear improvement in the growth indicators and the yield under study. This is generally due to the advantages of the fertilizer prepared with Nanotechnology as it has a large surface area. The reason for this is due to the small particle size, which makes it highly soluble in different solvents. This feature contributes to increasing the penetration of Nanoparticles to the surfaces in contact with them, such as leaves and roots. The Nano-fertilizers provide more space for different metabolic reactions in the plant, which in turn increases the rate of photosynthesis, causing an increase in plant dry matter production and improving plant growth (DeRosa et al., 2010; Khandelwal and Josh, 2018). The addition of Nano-potassium also led to an increase in the efficiency of the photosynthesis process, an increase in the respiration process, and then an increase in energy production. The presence of potassium gives nutritional balance, in addition to the contribution of potassium in activating vital processes, which eventually increased the content of the leaves from total chlorophyll, carbohydrates, calcium and fiber in the fruits (Kannan et al., 2012).

The use of Nano potassium also led to the regulation of the flowering process, through its role in stimulating plant hormones related to the formation, pollination and fertilization of florets. As well as its effective role in building proteins necessary for building plant tissues, as well as its role in increasing the plant's ability to grow by increasing enzymatic activity, improving biological processes within the plant and increasing the efficiency of the photosynthesis process during the stages of growth and development (Jarret and Baird, 2001). This in turn leads to increased growth, fruiting and the accumulation of nutrients in the fruits. In the end, it reflected positively in the increase in nutrients manufactured with leaves and their movement to the places where they are stored in the fruits, which resulted in an increase in the length and weight of the fruit and the yield of one plant (Hamid 202).

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