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EFFECT OF IBA GROWTH REGULATOR AND NITROGEN FERTILIZATION ON SOME TRAITS OF VEGETATIVE AND FRUIT GROWTH FOR TWO CULTIVARS OF ROSELLE PLANT (*HIBISCUS SABDARIFFA* L.)

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Abstract

A field experiment was conducted in AL-Gelawya village, north of Babylon province, during the summer season of 2019, To study the effect of three levels of nitrogen fertilization (0, 150, 200) kg.ha^{-1}, which are symbolized by (N0, N1, N2) and three concentrations of butyric acid (0, 1, 2) g.L^{-1}and which are symbolized by (B0, B1, B2,) and two cultivars of Roselle plant(Jordanian and Iraqi) and which are symbolized by (V1, V2). the Randomized Complete Block Design (RCBD) was used in it and the factors were of equal importance. The following results were obtained: The cultivar V2, the nitrogen fertilization level N2 and the B2 concentration of IBA were excelled on all studied traits giving values amounted to (76.25, 78.00, 93.50), (28.39, 30.43, 34.00), (157.68, 166.44, 173.18), (866.48, 1045.84, 1168.82) and (28.00, 28.78, 32.45 and (100.39, 108.35, 120.40) for traits of plant height, number of branches, number of nuts, the sepals leaves yield and number of seeds, and seed yield of plants, respectively. Bi-interaction (V2, N2), (N2, B2) and (V2, B2) gave the highest values for the bi-interaction, giving the values for traits of the plant height, number of branches, number of nuts, the Sepals leaves yield, number of seeds, and seed yield of plants, respectively. Triple interaction(V2, N2, B2) was excelled and giving the highest values amounted to (112.20, 39.57, 232.50, 1366.72, 37.75, 157.50) for all of the studied traits above according to the order.

***Keyword*:** IBA, RCBD, Bi-interaction, Triple interaction, Roselle plant.

Introduction

Roselle (*Hibiscus sabdariffa* L.), belonging to the Malvacea family, is a medicinal plant (Al-Ayoubi, 2011) and then a food and economic crop where it is used in many industries (Ahmed, 1996) and is sometimes known as the Roselle in Egypt and is known in Roselle England (Al-Dajwi, 1996). The plant may be Annual, Biennial, or perennial plant. It reaches a height of 3 m (Nasrallah, 2012) is cultivated in subtropical or tropical regions such as India, Malaysia, and Indonesia (Al-Dajwi, 1996). It is also cultivated in Iraq, specifically in Al-Diwaniyah province (Al-Sarraf, 1991) and endures severe environmental conditions. However, with an average temperature of 3 ºC and relative humidity 20% (Yassin, 2001). Roselle plant has several uses, where it is an anti-oxidant and important in treating some cancerous tumors (Kilic *et al*., 2011), because its calcium leaves contain Hibiscin, which is a botanical organic compound that decomposes acids and is caused by enzymes to one or more of the effective non-glycemic substances to which the physiological and medicinal effect of the Roselle plant is due. (Shamkhi, 2012) Its leaf juice reduces high blood pressure, strengthens the heart's, reduces blood viscosity and calmness, and is rich in vitamins C, A and B, calcium, iron, phosphorous, anthocyanins, Thiocene, and repo flavin, It should be noted that Roselle tea helps in the process of digestion and works where an anti-rotten stomach and an antiseptic for microbes (Shaker, 2002) Citric and Malic acids in addition to its other uses where it is a drink that reduces the high temperatures in the body and includes candy making (Louis *et al*., 2013). The researcher (Hussein, 2014) found that nitrogen fertilization plays an important role in increasing plant growth, because it increases cell division and expansion, as well as increases the yield of flowering cups and active compounds such as anthocyanins, flavonoids and other compounds responsible for the acidic taste for Roselle, In order to increase the vegetative and fruity growth traits and specific qualities traits, It is necessary to add growth regulators that increase the formation of some acids, including salicylic acid, where it is of high importance in Plant physiological processes such as photosynthesis, growth and cellular metabolism. The process of closing and opening Stoma and exchanging gases, in addition to an important thing is to raise the plant's defense ability against various bacterial and viral diseases, increase antioxidants, increase nutrient absorption and speed, and its treatments within the plant (Ashraf and others, 2010). And the use of growth regulators such as IBA has the greatest impact on vegetative and fruity growth and production of Roselle tea (Nasrallah *et al*., 2015) and (Nasrallah, 2012) because its use reduces environmental pollution compared to chemical fertilizer in addition to its importance in cell division and specialization and in physiological processes such as Senescence and apical dominance, Nutrient transport and chloroplast development (Shuwayli, 2012) Stimulating vegetative growth and lateral bud growth through the process of preventing or reducing apical dominance, in addition to that it plays an important role in increasing the leaf area by enlarging its cells and increasing the percentage of chlorophyll (Al-Hassan and Al-Awadi, 2011) and (Al-Mousawi, 2015).

The study aimed to find out the effect of different levels of nitrogen fertilization and IBA on the growth and yield of Roselle plant.

The medical importance of Roselle plant

The containment of Sepals of the Roselle plant on the compound Protocatehenic acid (PCA) is of great medical importance for the treatment of cancerous tumors and liver cirrhosis due to its high ability to remove carbon tetrachloride (CCL4) and (Odigie '2003) and the researcher (Duhirl *et al*., 2003) Until human injections with a serum that contains a certain percentage of the Sepals extract of a Roselle plant has a great effect on stabilizing the level of

sugar in the blood and thus reduces atherosclerosis and reduces angina. Also, the Sepals extract of the Roselle plant works to prescribe the body from Free Radical roots and is useful in the uterine contractions of the pregnant woman and the elimination of tapeworms (Lin *et al*., 2007)

The Roselle plant Sepals extract is also used as an antibacterial such as E-Coli Bacillus and TB-causing microbes, and reduces the toxic products of Aerobes and is useful in treating fever and cholera because its acidity is high (pH = 3.5) (Chao, Yin, 2008) Finally, it was discovered that it is useful in reducing the pathogenic effects of Diethylnro in the liver. Its role decreases the action of carcinogenic genes and thus is considered an anticancer (Anticancer, 2008), Antilithiatic formed inside the kidney (Betanabhatla *et al*., 2009). A medical team confirmed that the Sepals extract of the Roselle plant is useful in reducing blood viscosity by reducing systolic and diastolic blood pressure (Kavitha, 2010). And (Mcky *et al*., 2010) proved that consuming Roselle plant tea reduces blood pressure in patients with high blood pressure because it reduces the level of harmful cholesterol in the blood. Another medical team has also proven to be helpful in treating anemia (Ghislain *et al*., 2011).

Effective medicinal and chemical substances in Roselle plant

Because of the different genetics, the cultivars differ in the proportions of their components. The important thing is the presence of medical chemicals in all its parts. It is a source of amino acids such as lysine, glutamate and leucine (Hainida *et al*., 2008). The Sepals leaves contain iron, potassium, phosphorus, calcium, manganese, sodium and aluminum, and they contain Niacin Riboflavin), (Shamkhi *et al*., 2012). As for the Sepals , they contain many organic acids, such as Malic , Citric and Ascorbic, which cause the acidity of Roselle plant and contain gelatinous materials, as well as they contain phenolic protocatechuic acid (El-Desouki, 1998). It was also found that the Aqueous solution for Sepals contains many active substances, such as phenols, flavones and Tinadines, which are Plant pigments (red, yellow and blue) that are used in medical uses (Tasi *et al*., 2002) in addition to containing pectin substances as they contain Mucilage, which is a refreshing and soothing substance in the same Time and chemical composition. Easy-to-regulate monosaccharides add flavor to Roselle plant syrup (Shaker, 2002). As for its seeds, it contains a percentage of unsaturated fatty acids (Rao, 1996) and it contains a high percentage of oil of up to 25%, which is valid for human use and contains organic acids such as Oleic, formic and citric in addition to that the seeds are an important food source because they contain macro elements such as potassium and phosphorous Magnesium, calcium, and micro-like manganese, zinc, and sodium (Nzikon, 2011) Most of the amino acids are found in the Sepals leaves (Aspartic acid (Frimpoyg, 2008) and they contain anthocyanin pigment that causes red color, as well as some colored substances such as carotene and thiamin) and also contain a group of vitamins, mainly the vitamin C mainly, as well as vitamin B 1, B 2, B12. The roots contain tartaric and saponins (Mahadevan *et al*., 2009).

Materials and Methods

A field experiment was conducted in the fields of AL-Musiab Technical College on 5/4/2019, To find out the effect of different levels of Nano-fertilizers, nitrogenous fertilizers, and Indole Butyric Acid (IBA) on some traits of growth, yield and specific qualitative traits of two cultivars of Roselle plant. The land of the experiment Tillage and was leveled and divided into a Furrow, the distance between one and the other 75 cm and between a pit and another 50 cm. Each experimental unit included 3 Furrow and 4 m in length and three replicates. Physical and chemical traits of the soil were studied (Table 1) by taking 3 samples from the experiment ground with a depth of (0 - 30) cm and analyzed in the laboratories of the Al-Musiab Technical Institute / Soil Department. the experiment soil was fertilized with phosphate fertilizers (P_2O_5) at 160 $kg.ha^{-1}$ in one batch before cultivated, then Nitrogenous fertilizers were added (urea 46 N%) and at three levels (0, 150, 200) $kg.ha^{-1}$, which are symbolized by (N0, N1, N2) at the average of two batches for each level, the first after two weeks of germination and the second at flowering (Nasrallah, 2012). The vegetative group of experimental plants was sprayed to complete wetness with the use of a 20-liter backpack sprayer for the growth regulator Indole Butyric Acid (IBA) and at three concentrations (0, 1, 2) $g.L^{-1}$ and which are symbolized by (B0, B1 and B3), respectively, and left a distance of 2 m between experimental units to prevent the influence of the growth regulator spread on other factors. The experiment land was cultivated on a Furrow by the exchange on both sides of the Furrow with a depth of 5 cm and when the plant reached a height of 20 cm the processes of patching and thinning were performed and then the weeding, irrigation and control operations continued whenever the need arises. The experiment was statistically designed using the Randomized Complete Block Design (RCBD) using the least significant difference (L.S.D) and the probability level 0.05 (Alrawi and Khalaf Allah, 1980).

Table 1 : Some chemical and physical characteristics of soil experiment in 2019.

traits	Units	Values
Organic matter	%	5.5%
Nitrogen	$g.kg^{-1}$	42
Phosphorus	$g.kg^{-1}$	10.6
Potassium	$g.kg^{-1}$	166
sand	%	24
Silt	%	46
Clay	%	30
texture	silty loam	

Ten plants from each experimental unit were approved for their studies, to be representative of that experimental unit

Studied traits

- Plant Height (cm)
- The number of branches for the plants identified (branch. Plant^{-1})
- Nuts number (nuts.plant^{-1})
- the Sepals leaves yield(kg. ha $^{-1}$)
- seeds number (seed. nut^{-1})
- Plant yield (g. plant^{-1})

Results and Discussion

Plant height (cm)

The results in Table (2) showed significant excelled of cultivar V2 in the plant height which gave 76.25 cm compared to the first cultivar V1, which gave the lowest average amounted to 692 cm.This is certainly due to the genetic differences between the species (Karim and Ihsan, 2015), as well as the interaction between environmental and genetic factors. It is clear from the same table the effect of nitrogen fertilization on the traits of plant height, we note the excelled of the N2 level on the rest of the levels giving the highest averages amounted to 78 cm while the control treatment gave the lowest averages amounted to 64.46 cm, and this explains that adding nitrogen fertilizer would increase the formation of nuclear acid RNA and DNA, then protein synthesis, which would encourage cells to divide. Added nitrogen also plays an important role in the formation of the amino acid Tryptophan, which is the primary material for the manufacture of IAA that works to increase cell elongation and then increase plant height (Jensen, 2004).

As for the IBA spray on the plant, the B2 concentration excelled by giving it the highest average compared to other concentrations of 93.56 cm, while the control treatment gave the lowest average amounted to 51.04 cm. As for the bi-interaction between the cultivars and nitrogen fertilization, the treatment (V2 and N2) was distinguished, giving the highest average of the trait amounted to 82.36 cm. As for the interaction between the cultivars and the IBA, which the interaction (V2 and B2) was giving the highest averages amounted to 103.50 cm, As for the interaction between fertilization and IBA, the treatment (N2 and B2) was excelled to which giving the highest averages amounted to (102.65) cm, while the triple interaction between the cultivars, nitrogen fertilization and spraying with IBA (V2, N2 and B2) gave the highest averages of the studied trait amounted to (112.20) cm. While the triple interaction (V1, N0, B0) achieved the lowest averages of 46.37 cm.

Table 2 : Effect of nitrogen fertilization and IBA spraying of two cultivars of Roselle plant on plant height (cm)

Cultivars	Fertilization	0 g.L^{-1} IBA	1 g.L^{-1} IBA	2 g.L^{-1} IBA	Average cultivars * Fertilization
V 1	0	46.37	55.83	72.82	58.34
	150	52.76	56.84	87.93	65.84
	200	60.16	77.39	93.40	76.98
V 2	0	44.24	67.30	88.99	66.83
	150	51.22	69.89	107.83	76.31
	200	56.40	78.49	112.20	82.36
Average		51.86	67.62	93.86	
L.S.D	Cultivars=1.57	Fertilization=1.92	IBA=1.92	triple interaction= 4.72	2.72
Cultivars / IBA	0 g.L^{-1} IBA	1 g.L^{-1} IBA	2 g.L^{-1} IBA	Average	
V1	53.10	63.35	84.72	67.05	
V2	50.62	71.34	103.50	75.15	
Average	51.86	67.62	93.86		
L.S.D	2.72				
Fertilization/ IBA	0 g.ha^{-1}	1 g.ha^{-1}	2g.ha^{-1}	Average	
0 g.L^{-1} IBA	45.30	51.99	58.28	51.86	
1 g.L^{-1} IBA	61.57	63.37	77.94	67.63	
2 g.L^{-1} IBA	80.91	97.88	102.65	93.86	
Average	62.59	71.08	79.62		
L.S.D	3.33				

Number of branches: (branch.plant^{-1})

Table (3) showed that there are significant differences in the traits of the number of branches for the studied cultivars, where the V2 cultivar was excelled by giving them the highest average amounted to (28.39) branch.plant^{-1}. This is due to the variation in the genetic factors and their interaction with environmental factors (Majeed and Ali, 2011). From the same table, it was found that there were significant differences between the number of branches with the effect of nitrogen fertilization, so they excelled the level (N2) by giving it the highest average of the studied trait that reached 30.43 branches. Plant. The different concentrations of IBA affected the studied traits significantly, and B2 was distinguished by giving it the highest average amounted to 34.03 branch.plant^{-1} while the control treatment gave the lowest averages reached 21.27 branch.plant^{-1}, and this factor affected the increase in the number of branches and is the result of preventing the occurrence of oxidative processes that occur for the internal plant hormones, In addition, the IBA has a major role in building Cytokinins such as Zeatin, which encourages the growth of lateral buds in addition to its role in increasing plant height. Experiments have shown that adding it increases the efficiency of photosynthesis, and after that the growth increases, so the number of branches increases (Khan *et al*., 2003).

Table 3 : Effect of nitrogen fertilization and IBA spraying of two cultivars of Roselle plant on the branches number

Cultivars	Fertilization	0 g.L^{-1} IBA	1 g.L^{-1} IBA	2 g.L^{-1} IBA	Average cultivars * Fertilization
V 1	0 g.ha^{-1}	17.97	23.90	29.11	23.66
	150 g.ha^{-1}	20.68	25.42	33.60	26.57
	200 g.ha^{-1}	22.50	28.80	35.93	29.08
V 2	0 g.ha^{-1}	19.22	24.39	30.17	24.59
	150 g.ha^{-1}	22.92	27.83	35.66	28.80
	200 g.ha^{-1}	24.33	31.40	39.57	31.77
Average		21.27	26.96	34.00	
L.S.D	Cultivars=1.23	Fertilization=1.51	IBA=1.51	triple interaction= 3.70	2.13
Cultivars / IBA	0 g.L^{-1} IBA	1 g.L^{-1} IBA	2 g.L^{-1} IBA	Average	
V1	20.38	26.04	32.88	26.44	
V2	22.16	27.87	35.13	28.39	
Average	21.27	26.96	34.00		
L.S.D	2.13				
Fertilization/ IBA	0 g.ha^{-1}	1 g.ha^{-1}	2g.ha^{-1}	Average	
0 g.L^{-1} IBA	18.60	21.80	23.42	21.27	
1 g.L^{-1} IBA	24.15	26.62	30.10	26.96	
2 g.L^{-1} IBA	29.69	34.66	37.75	34.03	
Average	24.15	27.69	30.43		
L.S.D	2.61				

Number of Nuts (nut.plant^{-1})

Table (4) shows that treatment V2 was significantly excelled on treatment V1 which giving it the highest average amounted to 157.68 nut.plant^{-1}, which is due to the difference in the genotypes of the cultivated varieties and the interaction between the genotypes and environmental factors (Karim and Ihsan, 2015).As for the effect of nitrogen fertilization on the trait, it was clear from the same table that the level N2 significantly increased, giving the highest averages for the studied trait amounted to 166.44 nut.plant^{-1}, Whereas, the control treatment gave the lowest averages amounted to 122.49 nut.plant^{-1} can be explained by the fact that nitrogen increases vegetative growth and therefore increases the percentage of nutrients transported from the sources and sinks, so the number of flowers and the percentage of Fruit set will increase so that the percentage of their fertilization increases and thus the number of nuts in the plant increases. (Tisdale *et al*., 1997) and (Hussein *et al*., 2014). As for the effect of IBA on the traits number of nuts, the same table clearly indicates the concentration of B2 concentration on the rest of concentrations and significant differences, giving the highest averages amounted to 173.18 nut.plant^{-1}, while the control treatment gave the lowest average amounted to 114.39 nut.plant^{-1}can be explained by the fact that the IBA clearly affects biochemical physiological processes by stimulating cell division and differentiation and regulating the transport of nutrients between the sources and sinks and the efficiency of protein production and all of this is traits of the yield in general, including the number of nuts per plant (Abdel-kader, 2012) . Bi-interaction between the cultivar and fertilization (V2, N2) significantly excelled and gave the highest averages amounted to 186.70 nut.plant^{-1}, while the Bi-interaction between the varieties and the IBA, the combination (V2 'B2) was excelled and giving it the highest averages amounted to 192.49 nut.plant^{-1}, while the Bi-interaction between the fertilization and the IBA, the combination (N2, B2) was significantly excelled on the rest of the combinations by giving it the highest averages amounted to 202.30 nut.plant^{-1}. While the triple interaction (V2, N2, B2) significantly excelled on the rest of the combinations by giving it the highest averages amounted to 232.50 nut.plant^{-1}.

The Sepals leaves yield(kg. ha $^{-1}$)

Table (5), showed that the excelled of cultivar V2 for the trait weight of Sepals leaves with highly significant differences and gave 990.97 kg. ha^{-1}, while cultivar V1 gave an average amounted to 866.42 kg. ha^{-1} and this difference is due to their genetic differences and the suitability of the cultivar to environmental conditions. (Ottai *et al*., 2006). Nitrogen fertilization levels showed significant differences for the studied trait, where treatment N2 excelled and gave the highest average amounted to 1045.84 kg. ha^{-1}, while the control treatment gave the lowest average amounted to 810.82 kg. ha^{-1}. As for the effect of IBA, the B2 concentration was excelled and gave the highest average amounted to 1168.28 kg. Ha, while the control treatment gave the lowest average amounted to 687.02 kg. ha^{-1}. As for the bi-interaction between the cultivars and the fertilization levels, the combination (V2, N2) was expelled by giving it the highest averages of the trait amounting to 1129.95 kg. ha^{-1}, while the bi-interaction between cultivar and IBA excelled the combination (V2, B2) and gave the highest averages amounted to 1225.99 kg. ha^{-1}. As for the bi-interaction between the fertilization and the IBA, the combination (N2 B2) excelled which gave 1283.96 kg. ha^{-1}. As for the triple interaction between the cultivar and the nitrogen fertilization and the IBA, the differences were significant due to their effect on the studied trait. The combination (V2, N2, B2) was characterized by giving average amounted to 1366.72 kg. ha^{-1}.

Table 4 : Effect of nitrogen fertilization and IBA spraying of two cultivars of Roselle plant on the number of nuts per plant.

Cultivars	**Fertilization**	**0 g.L^{-1} IBA**	**1 g.L^{-1} IBA**	**2 g.L^{-1} IBA**	**Average cultivars * Fertilization**
V 1	0 g.ha^{-1}	92.40	122.87	136.59	117.29
	150 g.ha^{-1}	102.66	137.35	152.90	130.97
	200 g.ha^{-1}	120.69	145.73	172.10	146.17
V 2	0 g.ha^{-1}	103.69	131.49	147.87	127.68
	150 g.ha^{-1}	126.30	152.62	197.10	158.67
	200 g.ha^{-1}	140.63	186.96	232.50	186.70
Average		114.39	146.17	173.18	
L.S.D	Cultivars=7.42	Fertilization=10.27	IBA=10.27	triple interaction= 20.72	13.66
Cultivars/IBA	0 g.L^{-1} IBA	1 g.L^{-1} IBA	2 g.L^{-1} IBA	Average	
V1	105.25	135.32	153.86	131.48	
V2	123.54	157.02	192.49	157.68	
Average	114.39	146.17	173.18		
L.S.D	13.66				
Fertilization/ IBA	0 g.ha^{-1}	1 g.ha^{-1}	2g.ha^{-1}	Average	
0 g.L^{-1} IBA	130.66	114.48	130.66	114.39	
1 g.L^{-1} IBA	166.44	144.99	166.44	146.17	
2 g.L^{-1} IBA	202.30	175.00	202.30	173.18	
Average	166.47	144.82	166.47		
L.S.D	14.65				

Table 5 : Effect of nitrogen fertilization and IBA spraying of two cultivars of Roselle plant on the Sepals leaves yield

Cultivars	**Fertilization**	**0 g.L^{-1} IBA**	**1 g.L^{-1} IBA**	**2 g.L^{-1} IBA**	**Average cultivars * Fertilization**
V 1	0 g.ha^{-1}	560.89	782.91	982.97	775.59
	150 g.ha^{-1}	620.22	844.53	1117.52	860.76
	200 g.ha^{-1}	752.19	931.81	1201.20	961.73
V 2	0 g.ha^{-1}	616.14	861.40	1060.66	846.06
	150 g.ha^{-1}	723.99	1016.26	1286.10	1008.78
	200 g.ha^{-1}	852.33	1170.79	1366.72	1129.95
Average		687.62	934.62	1169.20	
L.S.D	Cultivars=8.81	Fertilization=10.79	IBA=10.79	triple interaction=26.43	15.26
Cultivars / IBA	0 g.L^{-1} IBA	1 g.L^{-1} IBA	2 g.L^{-1} IBA	Average	
V1	644.43	853.08	1100.56	866.92	
V2	730.82	1016.10	1225.99	990.97	
Average	660.62	934.62	1169.28		
L.S.D	15.26				
Fertilization/IBA	0 g.ha^{-1}	1 g.ha^{-1}	2g.ha^{-1}	Average	
0 g.L^{-1} IBA	588.51	672.10	802.26	687.62	
1 g.L^{-1} IBA	822.15	930.40	1051.30	922.62	
2 g.L^{-1} IBA	1021.82	1199.06	1283.96	1168.28	
Average	810.82	934.62	1045.84		
L.S.D	18.69				

Number of seeds(seed. nut^{-1})

Table (6) indicated that there were significant differences between the cultivars of the studied trait, where it gave the V2 cultivar an average and significantly excelled on the V1 cultivar which gave its value amounted to 28.03 seed. nut^{-1}, while cultivar V1 gave a value amounted to 25.19 seed. nut^{-1}. The reason for this can be due to the presence of a variation in the genotypes between the two species, as well as the environmental genetic interaction that affects the performance of each of their different functions, including the number of seeds (Matar, 2010) and (Ottai *et al*., 2005). The same table shows the effect of different levels of nitrogen fertilization on the number of seeds in the nut. We find that the level N2 gave the highest average amounted to 28.78 seed. nut^{-1}, while control treatment gave an average amounted to 24.57 seed. nut^{-1}.

Perhaps the reason for increasing the number of seeds in a nut when adding nitrogen fertilizers is that nitrogen increases vegetative growth and thus increases the carbon representation, so the manufactured materials move from the source to the estuary at the end of the reproductive stage, so the number of seeds increases (Al-Nuaimi, 2000). As for the effect of spraying IBA in different concentrations, the concentration B2 significantly excelled and gave the highest averages amounted to 32.45 seed. nut^{-1},compared to the control treatment, which gave the lowest average amounted to 21.67 seed. nut^{-1}, and it can be explained that the IBA organizes and increases the transfer of processed materials

from the leaf to the flower and increases the efficiency of protein production, and this increases the number of seeds. His nuts. As for the interaction between the cultivars and nitrogen fertilization, the combination (V2, N2) gave the highest average of the trait, with a significant difference compared to the other combinations, and reached 30.74 seed. nut^{-1}. As for the bi-interaction between the cultivars and spraying with IBA, the combination (V2, B2) gave the highest average of 34.42 seed. nut^{-1}and the differences were significant with other combinations of the studied trait. As for the bi-interaction between nitrogen fertilization and IBA concentrations, the combination (N2, B2) was excelled by giving it the highest average amounted to 35.07 seed. nut^{-1}. As for the triple interaction between the three experiment factors, the triple combination (V2, N2, B2) was distinguished by giving it the highest average of the trait that reached (37.75) seed. nut^{-1}.

Table 6 : Effect of nitrogen fertilization and IBA spraying of two cultivars of Roselle plant on the Number of seeds(seed. nut^{-1})

Cultivars	**Fertilization**	**0 g.L^{-1} IBA**	**1 g.L^{-1} IBA**	**2 g.L^{-1} IBA**	**Average cultivars * Fertilization**
V 1	0 g.ha^{-1}	19.87	22.17	28.40	23.48
	150 g.ha^{-1}	20.92	24.29	30.62	25.27
	200 g.ha^{-1}	22.24	25.81	32.40	26.82
V 2	0 g.ha^{-1}	20.70	24.60	31.69	25.66
	150 g.ha^{-1}	22.45	26.83	33.85	27.70
	200 g.ha^{-1}	23.81	30.65	37.75	30.74
Average		21.66	25.73	32.45	
L.S.D	Cultivars=0.74	Fertilization=0.91	IBA=0.91	triple interaction= 2.9	1.29
Cultivars / IBA	0 g.L^{-1} IBA	1 g.L^{-1} IBA	2 g.L^{-1} IBA	Average	
V1	21.01	24.09	30.47	25.19	
V2	22.32	27.36	34.42	28.03	
Average	21.67	25.73	32.45		
L.S.D	1.29				
Fertilization/ IBA	0 g.ha^{-1}	1 g.ha^{-1}	2g.ha^{-1}	Average	
0 g.L^{-1} IBA	20.28	21.69	23.02	21.67	
1 g.L^{-1} IBA	23.39	25.56	28.23	25.73	
2 g.L^{-1} IBA	30.05	32.24	35.07	32.45	
Average	24.57	26.49	28.78		
L.S.D	1.58				

Seed yield (g.plant^{-1})

The results in Table (7) showed that the two cultivars of Roselle plant differed significantly for the seed yield trait for each plant, where the cultivar V2 significantly increased and gave the highest average of the trait reaching 100.39 g.plant^{-1}, while cultivar V1 gave the lowest averages amounted to 80.51 g.plant^{-1}. The reason for this may be due to the genetic difference between them, as well as the interaction between genetic and environmental factors. As for nitrogen fertilization, it clearly affected the seed yield, where the level N2 excelled in the rest of the levels, it gave an average amounted to 108. g.plant^{-1}, while the control treatment gave the lowest averages amounted to 71.06 g.plant^{-1}and the reason for the increase in the yield due to the addition of nitrogen fertilizer will lead to an increase in the percentage of chlorophyll in the leaf and this will positively affect the efficiency of photosynthesis and thus increase the yield and its components (Khandaker, 2011).

While the effect of spraying the IBA on the two cultivars of Roselle plant resulted in increasing seed yield, treatment B2 gave the highest average amounted to 120.41 g.plant^{-1} The plant significantly excelled on the other two concentrations. The control treatment gave an average amounted to 58.96 g.plant^{-1}. Achieving plant is of the lowest average and this can be explained by the accumulation of dry matter in the sink, especially carbohydrate averages and proteins in seeds, which increases its weight (Khandaker, 2011). As for the bi-interaction between the cultivars and fertilization, where the combination (V2'N2) was excelled and gave an average amounted to121.94 g.plant^{-1}. The plant, while the bi-interaction between the cultivars and the IBA was distinguished by the combination (V2, B2), as it gave the highest averages of the studied trait, amounted to 130.42 g.plant^{-1}. As for the bi-interaction between fertilization and IBA, the treatment (N2, B2) was excelled by giving it the highest average and with significant differences with the control treatment reached 142.57 g.plant^{-1}.As for the triple interaction between the experiment factors, the combination (V2, N2, B2) was significantly distinguished on the other combinations by giving it the highest averages amounted to 157.50 g.plant^{-1}

Table 7 : The effect of nitrogen fertilization and IBA spraying of two cultivars of Roselle plant on the seed yield

Cultivars	Fertilization	0 g.L^{-1} IBA	1 g.L^{-1} IBA	2 g.L^{-1} IBA	Average cultivars * Fertilization
V 1	0 g.ha^{-1}	40.11	66.46	92.44	66.34
	150 g.ha^{-1}	50.37	79.83	111.11	80.44
	200 g.ha^{-1}	62.81	93.84	127.63	94.76
V 2	0 g.ha^{-1}	55.51	71.81	101.30	76.20
	150 g.ha^{-1}	66.56	110.03	132.47	103.02
	200 g.ha^{-1}	78.40	129.92	157.50	121.94
Average		58.96	91.98	120.40	
L.S.D	Cultivars=3.02	Fertilization=3.70	IBA=3.70	triple interaction= 9.06	5.23
Cultivars / IBA	0 g.L^{-1} IBA	1 g.L^{-1} IBA	2 g.L^{-1} IBA	Average	
V1	51.09	80.04	110.39	80.51	
V2	66.82	103.92	130.42	100.39	
Average	58.96	91.98	20.411		
L.S.D	5.23				
Fertilization/ IBA	0 g.ha^{-1}	1 g.ha^{-1}	2g.ha^{-1}	Average	
0 g.L^{-1} IBA	47.18	58.47	70.60	58.96	
1 g.L^{-1} IBA	69.13	94.93	111.88	91.98	
2 g.L^{-1} IBA	96.87	121.79	142.57	120.41	
Average	71.66	91.73	108.35		
L.S.D	6.41				

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