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EFFECT OF THE SPRAYING WITH TDZ AND G-GANA IN SOME VEGETATIVE GROWTH CHARACTERISTICS OF STRAWBERRY

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ABSTRACT : A factorial experiment was conducted in the Complete Randomized Blocks Design (CRBD) in the greenhouses of the Department of Horticulture, College of Agriculture, Anbar University, at the agricultural season 2018-2019 to determine the effect of spraying with TDZ and G-GANA growth regulators in some vegetative growth characteristics of Strawberry (*Fragaria ananassa* Duch.). The experiment included two factors, the first one was spraying with TDZ growth regulator in three concentrations (0, 3 and 6 mg L^{-1}) while the second factor was the spraying with G-GANA growth regulator in four concentrations (0, 500, 1000, and 1500 mg L^{-1}). The results showed that the spraying with TDZ at a concentration of 6 mg L^{-1} (T_2) significantly increased the number of runners on the plant (3.55 runner $plant^{-1}$), number of daughter plants on the runner (1.40 plant $runner^{-1}$), number of total daughter plants per mother plant (5.06 plant), number of lateral branches (crowns) on the main stem of mother plant (4.83 crown $plant^{-1}$, leaves area (904.10 cm^2) and number of leaves on the mother plant (32.67 leaf $plant^{-1}$) which all significantly differed with control treatment. On the other hand, the spraying with G-GANA at 1000 mg L^{-1} (G_2) significantly increased the number of runner on the plant (3.60 runner $plant^{-1}$), number of daughter plants on the runner (1.37 plant $runner^{-1}$), number of total daughter plants per mother plant (5.11 plant), leaves area (771.90) and number of leaves on the mother plant (30.56 leaf $plant^{-1}$) Compared with the control treatment. The interaction between spraying with 6 mg L^{-1} of TDZ and 1000 mg L^{-1} of G-GANA (T_2G_2) significantly increased the number of runner on the plant (5.13 runner $plant^{-1}$), number of daughter plants on the runner (1.54 plant $runner^{-1}$), number of total daughter plants per mother plant (7.93 plant), number of lateral branches (crowns) on the main stem of mother plant (6.33 crown $plant^{-1}$), number of leaves on the mother plant (39.67 leaf $plant^{-1}$) and leaves area (1370.90 cm^2) compared with the control treatment.

Key words : Strawberry (*Fragaria ananassa*), spraying, TDZ, G-GANA.

INTRODUCTION

Strawberry (*Fragaria ananassa* Duch.) is an important fruit plant, which belongs to the Rosaceae family and it is one of the most widespread and consumed berries crops in the world. It is economically and commercially important, with global production equals doubling of other berries production (Giampieri *et al*, 2014)) and it is the fourth most consumed fruit after apples, oranges and bananas (Virginie, 2010). Strawberry fruits discriminatewith its high nutritional value because it contains important food compounds (Raab *et al*, 2006).

The plant spraying with growth regulators has an essential role in the growth and development as the necessary biological and physiological processes happened in the plant area result of the control and influence of these substances. Cytokinine plays an important role in reducing the apical dominance, it was observed that treating plants with cytokinines inhibit the role of auxin and it is also works as a sink to suck nutrient substances to the treatment site causing stimulating lateral buds growth (Krishnamorthy, 1981).Thidiazuron (TDZ) is one of the industrial cytokinines and is highly effective due to its non-metabolism by the cytokinine oxidation enzyme, so its effect stay long time (Pai and Dessai, 2018). TDZ physiological effectiveness includes the inhibition of apical dominance resulting in the growth of lateral buds as well as the stimulation of cell division and elongation in addition to its effect on the movement, transition and metabolism of elements in the location of the treated tissues. It also plays an important role in delaying chlorophyll degradation as well as hormonal regulation of plant phenotypic and other physiological functions (Shudo, 1994). Growth regulators play a major role in many important physiological events in the regulation of plant growth. One of these growth regulators is gibberellins as (GA_3), which promotes cell elongation and increases the efficiency of plant absorption of nutrients which leads to increase plant growth. NAA is an industrial auxin that has an effect in many of

development processes (Taiz and Zeiger, 2010). It is found that the spraying with 500 ppm of GA_3 and 1200 ppm of BA on the strawberry plant resulted in a significant increase in the number of crowns on the plant and the number of daughter plants on the runner and the number of leaves compared with the control treatment (Momenpour *et al*, 2011). This research aimed to vegetative propagation of strawberry by studying the effect of TDZ and G-GANA growth regulators in some vegetative growth characteristics.

MATERIALS AND METHODS

The experiment was carried out in the greenhouses of the Department of Horticulture and Garden Engineering, College of Agriculture, Anbar University during the growth season 2018-2019. Albion cultivar strawberry plants at three months age were obtained from Janat Al-Nakheel company for tissue culture located in Baghdad, Iraq. The plants cultured in 7 liters capacity pots and sprayed with insecticides and fungicides. The service operations were carried out for all plants equally included the weeding, irrigation and fertilization as followed by most of the farms of the Strawberry plant. A factorial experiment two factor was carried out. The first factor included TDZ spraying with three concentrations (0, 3 and 6 mg L^{-1}) given the symbols T_0, T_1 and T_2 respectively. The second factor was spraying with four concentrations of G-GANA growth regulator(0, 500, 1000 and 1500 mg L^{-1}) given the symbols G_0, G_1, G_2 and G_3 respectively. The G-GANA used in this research is a growth regulator produced from Vapco company and consist of the following (% w/w): GA3 (0.7), NAA (0.5) and Glycine (40.0). The experiment was conducted with the Complete Randomized Blocks Design (CRBD) with three replicates. The total number of treatments iss 12 and the total experimental units became 36. The data were collected and analyzed by using the Genstat program and the means were compared using the least significant difference test (LSD) at the probability level 0.05.

The following characteristics were studied and their data were recorded:

Number of the runners per plant (runner plant^{-1})

This character was calculated by recording the total number of runners produced in all plants in each experimental unit and divided on the number of plants in it and calculate the mean of the three replicates.

Number of the daughter plants per runner (plant runner^{-1})

All daughter plants were recorded and divided the sum on the number of runners in each experimental unit then calculate the mean of the three replicates.

Number of the daughter plants per mother plant (daughter plant mother plant^{-1})

It was calculated by recording all daughter plants produced in the experimental unit and divided on the number of plants in it then calculate the mean of the three replicates.

Number of the crowns per plant (crown plant^{-1})

The number of lateral branches (crowns) formed on the main stem of all plants in each experimental unit had been calculated and divided on plants number then calculate the mean of the three replicates.

Number of the leaves per plant (leaf plant^{-1})

This character had been calculated by calculating the total number of leaves formed on the mother plants in each experimental unit and divided on the number of plants in it then calculate the mean of the three replicates.

The plant leaves area (cm^2)

The leaves area had been calculated by recording the single leaf area according to Dvornic (1965) and multiply with leaves number in the mother plant.

RESULTS AND DISCUSSION

Number of the runners per plant (runner plant^{-1})

The results in Table 1 shows that the spraying with the TDZ resulted in significant superiority in the number of runners per plant. The treatment T_2 recorded the highest mean of runners (3.55 runner plant^{-1}), which is significantly differed with the other treatment, while T_0 treatment gave the lowest number of runners(1.95runner plant^{-1}). On the other hand, the spraying with G-GANA also showed significant differences between the treatments. G_2 treatment gave the highest number of runners (3.60 runner plant^{-1}), which was significantly differed with theother treatments. The control treatment (G_0) recorded the lowest number of runners (2.20).

The results of the interaction between the two factors showed that there are significant differences between the runner number means obtained. The treatment T_2G_2 recorded the highest number of runners per plant (5.13), which is significantly differed with all other interactions, while T_0G_0 gave the lowest number of runners per plant (1.33) (Table 1).

Number of the daughter plants per runner (plant runner^{-1})

The spraying with TDZ significantly affected in daughter plants number produced per runner. Table 2 refers that the T_2 treatment caused significant differences, which gave the highest number of the

daughter plants per runner (1.40), while the treatment T_0 recorded the lowest number (1.25 plant runner^{-1}). For the spraying with G-GANA, the treatment G_2 recorded significant superior on the other two treatments and gave the highest number of the daughter plants per runner (1.37), while G_1 treatment recorded the lowest number (1.32), which is not significantly differed with the control treatment (G_0).

The interaction between the two factors of this study showed that the treatment T_2G_2 recorded the highest number of the daughter plants per runner (1.54), which is significantly differed with all other interactions, while the treatment T_0G_2 gave the lowest number of daughter plants per runner (1.21).

Number of the daughter plants per mother plant (daughter plant mother plant^{-1})

The results in Table 3 refers that the TDZ spraying was significantly affected in the daughter plants produced from the mother plant. The treatment T_2 gave the highest number of daughter plants per the mother plant (5.06), which is significantly differed with the two other treatments, while T_0 treatment recorded lowest number totaled 2.43 daughter plant per mother plant. Also the spraying with G-GANA was significantly affected in the same character, the treatment G_2recorded the highest number (5.11), while the control treatment (G_0) gave the lowest number of daughter plants per mother plant (2.93).

On the other hand, the interaction between the two factors caused a significant difference between the treatments. The treatment T_2G_2 significantly superior on all other interactions and gave the highest number of daughter plants per mother plant (7.93), while the treatment T_0G_0 recorded the lowest number (1.73).

Number of lateral branches (crowns) per plant (crown plant^{-1})

The results shown in Table 4 refer that the spraying with 6 mg L^{-1} of TDZ (T_2) gave the highest number (4.83) of crowns formed on main stem of the mother plant, which is significantly differed with T_1 treatment and control treatment (T_0), which recorded the lowest number (2.83), while the spraying with G-GANA did not significantly affected in this character.

On the other hand, the interaction treatments resulted in significant differences. The treatment T_2G_2 was significantly superior on all other treatments and gave the highest number of crowns (6.33 crown plant^{-1}), while the lowest number (2.33) recorded in the treatment T_0G_2.

Number of leaves per plant (leaf plant^{-1})

The results in Table 5 shows that there are significant differences between the means of leaves number formed on the mother plant when sprayed with different concentrations of TDZ. The concentration 6 mg per liter (T_2) gave the highest number of leaves (32.67), while T_0 (control treatment) recorded the lowest number (22.08 leaf plant^{-1}). Also the spraying with G-GANA affected

Table 1 : Effect of Thidiazuron and G-GANA spraying in the runners number formed on strawberry plant (runner plant^{-1}).

Treatments	G_0	G_1	G_2	G_3	Mean (T)
T_0	1.33	1.86	2.46	2.13	1.95
T_1	2.40	2.86	3.20	3.60	3.01
T_2	2.86	3.20	5.13	3.00	3.55
Mean (G)	2.20	2.64	3.60	2.91	
LSD 0.05	T		G	T×G	
	0.27		0.32	0.55	

Table 2 : Effect of Thidiazuron and G-GANA spraying in the number of strawberry daughter plants formed on the runner (plant runner^{-1}).

Treatments	G_0	G_1	G_2	G_3	Mean (T)
T_0	1.30	1.25	1.21	1.24	1.25
T_1	1.33	1.37	1.37	1.37	1.36
T_2	1.35	1.35	1.54	1.37	1.40
Mean (G)	1.33	1.32	1.37	1.33	
LSD 0.05	T		G	T×G	
	0.03		0.03	0.06	

Table 3 : Effect of Thidiazuron and G-GANA spraying in the number of strawberry daughter plants produced from the mother plant.

Treatments	G_0	G_1	G_2	G_3	Mean (T)
T_0	1.73	2.33	3.00	2.66	2.43
T_1	3.20	3.93	4.40	4.93	4.11
T_2	3.86	4.33	7.93	4.13	5.06
Mean (G)	2.93	3.53	5.11	3.91	
LSD 0.05	T		G	T×G	
	0.35		0.41	0.71	

Table 4 : Effect of Thidiazuron and G-GANA spraying in the number of crowns formed on the main stem of the mother plant (crown plant^{-1}).

Treatments	G_0	G_1	G_2	G_3	Mean (T)
T_0	2.67	2.33	2.33	4.00	2.83
T_1	3.67	4.67	3.00	3.67	3.75
T_2	4.33	4.00	6.33	4.67	4.83
Mean (G)	3.56	3.67	3.89	4.11	
LSD 0.05	T		G	T×G	
	0.59		N.S	1.19	

in the leaves number, the treatment G_2 recorded the highest number of leaves reached 30.56 leaf plant^{-1} which is significantly differed with G_1 and G_0 (control treatment) which gave the lowest number of leaves (26.44).

The interaction between the two factors of this study refer that the treatment T_2G_2 recorded the highest number of leaves mean (39.67 leaf plant^{-1}), which is significantly superior on all other interactions. The lowest number of leaves (22.00) had been recorded in the control treatment (T_0G_0).

The plant leaves area (cm^2)

The results in Table 6 shows that the spraying with TDZ affected in significant differences between the means of leaves area. The treatment T_2 is significantly differed with the two other treatments and recorded the highest value of leaf area reached 904.10 cm^2 per plant, while the control treatment (T_0) gave the lowest area (348.10 cm$_2$ plant^{-1}). And in the same context, the spraying with 1000 mg L^{-1} of G-GANA (G_2) gave the highest leaf area (771.90 cm^2), which significantly differed with the three other concentrations, while the lowest mean of area (488.10) had been recorded in the control treatment (G_0).

The interaction between the two studied factors showed that T_2G_2 treatment recorded the highest value of leaf area (1370 cm^2), which is significantly differed with all other treatments. The control treatment (T_0G_0) gave the lowest leaf area (254.00 cm^2).

The increase in the number of runners per plant, the daughter plants per runner and the number of crowns produced from the mother plant, caused by TDZ spraying, may be attributed to the cytokinin role in limiting the effect of apical dominance controlled by the auxin (Bangerth, 1994). As a result of the above, some of the lateral buds may be enhanced to grow and a part of them developed to runners, which hold the daughter plants, and the other part grows to crowns on the main stem of the mother plant. This increase resulted in an increase of the total plants produced from the mother plant. These results conformed with those found by Kirschbaum (1998). On the other hand, the spraying with TDZ at the suitable concentration affected in the leaves number mean and leaves area which may be due to the cytokinine effect in the enhancement of cell division and increase the growth rate (Singh *et al*, 2011). Also, the cytokinins effect CO_2 fixation in photosynthesis process via the effect on the Carbonic anhydrases enzyme activity, which increases CO_2 availability that increased photosynthesis efficiency (Sadeghi and Shekafandeh, 2014). This is maybe reflected in the increase in growth rate and resulting in the increase of leaves number, which led to the increase in the leaves area. In addition, TDZ plays an important role in the biological processes inside the plant and the synthesis of enzymes, proteins, organic acids and nucleic acids DNA and RNA, in addition to its role in the synthesis of purines and pyrimidines that enter in the chlorophyll structure, the active element in the photosynthesis process (Mok and Mok, 1985).

Table 5 : Effect of Thidiazuron and G-GANA spraying in the number of leaves formed on the strawberry mother plant (leaf plant^{-1}).

Treatments	G_0	G_1	G_2	G_3	Mean (T)
T_0	22.00	23.33	24.67	26.33	24.08
T_1	27.00	28.00	27.33	29.00	27.83
T_2	30.33	30.00	39.67	30.67	32.67
Mean (G)	26.44	27.11	30.56	28.67	
LSD 0.05	T		G	T×G	
	1.47		1.69	2.94	

Table 6 : Effect of Thidiazuron and G-GANA spraying in the Leaves area of strawberry plant (cm^2 plant^{-1}).

Treatments	G_0	G_1	G_2	G_3	Mean (T)
T_0	254.00	335.30	362.00	441.20	348.10
T_1	485.50	536.00	583.60	647.10	563.00
T_2	724.90	703.20	1370.20	818.10	904.10
Mean (G)	488.10	524.80	771.90	635.50	
LSD 0.05	T		G	T×G	
	40.99		47.33	81.97	

The spraying of G-GANA, at the appropriate concentration, positively affected in most studied growth indicators, and this may be attributed to the role of GA_3 (which is one of the components of G-GANA) in cell division and elongation that resulting in the increase of cells size as a result of its effect in the increase of cell walls elasticity and plasticity (Krishnamorthy, 1981). GA_3 promotes nutrient uptake, which is reflected in the biosynthesis processes in the plant, also GA_3 helps to increase the permeability of the cellular membranes, thus increasing the cell's content of protoplasm (Taize and Zeiger, 2010). Our results are conformed with those found by Momenpour et al. (2011) who found that the spraying with GA_3 and BA affected in increasing the number of crowns, the number of plants on the runner and the number of leaves. On the other hand, G-GANA contains the auxin NAA, which has a main role in cell division resulting in the increase of the cells number, also the auxins may affect in enzymes synthesis, which enhance the biological processes (Daves, 2004). The plant hormones play an important role in the photosynthesis

processes, which may led to the increase in the growth indicators such as plants number, leaves number and leaves area (Luckwill, 1981). G-GANA in its component contains the amino acid glycine. The amino acids, directly and indirectly, affect in the physiological events that are reflecting on the plant growth and development, as well as the spraying of the amino acids on the plants, affect in reducing the damages caused by oxidation stresses (Ashraf and Foolad, 2007; Gill and Tuteja, 2010). Furthermore, the amino acids, have an importance in plant growth and development because they are involved in the bio-processing of many kinds of non-protein compounds, such as stains, vitamins and co-enzymes (Salwa and Osama, 2014). There are many hypotheses explain the role of amino acids in the growth and development in the plant, one of them supposes that the amino acids are primers for auxin synthesis (Hashimoto and Yamada, 1994), also they have higher ability for conjugation with different rings at the metabolism processes in the plant that enhance the growth (Coruzzi and Last, 2000).

CONCLUSION

Spraying with TDZ and G-GANA has significant positive effect on the vegetative growth of the plant.

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