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Effect of Foliar Application of Zinc and Benzyladenine on Growth, Yield and Chemical Constituents of Tuberose Plants

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Abstract: This study was conducted in Oseim district, Giza governorate, during the two successive seasons of 2007 and 2008, to investigate the effect of zinc sulphate and benzyladenine foliar application on the flowers, yield and some chemical constituents of *Polianthes tuberosa* L. plants. The soil of the experiments was clay loam in texture, tented to alkalinity in reaction and had low content of zinc. Plants were sprayed three times with Benzyladenine (BA) (N-6-benzylaminoacid at (25, 50 and 100 ppm) and zinc sulphate at (0.75, 1.50 and 3 g/l). All studied parameters of flowering characteristics, number of bulblets/plant and fresh weight of bulbet and bulblet / plant were significantly increased by foliar spraying of zinc (Zn) or benzyladenine (BA), at all investigated rates over the control. The increase of Zn or BA rates from the lower to the middle rates significantly increased all floral characters and further increments of either Zn or BA rates had no significant effect or declined some of the investigated flowering traits and bulbets yield. The interaction between Zn and BA had significant effect on flowering and bulbs characteristics of tuberose. Zn foliar application significantly increased N, P, K, Fe, Mn, Zn and Cu content in plant organs, with the exception of K in flowers and P in bulbs also. Total carbohydrate contents of different tuberose plant organs and flowers oil percentage were significantly increased with Zn and or BA foliar spraying. The highest total carbohydrates content of different plant organs and flowers oil percentage resulted from the combination of 3.0g Zn/l with 100 ppm BA, and 1.5g Zn/l with 50 ppm BA, respectively. Component of essential oil of tuberose was analysed.

Key words: *Polianthes tuberosa.L,* zinc sulphate, benzyladenine, plant growth, chemical constituents**,** oil of flowers.

INTRODUCTION

Tuberose, (*Polianthes tuberose* L.) is the most popular summer flowering bulb grown in Egypt. Waxy white flowering spikes of tuberose with sweet and pleasant fragrance are in great demand for indoor decoration, garlands, bouquets, cut flower trade, and extraction of essential oil (Dahiya *et al*.[1], also, long vas life. Tuberose plants can be grown in soil from light sandy loam to clay loam. In Egypt, tuberose cultivation is concentrated in alluvial soil, which characterized with high fertility for demand the higher amount of nutrients requirements for tuberose plant growth. On the other hand, the survey studies of such soil analysis in Egypt by the Egypto-German Project of micronutrients and other plant nutrition problems in Egypt revealed the shortage of micronutrient, especially Zn soil content. Zinc (Zn) is an essential element for plant that act as a metal component of various enzymes or as a functional structural or regulatory cofactor and for protein synthesis, photosynthesis, the synthesis of auxin, cell division, the maintains of membrane structure and function and sexual fertilization[2]. Cytokinins are plant growth regulators used for stimulating cell division, as well as for the formation and growth of axillary and shoots. This group consisted of the naturally occurring cytokinins which include zeatin, zip and another type is synthetic cytokinins that consists of substituted purine, B- benzylamino-purine and kinetin. Rawia and Bedour[3] reported that application of benzyladenine on Caroton plant resulted an increases in plant growth (fresh weight, plant height, No. of branches). The influence of cytokinins on the biosynthesis and accumulation of fixed oils and fatty acids were studied by many investigators. Youssef *et al*.[4] reported that foliar application of kinetin to Mattiola plants significantly promoted growth of plant and gave the highest oil percentage. Fatma *et al*.[5] reported that spraying Cupressus Sempervirers with kinetin produced the highest seed oil content. Thus, this study aimed to investigate the effect of Zn and benzyladenine on tuberose plants.

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MATERIALS AND METHODS

The field experiments were carried out in Oseim district, Giza governorate during the two successive seasons 2007 and 2008. The aim of the study was to investigate the effect of zinc (Zn) and benzyladenine (BA) foliar application on the flowers, yield and some chemical constituents of *Polianthes tuberosa* L. plants.

Experimental Procedures: Bulbs of tuberose were obtained from ornamental plant research Dept., Ministry of Agric, Egypt for cultivation. The soil is clay loam in texture (sand 37, silt 28 and clay 35 %), tented to alkalinity in reaction (pH 7.91). It had low content of calcium carbonate (2.04%); organic matter (1.40%) and E.C. (0.45 dS/m). High in available phosphorus, potassium (3.2 and 78 mg/100g soil), and low in available Fe, Mn, Zn, Cu (9.3, 3.24, 0.84, 0.89 mg/1000g soil), respectively.

On April, 2007 and 2008, bulbs of tuberose plant were planted in rows, at spacing of 30 cm between bulbs within each row, and 60 cm between rows. The plants were fertilized with 80: 40: 60 g/m^2 from NPK, calcium superphosphate (15.5% P_2O_5) was added before planting while the plants were fertilized with ammonium nitrate (33.5%) and potassium sulphate (48% K_2O) after 30 days from planting at two side dressings. Plants were sprayed three times with Benzyladenine (BA) (N-6-benzylaminoacid at (25, 50 and 100 ppm) and of zinc sulphate foliar treatments at (0.75, 1.50 and 3.0 g/l). The control plants were sprayed with water. The experiments were set up in a completely randomized block design with three replicates. After the flowering period of each season, the following data were recorded, number of days to flowering, spike length (cm), spike diameter (cm), length of the rachis (cm), number of flowers/spike, fresh and dry weight of spike (g), No.of bulblets/plant, fresh and dry weight of bulbs (g). Fresh and dry weight of bulblets (g).

Experimental Design and Statistical Analysis: Treatments were arranged in a complete block design with three replicates. The data were statistically analysed using analysis of variance according to Snedecor and Cochran[6].

Chemical Analysis: Soil surface samples (0-30 cm depth) were taken before planting from the experimental site. Soil was air-dried and sieved through 2mm sieve. Physical & chemical characteristics, were evaluated according to Ankerman and Large[7]
Soil testing was determined as follows:
Texture: Hydrometer method[8]
$CaCO_3$: Collin's calcimeter[9]
O.M: Black method[10]
P: $NaHCO_3$ extraction at pH 8.5[11]. K, Ca and Mg: NH_4-OAC extraction at pH 7[12]
Fe, Mn, Zn and Cu: DTPA extraction at pH 7.3[13]
Plant nutrients were determined as follows:

Total nitrogen percentages were determined by using the micro kjeldahl method described by A.O.A.C[14]; total P was photo metrically determined using vanadate method, while, potassium were determined by Flame photometer. Micronutrients and magnesium was measured using atomic absorption spectrophotometer, according to Chapman and Pratt[15]. Total carbohydrate percentages were determined according to Herbert *et al*[16].

Methods of Extracting Essential Oil: Flowers (200g) are placed in vessel and covered with the solvent (hexan). It gently heated electrically while the solvent extracts the fragrant molecules of the plant. This is filtered, resulting in a paste called a concrete. The concrete is then agitated with alcohol and chilled to remove the wax. Essential oil absolutes by conducting was GC-MS analysis system operating on EL mode, equipped with a capillary column HP-5MS 30 mx 0.25 mm, film thickness: 0.25 un, temperature program, 60 C^0 (5 min) to 280 C^0 at a rate of 3 C^0/ min; gnj. Temp. 200 C^0, GC MS analysis was also plus ions a trap mass spectrometer. Identification of components was based on comparison of their mass specters with those of Willey and NBS. Libraries Massada[17] and those described by Adams indices[18] with literature values[19].

RESULTS AND DISCUSSION

1. Effect on Some Flowering and Bulbs Traits: The data presented in Table (1) revealed that all studied parameters of flowering characteristics, i.e. number of days of flowering, number of flowers/spike, rachis length, spike length, fresh and dry weight of spike and spike diameter were significantly increased by foliar spraying of zinc (Zn) or benzyladenine (BA), at all investigated rates over the control of zinc or benzyladenine. It was noticed that with the increase of Zn or BA rates from the lower to the middle rates, all floral characters were significantly increased. But further increments of either Zn or BA rates had no significant effect or declined some of the investigated flowering traits. The effect of Zn on flower character reveals that Zn made promising response to the studied parameters, where floral characters showed better response to Zn application, due to Zn deficiency in experimental studied soil. In this respect, Halder *et al.*[20] mentioned that soil with critical level of Zn content meant highly responsive to the cut flower

plants such as Gladiolus, showed better response to Zn application. The previous results of Zn effects on flowering traits are in agreement with those attained by Prabhat and Arora[21] on Gladiolus, El-Khayat[22] on Antholyza aethiopica, Yadav *et al.*[23] on tuberose, Halder *et al.*[20] on Gladiolus, Nahed[24] on codiaeum variegatum, Nahed and Balbaa[25] on Salvia Forinacea plants, as well as, El-Bably, Samia and Mohmoud[26] on Tritonia plant. The beneficial effect of BA Application at suitable concentrations on the flowering characteristics was stated. The interaction between Zn and BA was found statistically significant for flowering characteristics of tuberose like number of days of flowering, number of flowers/spike, rachis length, spike length, fresh and dry weight of spike and spike diameter, Table (1). Number of flowers/spike, spike length and spike fresh weight increased with the increase of Zn and BA levels simultaneously up to $Zn_{3.0}$ BA_{50}, but further augmenting of BA levels up to 100 ppm incorporating with all Zn levels depressed most of studied traits.. Length of rachis and number of days of flowering improved with the increase of Zn and BA up to middle level of both Zn (1.5g/l) and BA (50ppm). The highest incorporating levels of Zn (3.0g/l) and BA (100pm) showed reducing trend. It was also inferred that combination of Zn and BA contributed more than their single application.

The effect of Zn on bulblets production is shown in Table (1), it appeared that the foliar application of Zn at all rates significantly increased bulblets number, fresh weight and dry weight of bulblets per plant over the zinc control. However, it was noticed that further increments of zinc dosage over 0.75g/L caused significant depression in the number and weight of bulblets per plant. These results was in agreement with the findings of Jhon *et al.*[27], Parbhot and Arora[21], Halder *et al.*[20] and El-Bably, Samia and Mahmoud[26] on Gladiolus and Yadav *et al.*[23] on tuberose. Concerning the effect of BA on bulb production of tuberose, Table (1) reveals that BA made a promising response to the studied parameters of bulbs production, which were significantly increased. It was noticed that number of bulblets/plant and dry weight of bulbet and bulblets/plant were increased progressively and significantly with the increasing of BA levels up to 100 ppm, as compared with the control treatment. However, fresh weight of bulbet and bulblets/plant significantly increased only up to 50 ppm, these results suggest that the mechanism of BA, like that of other cytokinins works directly on the deposition of dry matter in plant cells rather than on cell water relation[28]. Similar results were obtained by Refaey[29], El-Sayed *et al.*[30] and Mazrou[31]. Regarding the interaction effects, results in Table (1) show that the interaction between BA and Zn significantly affected on number of bulblets/plant as well as fresh and dry weight of bulblets/plant. The highest values of the bulblets number per plant was obtained from 100ppm BA combined with the middle level (1.5g/L). On the other hand, the treatments combination of 50 ppm BA with 1.5 g/L Zn and 50ppm with 0.75g/L Zn gave the highest values of fresh and dry weight of bulblets /plant, respectively.

2. Effect on Chemical Constituents:

2.1. Nutrients Content: Data of the effect of Zn and BA foliar spray treatments and their interaction on nutrients contents of leaves, flowers and bulbs, are presented in Tables (2, 3) and (4). indicated that the treatments of Zn foliar application significantly increased all nutrients in leaves, i.e N, P, K, Fe, Mn, Zn and Cu as compared with the control treatment. On the other hand, all these nutrients, with the exception of K in flowers and P in bulbs were significantly increased due to foliar spraying of Zn. It was also observed that the highest level of Zn (3.00g/L) foliar spray depressed N, Mn content of leaves, flowers and bulbs, while caused significant increases in Zn and Cu of leaves, Cu of flowers and Zn and Fe of bulbs.

These results may be due to that Zn is essential for sugar regulation and enzymes that control plant growth[32]. The obtained results are in conformity with those of El-Khayat[22], Gomaa[33]on Antholyza aethiopica, Yadav *et al.*[23] on tuberose and El- Bably, Samia and Mahmoud[26]. Also, Nahed and Balbaa[25] on Salvia farinacea plants and Farahat *et al.*[34] on Cupressus semperviens. Concerning the application of benzyladenine (BA), it is clear from the data in Tables (2, 3) and (4) that foliar spraying of BA significantly increased macro and micronutrients of different tuberose plant organs compared with the control treatment. Results also indicated that the treatment of the middle level concentration of BA (50ppm) produced the highest macro and micronutrients content of leaves, flowers and bulbs, except Cu content in all plant organs and P in leaves. In addition, the highest level of BA (100ppm) concentration caused significant reduction in leaves, flowers and bulbs contents from all measured nutrients, except Cu and P in leaves and Cu in flowers and bulbs. It could be stated that, 50 ppm BA seem to be the most effective level in increasing N, P, K, Fe, Mn, Zn and Cu in leaves, flowers and bulblets of tuberose plant. These results coincide with those obtained by El-sayed *et al.*[30] on tuberose, Al-Humaid[35] on rose and Raifa *et al.*[36] on Hibiscus Sabdariffa. These results could be explained through the role of BA in increasing the width of conductive tissues (xylem and phloem) and consequently increasing the absorption and translocation of the elements necessary for plant growth[37]. This again

Table 1: Main and interaction effect of zinc and benzyladenine foliar spray on growth, yield and yield components of tuberose plant ((Mean data of the two seasons)

Treatments	Number of days of flowering	Spike length (cm)	Fresh weight of spike (g)	Dry weight of spike (g)	Spike diameter (cm)	Number of flowers /spike	Length of rachis (cm)	Number of bulblets /plant	Fresh weight of bulbet and bulblets /plant (g)	Dry weight of bulbet and bulblets /plant (g)
Effect of zinc (Zn)										
Zero	82.08	74.35	89.3	8.68	1.01	27.45	3.12	21.84	64.91	29.6
0.75g/l	81.5	76.93	95.58	9.6	1.62	28.4	3.19	24.28	89.48	38.89
1.50g/l	79.45	80.55	108.23	10.99	1.65	30.4	3.34	24.58	86.87	39.24
3.00g/l	79.53	81.45	110.8	10.9	1.63	30.85	3.36	22.63	82.19	36.9
L.S.D at 5%	0.17	1.18	3.11	0.41	NS	0.74	0.08	1.18	1.89	2.35
Effect of benzyladenine (BA)										
Zero	83.38	74.6	75.98	7.62	0.99	24.03	2.98	18.21	63.16	27.74
25 ppm	81.85	76.78	103.18	10.39	1.09	28.98	3.11	22.65	65.76	30.37
50 ppm	78.43	81.45	116.55	11.59	1.93	32.85	3.46	25.45	109.45	38.29
100 ppm	78.9	81.68	110.7	10.59	1.9	31.25	3.48	26.6	94.84	40.43
L.S.D at 5%	0.24	1.34	5.36	0.35	NS	2.14	0.01	0.21	2.31	1.11
Interaction effect										
Zn 0+ BA 0	85.5	71.3	75.2	7.2	0.93	23.3	2.93	17.21	54.22	24.31
Zn 0+ BA 25	83.9	73.2	90.4	9.32	0.99	27.3	3.06	21.34	57.41	26.87
Zn 0+ BA 50	79.4	78.8	103.7	10.41	1.04	29.8	3.29	23.51	70	32.11
Zn 0+ BA 100	79.5	79.1	97.9	7.78	1.09	29.4	3.21	25.28	78	35.11
Zn 0.75 + BA 0	85.3	71.7	75.7	7.52	0.94	23.8	2.99	18.31	56.03	25.83
Zn 0.75+BA 25	83.1	75.4	101.3	10.21	1.11	27.8	3.08	23.81	70	31.4
Zn 0.75+BA 50	78.3	80.3	106.2	10.83	2.21	31.51	3.24	27	129.4	58.2
Zn 0.75+BA 100	79.3	80.3	99.1	9.84	2.2	30.15	3.43	28	102.5	40.13
Zn 1.50 + BA 0	81.4	77.4	76.1	7.83	1.04	24.4	2.99	20.11	80.21	32.34
Zn 1.50 + BA 25	80.4	78.2	105.8	10.52	1.12	29.3	3.13	23.61	70.83	32.1
Zn 1.50 + BA 50	78	81.2	128	12.8	2.24	35	3.56	26.8	131.45	47.2
Zn 1.50 + BA 100	78	83.4	123	12.83	2.21	32.9	3.68	27.5	105	45.3
Zn 3.0 + BA 0	81.3	78	76.9	7.91	1.05	24.6	3.01	17.19	63.19	28.49
Zn 3.0 + BA 25	80	70.3	115.2	11.5	1.14	31.5	3.12	21.62	64.48	31.12
Zn 3.0 + BA 50	78	83.5	128.3	12.31	2.23	35.1	3.67	24.47	116.95	46.84
Zn 3.0 + BA 100	78.8	83.9	122.8	11.89	2.1	32.2	3.65	25.63	93.87	41.18
L.S.D 5%	0.8	0.82	2.83	0.3	NS	0.81	0.04	0.78	1.017	2.51

suggests, the influence of BA on the mechanism of ions uptake may be related to its effect on membrane permeability and rate of ion entry through the membrane, or enhance their translocation to the shoot[38]. Furthermore, kinetin altered membrane composition, Merillon *et al.*[39], its selectivity, Dhakal and Erdei[40] and increased membrane fluidity[41]. With regard to the interaction between Zn and BA treatments it is evident from data in Tables (2, 3) and (4) that all nutrients, i.e. N, P, K, Fe, Mn, Zn and Cu concentration in leaves, flowers and bulbs were significantly affected due to all combination of Zn and BA. The highest values of leaves N, K and Mn content were attained from the treatment of 1.5g/L Zn + 50 ppm BA combination, while 1.5g/L Zn+ 100 ppm BA combination gave the highest P and Cu leaves content.

Table 2: Main and interaction effect of zinc and benzyladenine foliar spray on nutrient content of tuberose plant leaves ((Mean data of the two seasons)

Treatments	N (%)	P (%)	K (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
Effect of zinc (Zn)							
Zero	1.96	0.148	3.83	111.3	45.8	36	0.56
0.75g/l	2.09	0.152	3.87	140.3	52.3	52.3	1.68
1.50g/l	2.28	0.16	3.98	146.5	72	61.3	1.71
3.00g/l	2.24	0.164	4	146.8	62.3	69.5	2.07
L.S.D at 5%	0.04	0.003	0.03	2.11	2.07	3.58	0.03
Effect of benzyladenine (BA)							
Zero	1.82	0.135	3.36	122.8	54.3	47.5	0.87
25 ppm	2.26	0.142	3.57	137.5	58.8	58.5	1.18
50 ppm	2.37	0.17	4.46	149	70.5	61	1.91
100 ppm	2.13	0.177	4.29	135.5	48.8	52	2.07
L.S.D at 5%	0.08	0.003	0.03	1.38	1.44	2.13	0.04
Interaction effect							
Zn 0+ BA 0	1.5	0.13	3.21	105	37	28	0.06
Zn 0+ BA 25	2.01	0.14	3.43	110	39	33	0.08
Zn 0+ BA 50	2.23	0.16	4.35	130	51	42	1.03
Zn 0+ BA 100	2.11	0.17	4.33	100	56	41	1.08
Zn 0.75 + BA 0	1.8	0.13	3.25	122	47	42	1.11
Zn 0.75+BA 25	2.17	0.14	3.47	143	48	58	1.13
Zn 0.75+BA 50	2.26	0.17	4.41	153	71	61	2.08
Zn 0.75+BA 100	2.13	0.17	4.35	143	43	48	2.39
Zn 1.50 + BA 0	2.03	0.14	3.34	135	81	53	1.14
Zn 1.50 + BA 25	2.43	0.15	3.68	148	73	66	1.16
Zn 1.50 + BA 50	2.5	0.17	4.53	155	81	68	2.13
Zn 1.50 + BA 100	2.15	0.19	4.36	148	53	58	2.41
Zn 3.0 + BA 0	1.93	0.14	3.65	129	52	67	1.15
Zn 3.0 + BA 25	2.41	0.15	3.69	149	75	77	2.34
Zn 3.0 + BA 50	2.48	0.18	4.53	158	79	73	2.38
Zn 3.0 + BA 100	2.14	0.19	4.12	151	43	61	2.4
L.S.D 5%	0.13	0.005	0.06	1.04	1.03	4.21	0.01

Table 3: Main and interaction effect of zinc and benzyladenine foliar spray on nutrient content of tuberose plant flowers ((Mean data of the two seasons)

Treatments	N (%)	P (%)	K (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
Effect of zinc (Zn)							
Zero	2.16	0.12	0.22	83.3	29.3	26.3	0.04
0.75g/l	2.45	0.14	0.23	102.3	46.3	46.8	0.91
1.50g/l	2.65	0.2	0.23	104.3	55	51	0.93
3.00g/l	2.58	0.2	0.23	104.8	52.3	52.5	1.19
L.S.D at 5%	0.17	0.003	NS	1.05	1.04	1.82	0.01

Table 3: Continue

Effect of benzyladenine (BA)							
Zero	2.34	0.11	0.22	93.5	37.3	36	0.32
25 ppm	2.52	0.17	0.23	97.25	43.8	38.3	0.87
50 ppm	2.66	0.2	0.25	104	53.5	51.5	0.92
100 ppm	2.32	0.17	0.22	99.8	48.3	50.8	0.96
L.S.D at 5%	0.13	0.003	0.009	1.21	1.11	0.51	0.01
Interaction effect							
Zn 0+ BA 0	2.1	0.11	0.21	79	25	21	0.02
Zn 0+ BA 25	2.13	0.12	0.22	80	26	23	0.02
Zn 0+ BA 50	2.18	0.12	0.24	85	31	28	0.04
Zn 0+ BA 100	2.22	0.12	0.21	89	35	33	0.06
Zn 0.75 + BA 0	2.31	0.11	0.22	93	38	36	0.08
Zn 0.75+BA 25	2.5	0.12	0.23	100	36	38	1.14
Zn 0.75+BA 50	2.7	0.2	0.24	107	59	55	1.18
Zn 0.75+BA 100	2.28	0.13	0.22	109	52	58	1.23
Zn 1.50 + BA 0	2.52	0.12	0.22	99	45	41	0.08
Zn 1.50 + BA 25	2.8	0.23	0.23	105	56	44	1.16
Zn 1.50 + BA 50	2.9	0.24	0.25	110	61	60	1.21
Zn 1.50 + BA 100	2.38	0.23	0.22	103	58	59	1.28
Zn 3.0 + BA 0	2.41	0.12	0.22	103	41	46	1.1
Zn 3.0 + BA 25	2.63	0.23	0.24	104	57	48	1.16
Zn 3.0 + BA 50	2.87	0.23	0.26	114	63	63	1.23
Zn 3.0 + BA 100	2.4	0.22	0.22	98	48	53	1.28
L.S.D 5%	0.26	0.006	0.02	0.81	0.74	2.87	0.01

Table 4: Main and interaction effect of zinc and benzyladenine foliar spray on nutrient content of tuberose plant bulbs ((Mean data of the two seasons)

Treatments	N (%)	P (%)	K (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
Effect of zinc (Zn)							
Zero	0.99	0.07	1.76	67.3	28.2	24.6	0.02
0.75g/l	1.18	0.09	1.81	92.8	43.7	46	0.24
1.50g/l	1.25	0.09	1.89	96.8	47	52	0.31
3.00g/l	1.17	0.1	1.84	98.5	46.8	54.5	0.36
L.S.D at 5%	0.04	NS	0.04	0.51	0.34	0.83	0.06
Effect of benzyladenine (BA)							
Zero	0.89	0.04	1.78	79.8	36.9	35.8	0.06
25 ppm	1.23	0.09	1.83	88.08	38.8	43.4	0.13
50 ppm	1.4	0.11	1.87	93.8	48.7	51.08	0.34
100 ppm	1.06	0.19	1.82	93.8	41.3	46.9	0.36
L.S.D at 5%	0.04	0.11	0.04	0.31	0.45	1.73	0.01

Table 4: Continue

Interaction effect							
Zn 0+ BA 0	0.89	0.03	1.74	63	26	22	0.01
Zn 0+ BA 25	0.99	0.08	1.76	65	26.7	22.8	0.01
Zn 0+ BA 50	1.05	0.09	1.78	68	28.9	25.3	0.03
Zn 0+ BA 100	1.01	0.1	1.75	73	31.2	28.4	0.04
Zn 0.75 + BA 0	0.93	0.04	1.76	77	33.4	31.2	0.05
Zn 0.75+BA 25	1.21	0.08	1.81	95	41.5	46.8	0.08
Zn 0.75+BA 50	1.45	0.11	1.89	99	52	56	0.32
Zn 0.75+BA 100	1.11	0.12	1.78	100	48	50	0.53
Zn 1.50 + BA 0	0.97	0.04	1.82	87	45.1	44	0.08
Zn 1.50 + BA 25	1.32	0.09	1.91	95	43	51	0.11
Zn 1.50 + BA 50	1.56	0.12	1.93	104	56	60	0.51
Zn 1.50 + BA 100	1.13	0.12	1.89	101	44	53	0.54
Zn 3.0 + BA 0	0.74	0.05	1.8	92	43	46	0.08
Zn 3.0 + BA 25	1.38	0.11	1.83	97	44	53	0.31
Zn 3.0 + BA 50	1.54	0.12	1.87	104	58	63	0.51
Zn 3.0 + BA 100	1	0.13	1.85	101	42	56	0.54
L.S.D 5%	0.08	0.06	0.08	0.36	0.62	0.64	0.01

In addition, the treatments of 3.0 g Zn/L + 50 ppm BA and 3.0 Zn/l+25ppm gave the highest values of leaves Fe and Zn content, respectively. As for flowers nutrients content, data in Table (3) cleared that 1.5g/l Zn + 50 ppm BA gave the highest values of N, P flowers content, while 3.0 g/l Zn with 50 ppm BA revealed the highest values of K, Fe, Mn and Zn flowers content, as well as 3.0 g/l Zn with 100ppm BA combination gave the highest Cu content in flowers. Referring to the bulbs nutrients content, it is obvious from Table (4) that 1.5g/l Zn with 50 ppm BA gave the highest N, K and Fe content in bulbs. However, the treatment of 3.0g/l Zn + 50ppm BA gave the highest bulbs content from Mn and Zn. In addition, the highest P and Cu bulbs content were attained from 3.0g/lZn combined with 100 ppm BA.

2.2. Total Carbohydrate Content (%): Data presented in table (5) show that total carbohydrate content of leaves, flowers and bulbs were significantly increased as a result of foliar spray of zinc and /or benzyladenine over the control treatment. It was noticed that total carbohydrate contents of different tuberose plant organs progressively increased with increasing of Zn or BA concentration level. However, the increments of leaves carbohydrate content due to the highest level of both Zn (3.0g/l) and BA (100ppm) were not reached to the level of significant. In addition, the same trend occurred of increment in flowers carbohydrate content due to the highest level of Zn. Referring to the interaction between Zn and BA treatments, it is obvious from Table (5) that all combined treatments of Zn and BA had significant effect. The highest total carbohydrates content of different plant organs resulted from the combination of 3.0g Zn/l with 100 ppm BA. El-Khyat[22] and Gomaa[33] recorded that zinc increased total carbohydrate in Antholyza aethiopica, as well as Farahat *et al.*[34]. This trend of carbohydrate level due to BA foliar spraying was similar to that found by Mazrou and Al- humaid[42] and Al-humaid[35] on rose. Such a stimulating effect of BA on improving the percentage of the total carbohydrate of the leaf tissues could be ascribed to the positive effect of BA on the growth containing more plastids and chlorophyll leading to an increase in photosynthesis and carbohydrate formation[28]. Similarly, Awad *et al.*[43] reported that BA increased CO_2 fixation leading to more sugar synthesis in bean leaves. In this connection, available evidence indicates that spraying plants with cytokinin compounds such as kinetin and BA promote the opening of stomata on plant leaves, thus enhancing gas (CO_2) exchange, increasing photosynthesis and consequently carbohydrate accumulation in the leaves of treated plants[44].

Table 5: Main and interaction effect of zinc and benzyladenine foliar spray on some chemical constituents of flowers and bulbs of tuberose plant ((Mean data of the two seasons)

Treatments	Carbohydrate %			Oil of flowers (%)
	Leaves	Flowers	Bulbs	
Effect of zinc (Zn)				
Zero	23.74	29.2	30.38	0.27
0.75g/l	23.99	30.39	31.59	0.3
1.50g/l	24.91	32.97	34.54	0.32
3.00g/l	25.03	33.52	35.89	0.3
L.S.D at 5%	0.13	0.83	1.03	0.03
Effect of benzyladenine (BA)				
Zero	20.07	24.79	17.78	0.24
25 ppm	22.89	27.11	24.04	0.27
50 ppm	27.39	35.95	41.88	0.35
100 ppm	27.32	38.22	48.69	0.32
L.S.D at 5%	1.03	1.11	1.34	0.01
Interaction effect				
Zn 0+ BA 0	19.81	24.13	16.86	0.2
Zn 0+ BA 25	22.31	25.32	20.22	0.23
Zn 0+ BA 50	26.41	33.71	38.23	0.35
Zn 0+ BA 100	26.42	33.74	46.22	0.31
Zn 0.75 + BA 0	19.97	24.29	16.92	0.25
Zn 0.75+BA 25	22.74	26.17	22.41	0.27
Zn 0.75+BA 50	26.81	35.26	38.91	0.37
Zn 0.75+BA 100	26.45	35.82	48.11	0.32
Zn 1.50 + BA 0	20.21	25.13	18.51	0.26
Zn 1.50 + BA 25	23.11	28.21	25.31	0.28
Zn 1.50 + BA 50	28.13	37.41	44.11	0.39
Zn 1.50 + BA 100	28.19	41.11	50.21	0.34
Zn 3.0 + BA 0	20.28	25.62	18.83	0.26
Zn 3.0 + BA 25	23.42	28.83	28.21	0.28
Zn 3.0 + BA 50	28.21	37.43	46.25	0.32
Zn 3.0 + BA 100	28.21	42.21	50.25	0.32
L.S.D 5%	0.14	0.16	0.81	0.004

2.3. Flowers Oil Content (%): Data in Table (5) indicated that foliar spraying of benzyladenine and or zinc sulphate as well as their interaction significantly increased flowers oil content of tuberose plants as compared with the control plants. It is worthy to note that foliar spraying with both benzyladenine and zinc sulphate tended to increase flowers oil content from 20 to 35% and from 20 to 26%, respectively. Regarding the effect of interaction between benzyladenine and zinc sulphate, the results in Table (5) apparently indicate that interaction caused significant increases in flowers oil content. Moreover, the highest values of oil content were obtained by the treatment of combination of 50 ppm benzyladenine with 1.5g/l zinc sulphate. These results are in agreement with those obtained by Farahat *et al.*[34].

Table 6: Effect of foliar application of zinc and benzyladdnine on oil composition of tuberose flowers.

Treatment Component	RT(min)	Control	25 BA	50 BA	100 BA	0. 75 Zn	1.5 Zn	3.0 Zn
Furfural	8.36	0	0	0	0		0	0.08
Hexanol	8.69	0	0	0	0		0	0.05
1,13,p.c. anthranilis acid	9.35	0	0	0	0		0	1.22
Methyl eugenol	9.46	1.34	1.34	1.36	1.44	1.52	1.52	1.53
Methyl isoeugenol	9.61	0.12	0.12	0.15	0.24	0.25	0.27	0.29
1-hexadecene	10.36	5.34	5.37	5.64	5.68	5.69	5.69	5.74
Alph- farnesol	10.4			0.11	0.15	0.21	0.32	0.36
Benzyl benzoate	11.43	22.34	22.42	22.42	22.64	22.69	22.75	22.85
Benzyl salicylate	11.48	1.41	1.44	1.48	1.51	1.54	1.58	1.62
Geraniol	14.51	2.31	2.35	2.41	2.42	2.46	2.46	2.48
Nerol	14.83	2.37	2.37	2.37	2.39	2.38	2.39	2.53
Pentacosane	16.23	20.11	20.14	20.19	20.22	20.25	20.38	20.67
heptacosane	16.71	2.15	2.17	2.16	2.16	2.18	2.19	2.34
Tuberons	17.22	23.21	23.23	23.23	23.45	23.49	23.53	23.54
7-decan-5-olide	19.33	9.32	9.34	9.38	9.55	9.55	9.58	9.77
butyric acid	20.14	0	0		0.11	0.11	0.13	0.15
Total identified compounds		90.02	90.29	90.9	91.96	92.32	92.79	95.22

Table 7: Interaction effect between zinc and benzyl addnine on oil composition of tuberose flowers.

Treatment Component	25BA+ 0.75Zn	25BA+ 1.5Zn	25BA+ 3.0Zn	50BA+ 0.75Zn	50BA+ 1.5Zn	50BA+ 30.Zn	100BA+ 0.75Zn	100BA+ 1.5Zn	100BA+ 3.0Zn
furfural		0.17	0.17	.0.19	0.19	0.21	.0.18	0.22	0.2
Hexanol		0.21	0.23	0.23	0.23	0.33	0.31	0.33	0.3
1,13,p.c. anthranilis acid	1.66	1.34	1.38	1.35	1.35	1.41	1.4	1.42	1.4
Methyl eugenol	1.58	1.38	1.36	1.36	1.36	1.36	1.36	1.38	1.3
Methyl isoeugenol	0.39	1.33	1.33	1.36	1.36	1.38	1.38	1.4	1.4
1-hexadecene	5.76	4.33	4.23	4.26	4.26	4.26	4.25	4.28	4.23
Alph- farnesol	0.37	1.38	1.38	1.41	1.41	1.41	1.4	1.42	1.42
Benzyl benzoate	22.86	24.11	24.15	24.25	24.25	24.36	24.35	24.37	23.22
Benzyl salicylate	1.63	1.82	1.83	1.86	1.86	1.66	1.65	1.68	1.6
Geraniol	2.51	1.33	1.33	1.35	1.35	1.36	1.36	1.4	1.4
Nerol	2.58	1.45	1.46	1.54	1.54	1.54	1.55	1.55	1.55
Pentacosane	20.68	21.22	21.23	21.26	21.26	21.26	21.26	21.26	21.26
heptacosane	2.34	2.17	2.17	2.2	2.2	2.2	2.2	2.2	2.22
Tuberons	23.53	25.31	25.31	25.35	25.35	25.38	25.3	25.3	25.1
7-decan-5-olide	9.79	10.21	10.21	10.22	10.22	10.22	10.22	10.26	9.98
butric acid	0.16	1.23	1.23	1.39	1.39	1.39	1.34	1.4	1.41
Total identified compounds	95.84	98.99	99	99.39	99.58	99.73	99.33	99.87	97.99

2.4- Component of Essential Oil of Tuberose: The chemical composition of the oils was analyzed using various gas chromatography mass spectrometric GC/MS techniques qualitative and quantitive analytical results are listed in Tables (6) and (7) with the retention indices of the identified compounds. The identification of components was based on comparison of their mass spectra with (Massada[17] and described by Adams[19].

The analysis of the essential oils of tuberose led to the identification of 16 constituents in (Table 6) resulting the effect of foliar application of benzyladenine and zinc on plant. The major constituents of the essential oil were Tuberons, Benzyl benzoate, Pentacosane, Geraniol among all applied treatments of foliar application by BA at 50 ppm or Zn at 1.5 g/l and the interaction between BA and Zn at (BA 50ppm+Zn 1.5 g/l) gave the highest major components compared with untreated plant. Several studies have shown that the main chemical component detected in fragrance absolutes were benzyl benzoate, Pentacosane, eugenol, nerol (Prapassorn *et al.*[45] while, Nuntavan[46]found that the tuberose absolute contained many chemical constituents such as benzylbenzeate, 7-decan-5-olide eugenol, farnesol, nerol, methyl benzoate. Jumras and Passon[47] reported that tuberose oil chemical as follows, methyl benzoate, methyl anthranitade, butyric acid, eugenol, nerol. Many researchers found that major components of oil tuberose on absolutes of oil obtained by cold or hot enfleur age extraction and by solvent extraction using Maliga[48], Prapassorn *et al.*[45].

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