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Influence of Tyrosine and Zinc on Growth, Flowering and Chemical Constituents of *Salvia farinacea* Plants

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Abstract: Two pot experiments were carried out in the greenhouse of National Research Centre, during two successive seasons (2005 and 2006) to study the effect of foliar application with tyrosine (50 and 100 ppm) and zinc (100 and 200 ppm) on growth , flowering and chemical constituents of *Salvia farinacea* plants. Plant height, number of leaves and branches, fresh and dry weight of (leaves, branches, shoots) and stem diameter in both cuttings for the two seasons were significantly promoted by increasing the concentration of tyrosine from 50 to 100 ppm as well as flowering parameters and chemical constituents. It is clear that 100 ppm of zinc is sufficient to accelerate the growth parameters as well as flowering parameters (length of peduncle, length of main inflorescence, number of inflorescence and florets, and fresh and dry weight of inflorescences/ plant). Zinc at 100 ppm had insignificant effect on chlorophyll a, total free amino acids, nitrogen and protein content compared with zinc 200 ppm in both cuttings. The highest content of chlorophyll a, total chl. and total caroteniodes in leaves were obtained with zinc at 100 ppm, whereas foliar application 200ppm zinc lead to the highest content of soluble sugars in leaves. Application of tyrosine at 100 ppm followed by zinc at 200 ppm gave the highest value of soluble sugars content. The most promising results were obtained from plants treated with zinc 100 ppm combined with tyrosine 100 ppm which significantly increased growth parameters, flowering parameters and chemical constituents in both cuttings for the two seasons in *Salvia farinacea* plant.

Keywords: *Salvia farianacea,* tyrosine (ty), zinc (zn)

INTRODUCTION

Blue sage (*Salvia farinacea*) Fam. Lamiaceae is originally from Mexico and Texas, where the species grows to (0.9-1.2 m) and it uses border, cut flowers, attracts butterflies and attracts humming birds. Blue salvia, native to southwestern United States, adds a soft white color to any sunny landscape. Flower spikes are held well above the dense, grey/green, foliage, displaying the striking white color nicely. Many cultivars have been selected for flower color and plant height. Most cultivars are bear flowers in shades of purple and blue. There is also a white selection[1].

Amino acids as organic nitrogenous compounds are the building blocks in the synthesis of proteins[2]. Amino acids are particularly important for stimulation cell growth. They act as buffers which help to maintain favorable pH value within the plant cell, since they contain both acid and basic groups; they remove the ammonia from the cell. This function is associated with amide formation, so they protect the plants from ammonia toxicity. They can serve as a source of carbon and energy, as well as protect the plants against pathogens. Amino acids also function in the synthesis of other organic compounds, such as protein, amines, purines and pyrimidines, alkaloids, vitamins, enzymes, terpeniods and others[3]. Hass[4] stated that the biosyntheses of cinamic acids (which are the starting materials for the synthesis of phenols) are derived from phenylalanine and tyrosine. Tyrosine is hydroxy phenyl amino acid that is used to build neurotransmitters and hormones. Several other authors indicated the promotive effect of amino acids on ornamental and medicinal plants including,[5] on *Antirrhinum majus, Matthiola incana* and *Callistephus chinensis,*[6] on *Datura metel,*[7] on *Rosmarinus officinalis* and Abou-Dahab and Nahed[8] on *Philodendron erubescens*.

Micronutrients greatly affect plant growth and development. Among micronutrients, zinc which is closely involved in the metabolism of RNA and ribosomal content in plant cells which lead to stimulation of carbohydrates, proteins and the DNA formation. It is also, required for the synthesis of tryptophan, a precursor of IAA which acts as a growth promoting substance[9]. Zinc has three functional: catalytic, cocatalytic (coactive) and structural[10,11].

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In the last decade the role of zinc in protein molecules involved in DNA replication and in the regulation of gene expression has attracted much interest. Changes in metabolism brought about by zinc deficiency are quite complex. Nevertheless, some of the changes are typical and can be rather well explained by the functions of zinc in specific enzyme reactions or steps in particular metabolic pathways [12].Various investigators demonstrated the beneficial affect of zinc on several plants. Farahat *et al*.[13] on *Cupressus sempervirens,*[14] on *Thymus vulgaris* L. and Harridy[15] on *Catharanthus roseus.*

The aim of this work was to enhance plant growth, flowering growth and chemical constituents of *Salvia farinacea* by foliar application of tyrosine and zinc.

MATERIALS AND METHODS

This work had been conducted at the green house of National Research Centre (NRC), Dokki, Cairo. To investigate the effect of tyrosine and zinc on growth, flowering and chemical constituents of sage plants. Rooted terminal cuttings of *Salvia farinacea* (20-25 cm height) with 6-7 leaves from Research and Production Station (NRC), Nubaria were transplanting during the first week of February of both seasons 2005 and 2006. Two cuttings were cultivated in loamy clay soil in plastic pots 30 cm diameter. Each pot was supplied with 3 g calcium super phosphate (15.5% P_2O_5) mixed with soil before transplanting. Ammonium nitrate (33.5% N) was applied twice with 3 g nitrogen, while potassium sulfate (48% K_2O) was added at 2 g after 30 days from transplanting. Fertilization was repeated after collecting the first cut. Other agricultural processes were performed according to normal practices.

Treatments in the experiments were as follow: foliar spraying with tyrosine (0, 50 and 100 ppm) and zinc(0 , 100 and 200 ppm) .Interaction between two factors had been also carried out in addition to untreated plants as control which sprayed with distilled water .Treatments of tyrosine and zinc had been applied twice at every cutting with one month intervals at the 1st cutting (1st week of April) and the 2nd cutting (15th July).The volume of the spraying solution was maintained just to cover completely the plant foliage till drip. The plant herbage was harvested twice, by cutting 10 cm over the soil surface in the first week of July and October.

The nine treatments were arranged in factorial complete randomized blocks with three replicates, each replicate represented by 3 pots. After the first and the second cut the data were recorded on: plant height, number of leaves and branches, fresh and dry weights of (leaves, branches and shoots) and stem diameter. Fresh and dry weight of main inflorence, number of florets on main peduncle, length of peduncle, length of main inflorence , number of inferences/ plant, fresh and dry weight of inflorences/ plant. Chlorophyll a, b and total caroteniods were determined in fresh green leaves according to Saric *et al.*[16]. Total soluble sugar percent in the dried material was determined according to Dubois *et al.*[17]. The content of nitrogen (%) and protein (%) were determined in dry leaves in the first and second cut of the two seasons according to A.O.A.C.[18]. Free amino acid content was determined according to Rosen[19].

Data obtained (means of both growing seasons) were subjected to factorial analysis of variance procedure. The values of LSD were obtained, whenever F values were significant at 5% as reported by Snedecor and Cochran[20].

RESULTS AND DISCUSSIONS

Effect of Tyrosine, Zinc and Their Interaction:

On Growth Parameters: Data presented in Tables (1&2) indicate that foliar application of tyrosine significantly promoted plant height, number of (leaves and branches), fresh weight of (leaves, branches and shoots) , dry weight of (leaves, branches and shoots) and stem diameter in the both cutting. Increasing tyrosine concentration from 50 to 100 ppm to *Salvia farinacea* plant significantly increased all growth parameters over control plants. The increments effect on fresh and dry weight of shoots by (35.8 and 33.3%), respectively for the first cut and (33.4 and 40.6 %), respectively for the second cut compared with control plants. The positive effect of amino acids on yield may be due to the vital effect of these amino acids stimulation on the growth of plant cells. The positive effect of amino acids on growth was stated by Goss[3]. Who indicated that amino acids can serve as a source of carbon and energy when carbohydrates become deficient in the plant, amino acids are determinate, releasing the ammonia and organic acid from which the amino acid was originally formed. The organic acids then enter the Kreb's cycle, to be broken down to release energy through respiration. Thon *et al.*[21] pointed out that amino acids provide plant cells with an immediately available source of nitrogen, which generally can be taken by the cells more rapidly than inorganic nitrogen. The results are characteristically accompanied by Youssef *et al.*[22] on lemon basil, Gamal El-Din *et al.*[23] on lemon grass,[24] on basil plant,[25] on Chrysanthemum,[26] on peppermint plant[27], on datura plant and Mona and Talaat [28] on *Pelargonium graveolens* plant, they found that amino acids significantly increased vegetative growth. Hussein *et al.*[6] stated that soaking the seeds

Table 1: The influence of foliar application of tyrosine and zinc on growth parameters of *Salvia farinacea* plant at the first cut (Mean data of the two seasons).

Treatments(ppm)	Plant height (cm)	Number of		Fresh weight (g) of			Dry weight (g) of			Stem diameter (cm)
		Leaves	Branches	Leaves	Branches	Shoots	Leaves	Branches	Shoots	
Effect of tyrosine										
Zero	58.30	92.06	10.00	20.81	24.28	45.09	6.26	9.06	15.32	0.56
Tyrosine 50	63.57	110.67	13.22	24.70	26.93	51.63	6.57	9.25	15.82	0.67
Tyrosine 100	65.20	123.11	13.89	29.91	31.33	61.24	8.86	11.56	20.42	0.70
I.S.D at 5%	1.21	2.51	0.57	0.64	0.76	1.08	0.19	0.43	0.57	0.02
Effect of zinc										
Zero	60.18	100.11	9.44	23.50	25.64	49.14	6.77	9.00	15.77	0.61
Zinc 100	66.56	117.56	14.56	27.61	30.60	58.21	8.12	11.30	19.42	0.68
Zinc 200	60.33	108.17	13.11	24.31	26.30	50.61	6.79	9.57	16.36	0.64
L.S.D at 5%	1.21	2.51	0.57	0.64	0.76	1.08	0.19	0.43	0.57	0.02
Effect of interaction										
Control	50.60	90.3	8.00	18.30	20.73	39.03	4.93	7.87	12.80	0.45
Ty50 ppm	64.63	92.7	10.0	22.10	24.80	46.90	6.30	8.87	15.17	0.66
Ty 100 ppm	65.30	117.3	10.33	30.10	31.40	61.50	9.07	10.30	19.37	0.68
Zn 100 ppm	66.00	95.3	12.33	23.40	29.00	52.40	7.97	11.33	19.30	0.63
iZn 100 + Ty 50	65.67	125.3	14.67	27.20	30.20	57.40	6.90	9.93	16.83	0.69
Zn 100 + Ty 100	68.00	132.0	16.67	32.23	32.60	64.83	9.50	12.63	22.13	0.72
Zn 200	58.30	90.5	9.67	20.73	23.10	43.83	5.87	8.00	13.87	0.59
Zn200+ Ty50	60.40	114.0	15.00	24.80	25.80	50.60	6.50	8.87	15.37	0.63
Zn 200+ Ty100	62.30	120.0	14.67	27.40	30.00	57.40	8.00	11.83	19.83	0.69
L.S.D at 5%	2.10	4.34	0.99	1.10	1.32	1.88	0.33	0.74	0.98	0.03

Ty : Tyrosine , Zn : Zinc

Table 2: The influence of foliar application of tyrosine and zinc on growth parameters of *Salvia farinacea* plant at the second cut (Mean data of the two seasons).

Treatments (ppm)	Plant height (cm)	Number of		Fresh weight (g) of			Dry weight (g) of			stem diameter (cm)
		Leaves	Branches	Leaves	Branches	Shoots	Leaves	Branches	Shoots	
Effect of tyrosine										
Zero	65.21	225.22	11.33	28.93	34.58	63.51	7.57	12.27	19.84	0.62
Tyrosine 50	67.32	257.89	15.22	33.39	40.10	73.49	8.06	14.18	22.24	0.69
Tyrosine 100	70.40	274.78	16.44	36.69	48.06	84.75	10.56	17.33	27.89	0.71
I.S.D at 5%	1.69	4.27	1.11	1.26	1.18	2.09	0.23	0.76	0.78	0.02
Effect of zinc										
Zero	66.38	236.00	11.11	29.93	37.68	67.61	8.11	13.71	21.82	0.63
Zinc 100	73.00	285.44	17.56	36.13	44.37	80.50	9.59	15.83	25.42	0.71
Zinc 200	63.56	236.44	14.33	32.94	40.70	73.64	8.48	14.23	22.71	0.68
L.S.D at 5%	1.69	4.27	1.11	1.26	1.18	2.09	0.23	0.76	0.78	0.02
Effect of interaction										
Control	61.33	207.67	9.00	23.53	28.70	52.23	6.33	9.90	16.23	0.55
Ty50 ppm	67.30	231.33	11.67	32.80	38.50	71.30	8.10	14.37	22.47	0.69

Table 2: Continued

Ty 100 ppm	70.50	269.00	12.67	33.47	45.90	79.37	9.90	16.87	26.77	0.69
Zn 100 ppm	72.00	242.67	14.67	33.47	40.60	74.07	9.10	14.90	24.00	0.67
Zn 100 + Ty 50	71.30	303.33	17.33	34.93	41.50	76.43	8.10	14.43	22.53	0.71
Zn 100 + Ty 100	75.70	310.33	20.67	40.00	51.00	91.00	11.57	18.17	29.74	0.74
Zn 200	62.30	225.33	10.33	29.80	34.50	64.30	7.27	12.00	19.27	0.65
Zn200+ Ty50	63.37	239.00	16.67	32.43	40.30	72.73	7.97	13.73	21.70	0.69
Zn 200+ Ty100	65.00	245.00	16.00	36.60	47.30	83.90	10.20	16.97	27.17	0.70
L.S.D at 5%	2.92	7.39	1.92	2.19	2.04	3.62	0.40	1.32	1.35	0.03

Ty: Tyrosine, Zn: Zinc

Table 3: The influence of foliar application of tyrosine and zinc on flowering parameters of *Salvia farinacea* plant at the first cut (Mean data of the two seasons).

Treatments (ppm)	Length of peduncle (cm)	Length of main inflorescence (cm)	F.W of main inflorescence (g)	D.W of main inflorescence (g)	No. of florets	No. of inflorescences /plant	F.W of inflorescences /plant (g)	D.W. of inflorescences / plant (g)
Effect of tyrosine								
Zero	37.69	31.30	2.63	0.74	10.11	8.56	7.37	2.14
Tyrosine 50	43.57	32.13	3.23	0.90	11.67	10.89	8.39	2.38
Tyrosine 100	48.01	32.23	3.60	1.02	12.89	10.89	9.37	2.69
I.S.D at 5%	1.18	0.77	0.22	0.03	0.73	0.60	0.40	0.12
Effect of zinc								
Zero	39.91	25.53	2.97	0.85	9.56	9.33	7.77	2.23
Zinc 100	46.9	32.43	3.40	0.94	13.67	11.78	9.39	2.77
Zinc 200	42.43	37.70	3.10	0.88	11.44	9.22	7.97	2.21
L.S.D at 5%	1.18	0.77	0.22	0.03	0.73	0.60	0.40	0.12
Effect of interaction								
Control	33.00	23.20	2.40	0.70	8.00	6.7	5.90	1.67
Ty50 ppm	38.70	33.00	2.80	0.75	9.33	10.3	7.20	2.00
Ty 100 ppm	48.03	37.70	3.70	1.09	11.33	11.0	10.20	3.03
Zn 100 ppm	44.77	27.70	2.90	0.80	13.00	11.3	9.50	2.97
Zn 100 + Ty 50	45.30	28.00	3.30	0.90	13.33	11.7	8.27	2.27
Zn 100 + Ty 100	50.70	40.70	4.00	1.12	14.67	12.3	10.40	3.07
Zn 200	35.30	25.70	2.60	0.73	9.33	7.7	6.70	1.80
Zn200+ Ty50	46.70	36.30	3.60	1.05	12.33	10.7	9.70	2.87
Zn 200+ Ty100	45.30	34.70	3.10	0.86	12.67	9.3	7.50	1.97
L.S.D at 5%	2.04	1.34	0.37	0.05	1.26	1.04	0.69	0.20

Ty : Tyrosine , Zn : Zinc

with different levels of adenine, cytosine and thiamine of *Datura metel* were significantly increased plant height, number of leaves and branches, leaf area, as well as fresh and dry weights of different organs of plant.

Concerning the effect of zinc on saga growth, data presented in Tables (1&2) in the first and second cut revealed that application of zinc at 100 ppm resulted in the highest values of plant height, number of leaves, number of branches, fresh weight of leaves, branches and shoots, dry weight of leaves, branches and shoots and stem diameter. The increments on dry weight of leaves, branches and shoots by 19.9, 25.5and 23.1%, respectively for the first cut and 18.2, 15.5 and 16.5%, respectively for the second cut over control plants. Tarraf *et al.*[29] found that application of micronutrients on *Rosmarinus officinalis* had significant positive effect in most cases on growth fresh and dry yield. Increasing zinc concentration from 100 to 200 ppm significantly decreased all growth parameters. These results were resembled those reported by Abdalla *et al.*[30] on *Petroslenum crispum,* Harridy[15] on *Catharanthus roseus* and Gupta *et al.*[31] on *Cyamoposis tetragonoloba* plants, they showed that application of Zn at 100 ppm increased plant height, fresh and dry weight/ plant and number of branches/ plant, respectively. Nabila *et al.*[32] found that application of Zn caused significant increased in plant height on radish plants. Zinc at high concentrations inhibit root cell division and cell elongation of *Festuca rubra* L. [33]. Zinc toxicity in leaves lead to chlorosis, which may be due to iron deficiency, caused by a direct or indirect effect of zinc on foliar iron availability[34]. The decrement caused by application of zinc could be due to their interference with metabolic processes associated with normal development [35].

Regarding the interaction effects, data in Table (1&2) show that plant height, number of leaves, number of branches, fresh and dry weight of leaves, branches and shoots and stem diameter were significantly augmented in the first and second cut. It is also clear from the obtained data that foliar spray of sage plants with 100 ppm zinc combined with 100 ppm tyrosine resulted in the highest pronounced effects on all growth parameters. The increments on fresh and dry weights of shoots by 66.1 and 72.8%, respectively for the first cut and (74.2 and 83.2%), respectively for the second cut over control plants. The lowest values were recorded in control and zinc 200 ppm treatments.

The stimulatory effects of the interaction on growth could be explained by the notion that some amino acids (e.g. phenylalanine, ornithine) can affect plant growth and development through their influence on gibberellin biosynthesis [36]. Amino acids acting as the building blocks of proteins can serve in number of additional functions in regulation of metabolism, transport and storage nitrogen [37,38]. The favorable action of Zn may be attribute to the role of the synthesis of tryptophan (the precursor of indole acetic acid) which in turn affects several of plant phenomena as found by Valke and Wacker[39]. Farahat *et al.*[13] found that application of Zn at 40 ppm significantly increased all tested morphological parameters. Also, Mohamed and Whaba[7] reported that foliar application of Zn at 75and 100 ppm to *Tagetes erecta* plants increased plant height, number of the main branches/ plant and fresh weight of vegetative growth as compared with untreated plants. Negative effects on growth parameters was observed due to applications of high level of zinc treatment of *Ocimum sanctum* L. plant[40].

On Flowering Characters: Data presented in Tables (3&4) show that increasing tyrosine from 50 to 100 ppm significantly increased length of peduncle, length of main inflorescence, fresh weight of main inflorescence, dry weight of main inflorescence, number of florets and inflorescences, fresh and dry weight of inflorescences. The increments on fresh and dry weights of inflorescences/plant by 27.1 and 25.7%, respectively for the first cut and (21.9 and 18.5%), respectively for the second cut compared with control. Our results are comparable with those obtained by Wahba *et al.,*[41]on *Antholyza aethiopica*[25] on chrysanthemum and stated that foliar application of amino acids (Tryptophan and aspartic) led to the increment of flowering parameters and found that amino acids produced a high quality of inflorescences.

Data presented in Table (3& 4) show that foliar spray of sage plants with zinc at 100 ppm resulted in the highest values of flowering parameters. The maximum values of increments were observed for dry weight of inflorescences /plant in the first and second cut by 24.2 and 25.2%, respectively over control plants. The reduction in growth vigor of zinc concentration at 200 ppm (Table 4), might be due to a slight toxic effect of the highest Zn level[42,43].

The response of flowering parameters of *Salvia farincea* to foliar application with tyrosine and zinc Tables (3&4). Application of zinc 100 ppm + tyrosine 100 ppm significantly increased all flowering parameters. The increments on fresh and dry weights of inflorescences/ plant by 76.2 and 83.8%, respectively for the first cut and (62.8 and 69.0%), respectively for the second cut compared with untreated plants. These results are characteristically accompanied by Karima and Abd El-Wahed[44] who found that using amino acids led to significant increases in number of flowers, fresh and dry weight of flowers/ plant of *Matricaria chamomilla* L. plant. Also, Youssef *et al.,* [27] on *Datura innoxia* stated that application of phenylalanine 100 ppm + putrescine 100ppm significant promotion in all growth parameters at flowering stage.

On Chemical Constituents: Data presented in Table (5&6) show that chlorophyll a, b and caroteniodes, soluble sugars content, free amino acids, nitrogen content and protein content were significantly increased as a result of foliar spray of tyrosine 100 ppm in both cuttings. Hussein *et al.*[6] found that higher concentration of adenine and cytosine increased the photosynthetic pigments of datura plants. The present

Table 4: The influence of foliar application of tyrosine and zinc on flowering parameters of *Salvia farinacea* plant at the second cut (Mean data of the two seasons).

Treatments (ppm)	Length of peduncle (cm)	Length of main inflorescence (cm)	F.W of main inflorescence (g)	D.W of main inflorescence (g)	No. of florets	No. of inflorescences /plant	F.W. of inflorescences /plant (g)	D.W. of inflorescences / plant (g)
Effect of tyrosine								
Zero	40.27	30.79	3.61	1.02	14.11	14.33	9.02	2.64
Tyrosine 50	46.19	37.93	4.20	1.21	16.67	17.11	9.67	2.73
Tyrosine 100	52.10	40.30	4.73	1.31	18.78	19.22	11.00	3.13
I.S.D at 5%	1.25	1.00	0.35	0.03	1.13	1.14	0.63	0.27
Effect of zinc								
Zero	44.27	34.72	3.91	1.08	15.56	15.44	9.12	2.58
Zinc 100	48.60	37.57	4.47	1.24	17.67	19.22	10.83	3.23
Zinc 200	45.69	36.73	4.17	1.21	16.33	16.00	9.73	2.70
L.S.D at 5%	1.25	1.00	0.35	0.03	1.13	1.14	0.63	0.27
Effect of interaction								
Control	36.00	29.2	3.13	0.91	11.000	12.00	7.37	2.13
Ty50 ppm	45.50	35.7	3.90	1.12	16.67	14.33	9.00	2.50
Ty 100 ppm	51.30	39.3	4.70	1.23	19.00	20.00	11.00	3.10
Zn 100 ppm	43.90	33.0	4.00	1.09	17.33	18.00	11.00	3.40
Zn 100 + Ty 50	44.10	35.1	4.20	1.20	16.67	17.00	9.5	2.70
Zn 100 + Ty 100	57.80	44.6	5.20	1.42	19.00	22.67	12.00	3.60
Zn 200	40.90	30.2	3.70	1.06	14.00	13.00	8.70	2.40
Zn200+ Ty50	48.97	43.0	4.50	1.31	16.67	20.00	10.50	3.00
Zn 200+ Ty100	47.20	37.0	4.30	1.27	18.33	15.00	10.00	2.70
L.S.D at 5%	2.16	1.74	0.61	0.06	1.95	1.97	1.09	0.48

Ty : Tyrosine , Zn : Zinc

Table 5: The influence of foliar application of tyrosine and zinc on chemical constituents of *Salvia farinacea* plant at the first cut (Mean data of the two seasons).

Treatments (ppm)	Chl. a mg/g	Chl. b mg/g	Chl. a+b mg/g	Caroteniods mg/g	Soluble sugars %	Free amino acids (mg/g)	Nitrogen %	Protein %
Effect of tyrosine								
Zero	1.15	0.48	1.63	0.27	4.18	14.82	2.24	14.00
Tyrosine 50	1.22	0.54	1.76	0.30	3.73	19.73	2.31	14.46
Tyrosine 100	1.28	0.58	1.86	0.33	4.67	21.61	2.42	15.11
I.S.D at 5%	0.02	0.02	0.03	0.01	0.06	0.63	0.03	0.37
Effect of zinc								
Zero	1.17	0.49	1.66	0.29	4.28	15.68	2.24	14.00
Zinc 100	1.26	0.56	1.82	0.32	3.99	20.22	2.36	14.75
Zinc 200	1.22	0.54	1.76	0.30	4.31	20.27	2.37	14.81
L.S.D at 5%	0.02	0.02	0.03	0.01	0.06	0.63	0.03	0.37
Effect of interaction								
Control	1.10	0.43	1.53	0.27	3.00	14.3	2.11	13.19
Ty50 ppm	1.18	0.49	1.67	0.28	4.17	15.4	2.26	14.13

Table 5: Continued

Ty 100 ppm	1.24	0.55	1.79	0.32	5.66	17.3	2.35	14.69
Zn 100 ppm	1.23	0.53	1.76	0.30	4.37	14.3	2.28	14.25
Zn 100 + Ty 50	1.24	0.55	1.79	0.30	3.32	22.2	2.30	14.38
Zn 100 + Ty 100	1.32	0.60	1.92	0.35	4.29	24.2	2.50	15.63
Zn 200	1.13	0.48	1.61	0.25	5.17	15.8	2.33	14.56
Zn200+ Ty50	1.25	0.57	1.82	0.31	3.71	21.6	2.38	14.88
Zn 200+ Ty100	1.28	0.58	1.86	0.33	4.06	23.3	2.40	15.00
L.S.D at 5%	0.04	0.03	0.05	0.02	0.11	1.09	0.05	0.63

Ty : Tyrosine , Zn : Zinc

data are in agreement with the findings of[45] on *Foeniculum vulgare* L. plants and[8] on *Philodendron erubescens* plant, they reported that foliar application of amino acid (Tryptophan) caused an increase in photosynthetic pigments contents.

The accumulation of photosynthetic pigments as a result of these nitrogen compounds may be due to the important role of nitrogen in the biosynthesis of Chlorophyll molecules[46] .These result could be explained by the findings obtained by Youssef and Talaat[47] who found that application of thiamine significantly increased total carbohydrates % of rosemary plants. Gamal El-Din *et al.*[23] found that treated lemon grass plants with 100 ppm phenylalanine in the first cut and ornithine in the second cut recorded the highest level of carbohydrate percentage compared with control. Refaat and Naguib[26] reported that application of all amino acids (alanine, cytosine, guanine, thiamine and L-tyrosine) increased the total carbohydrates percentage in peppermint leaves. The promotive affect of the amino acids on the total carbohydrates content may be due to their important role on the biosynthesis of chlorophyll molecules which in turn affected carbohydrate content. In this concern[48] stated that there is agreement that succinyl COA (Krebs cycle intermediate) and the amino acid glycine, initiate the biosynthetic pathway leading to chlorophyll formation. Youssef *et al.*[27] found that using high level of phenylalanine significantly increased crude protein in leaves at flowering stages in *Datura stramonium*. They added that the maximum percentage of free amino acid for *D.innoxia* was observed in plants treated with phenylalanine 100 ppm + putrescine 100 ppm. Our results are in agreement with those obtained by Karima and Abdel–Wahed[44] on chamomile plants,[23] on lemon grass,[28] on *Pelargonium graveolens* L.,[49] on lupine plants and Youssef and Talaat[47] on rosemary plants. They reported that application of amino acids significantly increased total amino acids, total nitrogen and crude protein contents in a aerial vegetative parts. Davies [2] reported that amino acids as organic nitrogenous compound are the building blocks in the synthesis of proteins which formed by a process in which ribosome catalyze the polymerization of amino acids.

Data presented in Table (5& 6) show that application of Zn a100 ppm significantly increased chlorophyll a, b, total chl. and caroteniodes compared with control plants. The increments were 7.6, 14.2, 9.6 and 10.3%, respectively in the first cut and 6.6, 13.2, 8.6 and 15.1%, respectively in the second cut compared with control. The higher concentration of Zn lowered chl. content. Chlorophyll reduction could be due to inhibition of chlorophyll synthesis and protochlorophyllide reductase activity, [50] and stimulation of chlorophyll-degrading chlorophyllase activity by Zn, [51]. Regarding the beneficial effect of Zn on photosynthetic pigments, it may be due to its role in increasing the rate of photochemical reduction, [52] the favorable effect of Zn mentioned from many investigators, Farahat *et al.*[13] on *Cupressus sempervirens* and Massoud *et al.*[53] on pea plants. They reported that Zn increased chlorophyll content.

While,[54] found that increasing concentration of Zn led to decrease the chlorophyll in *Lupinus termis* plants.

Concerning the effect of Zn on soluble sugars, application of Zn at 200ppm had no significant effect compared with control, but there is a significant compared with Zn at 100 ppm in the first cut. Applications of Zn at 200 ppm significantly increased free amino acids, nitrogen and protein content. The increments were 29.3, 5.8 and 5.7%, respectively compared with control plants. (Table, 5).

The results presented in Table (6) illustrated that total soluble sugar, nitrogen and protein contents were significantly increased as a result of foliar application of Zn at 200 ppm. The increasing percentages were 16.5, 4.7 and 5.4, respectively compared with control plant in the second cut of. While, application of Zn at 100 ppm caused significantly increased free amino acids by 38.4%, compared with control. These results

Table 6: The influence of foliar application of tyrosine and zinc on chemical constituents of *Salvia farinacea* plant at the second cut (Mean data of the two seasons).

Treatments (ppm)	Chl. a mg/g	Chl. b mg/g	Chl. a+b mg/g	Careteniods mg/g	Soluble sugars %	Free amino acids (mg/g)	Nitrogen %	Protein %
Effect of tyrosine								
Zero	1.17	0.50	1.67	0.32	3.71	16.00	2.32	14.42
Tyrosine 50	1.25	0.58	1.83	0.36	3.75	15.79	2.36	14.75
Tyrosine 100	1.31	0.63	1.94	0.40	4.23	17.81	2.57	16.07
I.S.D at 5%	0.02	0.02	0.03	0.01	0.05	0.59	0.02	0.35
Effect of zinc								
Zero	1.20	0.53	1.73	0.33	3.63	13.29	2.34	14.56
Zinc 100	1.28	0.60	1.88	0.38	3.83	18.39	2.45	15.33
Zinc 200	1.24	0.58	1.82	0.36	4.23	17.92	2.45	15.34
L.S.D at 5%	0.02	0.02	0.03	0.01	0.05	0.59	0.02	0.35
Effect of interaction								
Control	1.13	0.48	1.61	0.30	2.51	12.30	2.25	13.81
Ty50 ppm	1.20	0.53	1.73	0.32	3.18	12.37	2.28	14.25
Ty 100 ppm	1.26	0.61	1.87	0.37	5.20	15.20	2.50	15.63
Zn 100 ppm	1.23	0.56	1.79	0.35	3.75	17.20	2.32	14.50
Zn 100 + Ty 50	1.27	0.60	1.87	0.37	3.77	18.50	2.37	14.81
Zn 100 + Ty 100	1.35	0.64	1.99	0.42	3.97	19.47	2.67	16.69
Zn 200	1.15	0.50	1.65	0.31	4.85	18.50	2.39	14.94
Zn200+ Ty50	1.27	0.62	1.89	0.38	4.31	16.50	2.43	15.20
Zn 200+ Ty100	1.31	0.63	1.94	0.40	3.52	18.77	2.54	15.88
L.S.D at 5%	0.03	0.04	0.05	0.02	0.09	1.02	0.03	0.61

Ty : Tyrosine , Zn : Zinc

agree with those obtained by Farahat *et al.* [13] on *cupressus sempervirens* L.,[55] on lemon grass,[56] on fenugreek,[32] on radish cultivars,[57] on *Ocimum basilicum* L. and Yossef *et al.*[40]on *Ocimum sanctum* L. plants. They reported that foliar application of Zn increased total soluble sugars, carbohydrate, nitrogen and crude protein.

Data represented in Table (5&6) showed the effect of combined treatments of tyrosine and zinc on chlorophyll a, b and careteniods, total soluble sugars, free amino acids, nitrogen and protein content in the first and second cut. All treatments significantly increased chemical constituents compared with untreated plants. The highest values in chl a, b, total chl. and careteniods were obtained with foliar application of tyrosine 100 ppm + Zinc 100 ppm. The increments were 20.0, 39.5, 25.4 and 29.6%, in the first cut and 19.5, 33.3, 23.6 and 40.0%, respectively in the second cut over the control plants. It is clear from the data that foliar application of tyrosine 100 ppm caused the highest accumulation in total soluble sugar content 88.6%, followed by zinc 200 ppm 72.3%, in the first cut. While in the second cut, the increments were 107.1% and 93.2,respectively. The highest values were obtained with the combinations of tyrosine 100 ppm + Zn 100 ppm for free amino acids, nitrogen and protein content. The increments were 69.2, 18.4 and 18.4%, respectively in the first cut over the control. Also the same trend were observed in the second cut. These results are agreement with those obtained by Gamal El-Din *et al,*[23] who indicated that the amino acid phenylalanine in combined with the micronutrients (Fe, Mn and Zn) gave the highest increment in nitrogen percent and crude protein of lemon grass plants. It could be suggested that carbohydrates play an important indirect role as one of primitive source for nitrogenous substances i.e. amino acids through the formation of organic acids particularly mevanolic acid[58]. Youssef *et al.*[22] and Talaat and Youssef[24] reported that application of tyrosine positively affected the total nitrogen and total protein on lemon basil plants. The effect of tested amino acids on the previous biochemical contents could be through plant protection form ammonia toxicity as they remove amide formation, serving as a source of carbon and energy as well as protection of plants against pathogens, functioning as buffers and biosynthesis of other organic compounds such as protein, amines, purines, pyrimidines, vitamins, enzymes terpeniods[3]

Finally it could be concluded that tyrosine or zinc treatments can induce favorable changes in *Salvia farinacea* plant in vegetative, flowering stage and chemical constituents especially with tyrosine 100 ppm + Zn 100 ppm treatment.

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