EFFECT OF TRYPTOPHAN, Fe, Zn AND Mn FOLIAR APPLICATION ON GROWTH, PRODUCTIVITY AND CHEMICAL COMPOSITION OF ROSELLE PLANTS

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ABSTRACT

Two-field trials were conducted at the Experimental Farm of the Hort. Dept., Faculty of Agric., Moshtohor Benha Univ during 2006 and 2007 seasons. Experiments aimed to study the effect of foliar spray with tryptophan at 0.0, 50, 100 and 150 ppm. and foliar nutrition with Fe, Zn and Mn each at rates of 150 ppm. plus the control on growth, yield and chemical constituents of roselle plants. Plants were sprayed with tryptophan, Fe, Zn and Mn three times started at 45 days after planting and at three weeks intervals. Experimental design was split plot; tryptophan arranged in the main plots and micronutrients were arranged in sub plots. Results showed that, foliar spray with tryptophan supplemented with Fe, Zn and Mn treatments enhanced most growth and productivity parameters, such as plant height, number of branches, fresh and dry weights of branches/plant, number of leaves, fresh and dry weights of leaves/plant and also, increased each of fruits number, fresh weight of fruits /plant, fresh and dry weights of sepals /plant as compared with control in both seasons. Moreover, total carbohydrates % and sepals acidity, N%, P%, K%, anthocyanin and vitamin-C content were increased by spraying roselle plants with all concentrations of the used treatments.

Generally, tryptophan foliar application at rates 50, 100 and 150 ppm. increased all growth and yield parameters especially the high rate (150 ppm.) compared with control in both seasons. Furthermore, Fe, Zn and Mn foliar nutrition at 150 ppm. of each increased the plant height, number of branches, fresh and dry weights of branches/plant, number of leaves, fresh and dry weights of leaves/plant and also, increased number of fruits/plant, fresh weight of fruits/plant, fresh and dry weights of sepals/plant., total carbohydrates% and sepals acidity, N%. P%, K%, anthocyanin and vitamin-C content as compared with control plants. The most favorable growth, yield and the highest chemical content were obtained when plants sprayed with the three micronutrients (Fe+ Zn+Mn) each at 150 ppm. in both seasons.

Furthermore, the combinations resulted from the interaction between spraying tryptophan at rates (50, 100 and 150 ppm.) and foliar nutrition of Fe, Zn and Mn at 150 ppm. for each increased plant height, number of branches, fresh and dry weights of branches/plant, number of leaves, fresh and dry weights of leaves/plant and also increased fruit's number/plant, fresh weight of fruits/plant, fresh and dry weights of sepals/plant., total carbohydrates% and sepals acidity, N%. P%, K%, anthocyanin and vitamin-C content compared with control plants in the first and second seasons.

Consequently, it can be safely spray Hibiscus sabdariffa plants with tryptophan at 150 ppm. supplemented with foliar nutrition with (Fe+Zn+Mn) each at 150 ppm. to enhance the most growth, yield and chemical constituents of roselle (Hibiscus sabdariffa, L.) plants.

Key Words: Roselle, Hibiscus sabdariffa, tryptophan, branches, fruits, sepals, carbohydrates, acidity, vitamin-C and anthocyanin.

INTRODUCTION

Roselle (*Hibiscus sabdariffa*, L.) plants are a member of Family Malvaceae, which produce a fleshly red calyxes and epicalyxes (sepals) Rovesta (1936) stated that beverage of roselle is used for its therapeutic properties due to its contents of citric acid and presence of large amount of an emollient and sedative mucilage which permit rapid digestion, decrease hyperviscosity of blood and arterial pressure. The sepals are used for the preparation of hot and cold red drinks and obtaining the natural food coloring pigments such as anthocyanin compounds, (Diab, 1968). Also it is used as hypotensive agent since it lowers blood pressure without producing side effect Sharaf (1962). Furthermore, the seeds of roselle plants contain about 17% fixed oil which is similar in its properties to cotton seed oil (Hussin *et.al.*, 1991). For the previously mentioned reasons, the cultivated area of roselle is increasing gradually in Egypt for local utilization and export. The interest of most investigators is to find out the most favorable conditions to get the best growth and yield of roselle. Many researches pointed out the importance of amino acids and nutrient elements in increasing growth, yield and chemical composition of some economic plants among them, El-Sherbeny and Hassan (1987) on *Datura stramonium,* Mohamed (1992) on *Dahlia pinnata* plants, Gamal El-Din *et.al.,* (1997) on lemongrass plants, Talaat (1998) on lavender plants, El-Khayat (2001) on *Hibiscus sabdariffa* plant, Wahabe *et.al.,* (2002) on *Antholyza aethiopica* plants, Youssef *et.al.,* (2004) on Datura plants and Balbaa and Talaat (2007) on rosemary plants. Tryptophan is known as growth regulating factor that influence many biological processes, Phillips (1971) suggested several alternative roles of IAA synthesis in plants, all starting from tryptophan, thus when tryptophan is supplied to most plant tissues, IAA was formed, Mohamed and Wahba (1993) stated that tryptophan at 100 ppm gave the highest oil content of *Rosmarinus officinalis* plants, Gomaa, (2001) found that, foliar spray of *Antholyza aethiopica* plants with some amino acids increased all growth and yield parameters and Balbaa and Talaat (2007) stated that, foliar spray with ascorbic acid, phenylalanine and ornithine at the concentrations 50, 100 and 150 mg/L. on rosemary plants increased plant height, number of branches/plant fresh and dry weights of herb/plant, N%, P% and K.% content of herb.

The role of iron is incorporated directly into the cytochromes, into compounds necessary to the electron transport system in mitochondria and into ferredaxin. Ferredaxin is indispensable to the light reactions of photosynthesis. Iron is essential for the synthesis of chlorophyll and it plays an essential chemical role in both the synthesis and degradation of chlorophyll (Nason and Mc-Elory, 1963). Iron is required in the synthesis of chloroplast proteins. Protoporphyrinin-9 is one of the intermediates in chlorophyll biosynthesis and may represent a branch point in the biosynthesis of either cytochromes or chlorophyll. The synthetic path is dependent on which metal, magnesium or iron, is incorporated into the porphyrin structure (Granick, 1950). Concerning iron, Mousa and El-Lakany (1984) indicated that, foliar application of iron to *Tagetes erecta* increased flower yield, weight and length of flower stalk, also Mohamed (1992) found that, foliar spray with iron increased vegetative growth, flowering and carbohydrates content of *Dahlia pinnata* plants.

Zinc is one of the essential microelements for growth and flowering of plants (Chandler, 1982; Gomaa, 1997 and Youssef, 2000). It is recorded that zinc is essential at a specific concentration for sucrose synthesis (Takaki and Kusizaki, 1987) and production of auxin in plants. Zinc also is a part of enzymes participate in starch and protein synthesis (Amberger, 1974). Many investigatore reported the stimulating effect of applied micronutrients as soaking or foliar spray on growth and flowering of different ornamental plants; Mohamed (1985) found that Mn at 75 or 375 ppm. and Zn at 45 or 225 ppm. increased the vegetative growth, flowering and tubrous roots production of *Dahlia hybrida* cv. "Moon Light sonata". Andon (1973) concluded that foliar application of Mn and Zn to tobacoo and to hybrid petunia stimulated flower formation and seed production. Savva (1977) revealed that foliar application of Mn to *Dianthus chinensis* improved yields quality and seed yield. Mousa and El-Lakany (1984) indicated that foliar application of Fe, Zn and Mn to *Tagates erecta* increased flower yield, weight and length of flower stalk.

This investigation was conducted to study the effect of foliar spray with tryptophan and nutrition of Fe, Zn and Mn and their combinations on growth and prodctivity of roselle (*Hibiscus sabdariffa*, L.) plants

MATERIALS AND METHODS

This work was carried out at the Experimental Farm, Fac. Agric., Moshtohor Benha Univ. during 2006 and 2007 seasons to study the effect of foliar spray with tryptophan at rates of 0.0, 50, 100 and 150 ppm. and combined with nutrition of Fe, Zn and Mn each at 150 ppm. and (Fe+Zn+Mn) plus the control on the growth and prodctivity of roselle (*Hibiscus sabdariffa*, L.) plants. Roselle seeds were obtained from Floriculture Farm, Horticulture Department, Faculty of Agriculture, Benha Univ. Seeds were sown in clay loam soils on mid April of each seasons in plots (1x1 m) containing two rows (50 cm. width) every row had two hills (50 cm. apart), and one month later, the plants were thinned, leaving only one seedling/hill. Tryptophan, Fe, Zn and Mn were applied as foliar spray at 45, 66 and

87 days after planting, respectively. The plants were sprayed till run off. The control plants were sprayed with distilled water.

Physical and chemical analyses of the experimental soil were determined according to Jackson (1973) and Black *et.al.*,(1982) respectively.The obtained results about soil analyses are presented in Tables(1)and (2).

Table (1): Mechanical analysis of the experimental soil.

Parameters	Unit	Seasons	
		2006	2007
Coarse sand	%	2.90	3.11
Fine sand	%	18.47	17.14
Silt	%	24.21	23.22
Clay	%	54.42	56.53
Textural class	------	Clay loam	Clay loam

Table (2): Chemical analysis of the experimental soil.

Parameters	Unit	Seasons	
		2006	2007
$CaCo_3$	%	1.45	1.63
Organic matter	%	1.63	1.72
Available nitrogen	%	0.41	0.45
Available phosphorus	%	0.18	0.19
Available potassium	%	0.21	0.23
E-C	M mhos/cm	0.86	0.89
pH	--------------	7.68	7.73

This experiment included 20 treatments were set up in a split plot design with three replicates. The main plots were sprayed with tryptophan at rates 0.0, 50, 100 and 150 ppm. Whereas, the sub plots were sprayed with Fe, Zn, Mn or Fe+ Zn+Mn each at rate of 150 ppm. plus the control.

Data recorded:

Plant height (cm.), number of branches, fresh and dry weights of branches (g.), number, fresh and dry weights of leaves (g.) {at the beginning of flowering}. Whereas, fruit's number/plant, fruit's fresh weight/plant, sepals fresh and dry weight/plant, were recorded at harvesting time.

The percentage of N,P,K, and total carbohydrates% were determined in the dry leaves during flowering stage, where total nitrogen was determined using the modified MicroKieldahl method according to A.O.A.C. (1980). Other nutrients P contents was determined after wet diggestion according to the method desscribed by Murphy and Riley (1962) and Modified by John (1970), whereas K content was determined by flame photometer according to Brown and Lilleland (1946). While total carbohydrates percent was determined according to Dubois *et.al.,* (1956). Anthocyanin content was determined in roselle sepals according to the method described by Fahmy (1970). Whereas, Vitamin-C was determined in sepals as discribed in A.O.A.C. (1980). Sepals acidity (pH value) was determined according to Diab (1968).

Statistical analysis:

All data obtained in both seasons of study were subjected to analysis of variance as a factorial experiments in split plot design. L.S.D. method was used to differenciate means according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

1- Plant height and number of branches/plant (cm.):

Data tabulated in Table (3) show that all used concentrations of tryptophan increased plant height and number of branches/plant. The highest value of roselle plant height was obtained as a result of spraying tryptophan at 150 ppm. While low concentration (50 ppm.) of tryptophan gave lowest value in both seasons. Furthermore, the effect of Fe, Zn and Mn application each at rate of 150 ppm. increased plant height and number of branches/plant compared with control in both seasons.

Moreover, all combinations of tryptophan and micronutrients (Fe, Zn and Mn) each at 150 ppm. increased plant height and number of branches/plant. The maximum values for plant height and number of branches/plant were obtained as a result of combined treatment between tryptophan at 150 ppm with foliar nutrition with (Fe+Zn+Mn) each at 150 ppm.compared with the other treatments in both seasons. These conclusions are in agreement with those obtained by several investigators, such as El-Sherbeny and Hassan (1987) on *Datura stramonium,* Mohamed (1992) on *Dahlia pinnata* plants, Gamal El-Din *et.al.,* (1997) on lemongrass plants, El-Khayat (2001) on *Hibiscus sabdariffa* plant, Wahabe *et.al.,* (2002) on *Antholyza aethiopica* plants, Youssef *et.al.,* (2004) on Datura plants and Balbaa and Talaat (2007) on rosemary plants.

2- Fresh and dry weights of branches/plant (g):

The data in Table (4) show that, in both seasons, all concentrations of tryptophan (50, 100 and 150 ppm.) significantly increased fresh and dry weights of branches/plant compared with the untreated plants, in both seasons. The highest growth values were obtained from plants treated with high level of tryptophan (150 ppm.) in both seasons. Also, data indicated the foliar nutrition with (Fe, Zn and Mn) each at rate of 150 ppm. increased fresh and dry weights of branches/plant compared with the untreated ones in the first and the second seasons. The highest fresh and dry weights of branches/plant were obtained when plants treated with foliar nutrition with (Fe+Zn+Mn) each at rate of 150 ppm. compared with control plants in both seasons.

Concerning the interaction effect of tryptophan levels with foliar nutrition with (Fe, Zn and Mn) each at rate of 150 ppm. on fresh and dry weights of branches/plant, data in Table (2) show that micronutrients application within tryptophan increased plant growth compared with the untreared plants, in both seasons. Moreover, high level of tryptophan (150 ppm.) combined with foliar nutrition with (Fe+Zn+Mn) each at rate 150 ppm. attained the highest values of fresh and dry weights of branches/plant compared with all other treatments in both seasons. Similar trend was obtained by Mohamed *et.al.*, (1992) on *Alpinia nutans*, El-Khayat (2001) on *Hibiscus sabdariffa* plant, Wahabe *et.al.,* (2002) on *Antholyza aethiopica* plants, Youssef *et.al.,*

(2004) on Datura plants and Balbaa and Talaat (2007) on rosemary plants,

3- Number, fresh and dry weights of leaves/plant:

Data in Table (5) indicate that all levels of tryptophan (50, 100 and 150 ppm.) succeeded to increase number, fresh and dry weights of leaves/plant especially the high level (150 ppm) compared with the control plants. Whereas, all foliar nutrition with (Fe, Zn and Mn) each at rate 150 ppm. increased number of leaves/plant, fresh and dry weights of leaves/plant in both seasons. Furthermore, all combinations between tryptophan and foliar nutritions with (Fe+Zn+Mn) progressively increased the number, fresh and dry weights of leaves/plant. The superior treatment was the combined treatment sprayed with tryptophan at 150 ppm. and foliar nutritions with (Fe+Zn+Mn) each at rate of 150 ppm. compared with all used treatments, in both seasons. These results agreed with those reported by Mohamed (1992) on *Dahlia pinnata* plants, Gamal El-Din *et.al.*, (1997) on lemongrass plants, El-Khayat (2001) on *Hibiscus sabdariffa* plant, Wahabe *et.al.*, (2002) on *Antholyza aethiopica* plants, Gomaa (2003) on *Polianthes* plants, Youssef *et.al.*, (2004) on Datura plants and Balbaa and Talaat (2007) on rosemary plants,

4- Number and fresh weight of fruits/plant:

It is clear from Table (6) that, spraying *Hibiscus sabdariffa* plants with tryptophan at rates of 50, 100 and 150 ppm. increased number of fruits/plant and fresh weight of fruits/plant when compared with control plants in both seasons. Moreover, all foliar nutrition with (Fe, Zn and Mn) each at rate of 150 ppm. succeeded in increasing the number and fresh weight of fruits/plant compared with control plants in the first and second seasons. Furthermore, foliar nutrition with (Fe+Ze+Mn) each at rate 150 ppm. succeeded in increasing the number of fruits/plant and fresh weight of fruits/plant, in both seasons. In addition, all combinations of tryptophan and foliar nutrition with (Fe+Zn+Mn) each at rate of 150 ppm. significantly increased the number and fresh weight of fruits/plant when compared with the different combinations or the untreated plants (control), in the first and second seasons. Similar conclusions were recorded by El-Khayat (2001) on *Hibiscus sabdariffa* plants.

Table (3): Effect of tryptophan and micronutrients (Fe, Zn and Mn) foliar application on plant height and number of branches of *Hibiscus sabdariffa* plant during 2006 and 2007 seasons.

Treatments \ Parameter	Plant height (cm.)					Number of branches / plant				
	Tryptophan									
	0.0 Control	50 ppm	100 ppm	150 ppm	Mean	0.0 Control	50 ppm	100 ppm	150 ppm	Mean
First season (2006)										
Control (0.0)	145.00	156.66	158.33	163.33	155.83	20.00	23.00	24.33	25.00	23.08
Fe at 150 ppm	158.33	168.33	173.33	178.33	169.58	26.00	27.00	29.33	30.66	28.25
Zn at 150 ppm	153.33	163.33	165.33	173.33	163.83	23.66	26.33	28.33	29.33	26.91
Mn at 150 ppm	150.00	157.00	163.33	163.33	158.41	22.66	25.00	26.00	26.66	25.08
Fe+Zn+Mn at 150 ppm	163.33	173.33	176.66	186.66	175.00	27.66	29.66	32.00	34.33	30.91
Mean	154.00	163.73	167.40	173.00		24.00	26.20	28.00	29.20	
L.S.D. at		5%	1%				5%	1%		
Tryptophan		10.73	16.26				1.20	1.82		
Micronutrients		6.24	8.39				1.09	1.47		
Interactions		3.12	4.19				0.54	0.73		
Second season (2007)										
Control (0.0)	152.66	159.00	163.33	168.00	160.75	21.33	22.66	24.00	24.66	23.16
Fe at 150 ppm	177.66	180.66	186.33	187.66	183.08	25.66	27.66	29.66	30.33	28.33
Zn at 150 ppm	172.00	176.00	178.66	182.66	177.33	24.33	25.33	26.33	28.00	26.00
Mn at 150 ppm	165.33	172.66	177.00	178.00	173.25	23.33	24.66	25.66	27.33	25.25
Fe+Zn+Mn at 150 ppm	181.00	186.33	189.33	192.66	187.33	27.33	29.33	31.66	32.66	30.25
Mean	169.73	174.93	178.93	181.80		24.40	25.93	27.46	28.60	
L.S.D. at		5%	1%				5%	1%		
Tryptophan		3.51	5.13				2.21	3.36		
Micronutrients		2.87	3.86				1.04	1.40		
Interactions		1.43	1.93				0.52	0.70		

Table (4): Effect of tryptophan and micronutrients (Fe, Zn and Mn) foliar application on fresh and dry weights of branches/plant (g) of *Hibiscus sabdariffa* plant during 2006 and 2007 seasons.

Treatments \ Parameter	Fresh weight of branches /plant (g)					Dry weight of branches /plant (g)				
	Tryptophan									
	0.0 Control	50 ppm	100 ppm	150 ppm	Mean	0.0 Control	50 ppm	100 ppm	150 ppm	Mean
First season (2006)										
Control (0.0)	800.00	920.00	973.33	1000.00	923.33	144.00	156.40	165.46	170.00	158.96
Fe at 150 ppm	1040.00	1080.00	1173.33	1226.66	1130.00	187.20	183.60	199.46	208.53	194.70
Zn at 150 ppm	946.66	1053.33	1133.33	1173.33	1076.66	170.40	179.06	192.66	199.46	185.40
Mn at 150 ppm	906.66	1000.00	1040.00	1066.66	1003.33	163.20	170.00	176.80	181.33	172.83
Fe+Zn+Mn at 150 ppm	1106.66	1186.66	1280.00	1373.33	1236.66	199.20	201.73	217.60	233.46	213.00
Mean	960.00	1048.00	1120.00	1168.00		172.80	178.16	190.40	198.56	
L.S.D. at		5%	1%				5%	1%		
Tryptophan		48.12	72.90				8.13	12.32		
Micronutrients		43.88	58.99				7.55	10.15		
Interactions		21.94	29.49				3.77	5.07		
Second season (2007)										
Control (0.0)	853.33	906.66	960.00	986.66	926.66	153.60	154.13	163.20	167.73	159.66
Fe at 150 ppm	1026.66	1106.66	1186.66	1213.33	1133.33	184.80	188.13	201.86	206.26	195.26
Zn at 150 ppm	973.33	1013.33	1053.33	1120.00	1040.00	175.20	172.26	179.06	190.40	179.23
Mn at 150 ppm	933.33	986.66	1026.66	1093.33	1010.00	168.00	167.73	174.53	185.86	174.03
Fe+Zn+Mn at 150 ppm	1093.33	1173.33	11266.66	1306.66	1210.00	196.80	199.46	215.33	222.13	208.43
Mean	976.00	1037.33	1098.66	1144.00		175.68	176.34	186.80	194.48	
L.S.D. at		5%	1%				5%	1%		
Tryptophan		88.75	134.50				15.38	N.S.		
Micronutrients		41.68	56.03				7.13	9.59		
Interactions		20.84	28.02				3.56	4.79		

Table (5): Effect of tryptophan and micronutrients (Fe, Zn and Mn) foliar application on leaves number, fresh and dry weights of leaves /plant of *Hibiscus sabdariffa* plant during 2006 and 2007 seasons.

Parameter / Treatments	Leaves number/plant					Fresh weight of leaves / plant (g)					Dry weight of leaves /plant (g)				
	Tryptophan														
	0.0 Control	50 ppm	100 ppm	150 ppm	Mean	0.0 Control	50 ppm	100 ppm	150 ppm	Mean	0.0 Control	50 ppm	100 ppm	150 ppm	Mean
First season (2006)															
Control (0.0)	155.00	160.00	163.33	165.00	160.83	108.33	111.66	114.00	115.33	112.33	15.16	15.07	15.38	15.43	15.26
Fe at 150 ppm	174.66	178.00	179.66	181.00	178.33	122.00	124.33	125.66	126.66	124.44	17.08	16.78	16.96	17.10	16.98
Zn at 150 ppm	167.66	170.00	174.33	178.66	172.66	117.33	118.66	121.66	124.66	120.58	16.42	16.01	16.42	16.82	16.42
Mn at 150 ppm	161.66	165.00	168.33	172.66	166.91	113.00	115.33	117.66	120.66	116.66	15.82	15.56	15.88	16.28	15.88
Fe+Zn+Mn at 150 ppm	177.33	182.33	186.33	186.00	183.00	123.66	127.33	130.00	130.00	127.75	17.31	17.18	17.54	17.54	17.39
Mean	167.26	171.06	174.40	176.66		116.86	119.46	121.80	123.46		16.36	16.12	16.44	16.63	
L.S.D. at		5%	1%				5%	1%				5%	1%		
Tryptophan		8.48	N.S.				3.17	4.80				N.S.	N.S.		
Micronutrients		3.32	4.47				2.36	3.17				0.32	0.43		
Interactions		1.66	2.23				1.18	1.58				0.16	0.21		
Second season (2007)															
Control (0.0)	160.66	163.00	167.66	168.66	165.00	112.33	114.00	117.00	117.66	115.25	15.72	15.39	16.46	15.88	15.86
Fe at 150 ppm	172.66	183.00	187.00	188.33	182.75	120.66	127.66	130.33	131.66	127.58	16.89	17.23	17.59	17.77	17.37
Zn at 150 ppm	168.00	177.33	179.66	182.66	176.91	117.33	123.66	125.66	127.66	123.58	16.42	16.69	16.96	17.23	16.82
Mn at 150 ppm	160.66	171.33	172.66	175.33	170.00	112.33	119.66	120.66	122.33	118.75	15.72	16.15	16.62	16.42	16.23
Fe+Zn+Mn at 150 ppm	178.33	187.00	189.33	193.33	187.00	124.66	130.33	132.33	135.00	130.58	17.45	17.59	17.86	18.22	17.78
Mean	168.06	176.33	179.26	181.66		117.46	123.06	125.20	126.86		16.44	16.61	17.09	17.10	
L.S.D. at		5%	1%				5%	1%				5%	1%		
Tryptophan		4.05	6.13				2.92	4.42				N.S.	N.S.		
Micronutrients		2.57	3.46				1.84	2.47				0.48	0.64		
Interactions		1.28	1.73				0.92	1.23				0.24	0.32		

Table (6): Effect of tryptophan and micronutrients (Fe, Zn and Mn) foliar application on number and fresh weight of fruit's / plant of *Hibiscus sabdariffa* plant during 2006 and 2007 seasons.

Parameter / Treatments	Fruit's number/plant					Fruit's fresh weight /plant (g)				
	Tryptophan									
	0.0 Control	50 ppm	100 ppm	150 ppm	Mean	0.0 Control	50 ppm	100 ppm	150 ppm	Mean
First season (2006)										
Control (0.0)	58.66	61.33	62.66	64.00	61.66	293.33	306.66	313.33	320.00	308.33
Fe at 150 ppm	65.33	70.66	70.66	72.00	69.66	326.66	353.33	353.33	360.00	348.33
Zn at 150 ppm	62.66	68.66	66.66	68.00	66.50	313.33	343.33	333.333	340.00	332.50
Mn at 150 ppm	58.66	62.66	64.00	66.66	63.00	293.33	313.33	320.00	333.333	315.00
Fe+Zn+Mn at 150 ppm	66.66	70.66	72.00	73.33	70.66	333.333	353.33	360.00	366.66	353.33
Mean	62.40	66.80	67.20	68.80		312.00	334.00	336.00	344.00	
L.S.D. at		5%	1%				5%	1%		
Tryptophan		N.S.	N.S.				30.95	N.S.		
Micronutrients		3.28	4.41				16.42	22.08		
Interactions		1.64	2.20				8.21	11.04		
Second season (2007)										
Control (0.0)	61.33	62.66	62.66	64.00	62.66	306.66	313.33	313.33	320.00	313.33
Fe at 150 ppm	66.66	70.66	70.66	70.66	69.66	333.33	353.33	353.33	353.33	348.33
Zn at 150 ppm	65.33	66.66	69.33	69.33	67.66	326.66	333.44	346.66	346.66	338.36
Mn at 150 ppm	62.66	65.33	66.66	68.00	65.66	313.33	326.66	333.33	340.00	328.33
Fe+Zn+Mn at 150 ppm	69.33	70.66	73.33	74.66	72.00	346.66	353.33	366.66	373.33	360.00
Mean	65.06	67.20	68.53	69.33		325.33	336.02	342.66	346.66	
L.S.D. at		5%	1%				5%	1%		
Tryptophan		3.04	4.09				15.25	20.50		
Micronutrients		2.12	3.08				10.63	16.11		
Interactions		1.52	2.04				7.62	10.25		

5- Fresh and dry weights of sepals/plant (g):

All concentrations of tryptophan increased fresh and dry weights of sepals/plant in both seasons (Table, 7) compared with the untreated plants. Moreover, increasing the rate of tryptophan from 50 up to 150 ppm. resulted in a steady increasing in fresh and dry weights of sepals/plant. Plants receiving the highest tryptophan rate (150 ppm.) had maximum fresh and dry weights of sepals/plant than the control plants in both seasons. Also data presented in Table (5) showed that, foliar nutrition with (Fe, Zn and Mn) each at rate of 150 ppm. increased fresh and dry weights of sepals/plant compared with control plants in the first and the second seasons. Furthermore, all combinations between tryptophan and foliar nutrition with (Fe, Zn and Mn) each at rate of 150 ppm. progressively increased the fresh and dry weights of sepals/plant compared with control plants and the superiority was the combined treatment between tryptophan at 150 ppm. and foliar nutrition with (Fe+Zn+Mn) each at rate of 150 ppm., in the first and second seasons. The above results confirm those reported by El-Khayat (2001) on *Hibiscus sabdariffa* plants.

6- Total carbohydrates percentage and sepals acidity (pH value):

Data in Table (8) indicate that, all levels of tryptophan statistically increased total carbohydrates percentage and sepals acidity especially the high level (150 ppm) as it gave the highest values compared with the untreated plants in the first and second seasons. Besides, all foliar nutrition with (Fe, Zn and Mn) each at rate of 150 ppm. succeeded in increasing total carbohydrates percentage and sepals acidity in both seasons Furthermore, all combinations between tryptophan and foliar nutrition with (Fe, Zn and Mn) each at rate of 150 ppm. progressively increased total carbohydrates percentage and sepals acidity and the superiority was the combined treatment between tryptophan at 150 ppm. with foliar nutrition with (Fe+Zn+Mn) each at rate of 150 ppm. compared with the other combinations in the first and second seasons. The results agree with those reported by Gamal El-Din *et.al.,* (1997) on lemongrass plants and El-Khayat (2001) on *Hibiscus sabdariffa* plant.

7- Nitrogen, phosphorus and potassium contents:

It is obvious from Table (9) that all levels of tryptophan application statistically improved nitrogen, phosphorus and potassium content of leaves compared with control in both seasons, particularly the high rate (150 ppm.). Additionally, all values of the nitrogen, phosphorus and potassium contents were increased with foliar nutrition with (Fe, Zn and Mn) each at rate of 150 ppm. compared with control in both seasons. Moreover, all the combinations between tryptophan and foliar nutrition with (Fe+Zn+Mn) each at rate of 150 ppm. succeeded in increasing nitrogen, phosphorus and potassium content of leaves compared with the other treatments in both seasons. These results agreed with those reported by Mohamed (1992) on *Dahlia pinnata* plants, El-Khayat (2001) on *Hibiscus sabdariffa*, L. plant, Youssef *et.al.* (2004) on Datura *plants*, El-Maadawy *et.al.* (2006). on turfgrass plants, Balbaa and Talaat (2007) on rosemary plants

8- Anthocyanin and vitamin-C contents (mg/g):

Data in Table (10) reveal that, all concentrations of tryptophan increased anthocyanin and vitamin-C content of sepals as a general trend in both seasons, the highest level of tryptophan (150 ppm.) gave the maximum increase in anthocyanin and vitamin-C contents in the first and second seasons. Besides, all foliar nutrition with (Fe, Zn and Mn.) each at rate of 150 ppm. succeeded in increasing the anthocyanin and vitamin-C contents compared with the untreated ones in both seasons. Moreover, foliar nutritions with (Fe+Zn+Mn) each at rate of 150 ppm. progressively increased the anthocyanin and vitamin-C contents in both seasons. Furthermore, all combinations between tryptophan and nutritions of Fe, Zn and Mn at 150 ppm. progressively increased the anthocyanin and vitamin-C contents compared with the untreated plants in both seasons. These results go on line with those obtained by El-Khayat (2001) on *Hibiscus sabdariffa* plants.

Table (7): Effect of tryptophan and micronutrients (Fe, Zn and Mn) foliar application on sepals fresh and dry weights / plant of *Hibiscus sabdariffa* plant during 2006 and 2007 seasons.

Treatments \ Parameter	Sepals fresh weight /plant (g)					Sepals dry weight /plant (g)				
	Tryptophan									
	0.0 Control	50 ppm	100 ppm	150 ppm	Mean	0.0 Control	50 ppm	100 ppm	150 ppm	Mean
First season (2006)										
Control (0.0)	117.33	122.66	125.33	128.00	123.33	15.94	16.42	16.29	16.64	16.32
Fe at 150 ppm	130.66	141.33	141.33	144.00	139.33	18.37	18.29	18.37	18.72	18.44
Zn at 150 ppm	125.33	137.33	133.33	136.00	133.00	17.85	17.54	17.33	17.68	17.60
Mn at 150 ppm	117.33	125.33	128.00	133.33	126.00	16.29	16.42	16.64	17.33	16.67
Fe+Zn+Mn at 150 ppm	133.33	141.33	144.00	146.66	141.33	18.37	18.66	18.72	19.06	18.70
Mean	124.80	133.60	134.40	137.60		17.36	17.47	17.47	17.88	
L.S.D. at		5%	1%				5%	1%		
Tryptophan		10.58	16.58				N.S.	N.S.		
Micronutrients		6.56	8.83				0.86	1.16		
Interactions		3.28	4.41				0.43	0.58		
Second season (2007)										
Control (0.0)	122.66	125.33	125.33	128.00	125.33	16.29	16.29	17.17	16.64	16.60
Fe at 150 ppm	133.33	141.33	141.33	141.33	139.33	18.37	18.37	18.66	18.37	18.44
Zn at 150 ppm	130.66	133.33	138.66	138.66	135.33	17.33	18.02	18.29	18.02	17.92
Mn at 150 ppm	125.33	130.66	133.33	136.00	131.33	16.98	17.33	17.54	17.68	17.38
Fe+Zn+Mn at 150 ppm	136.00	141.33	146.66	149.33	143.33	18.37	19.06	19.04	19.41	18.97
Mean	129.60	134.40	137.06	138.66		17.47	17.81	18.14	18.02	
L.S.D. at		5%	1%				5%	1%		
Tryptophan		5.45	8.27				N.S.	N.S.		
Micronutrients		3.83	7.84				0.59	1.03		
Interactions		2.91	3.92				0.38	0.51		

Table (8): Effect of tryptophan and micronutrients (Fe, Zn and Mn) foliar application on anthocyanin and vitamin-C in sepals of *Hibiscus sabdariffa* plant during 2006 and 2007 seasons.

Treatments \ Parameter	Anthocyanin (mg/g)					Vitamin-C (mg/g)				
	Tryptophan									
	0.0 Control	50 ppm	100 ppm	150 ppm	Mean	0.0 Control	50 ppm	100 ppm	150 ppm	Mean
First season (2006)										
Control (0.0)	16.66	17.66	18.66	18.66	17.91	34.00	34.66	36.00	37.00	35.41
Fe at 150 ppm	17.66	18.66	19.66	19.66	18.91	43.33	45.33	45.66	47.33	45.41
Zn at 150 ppm	17.33	18.00	19.00	19.33	18.41	39.00	40.33	42.00	44.66	41.50
Mn at 150 ppm	16.66	17.66	18.33	18.66	17.83	35.66	36.66	37.33	40.33	37.50
Fe+Zn+Mn at 150 ppm	18.33	19.66	19.66	20.00	19.41	44.66	46.33	47.33	48.66	46.75
Mean	17.33	18.33	19.06	19.26		39.33	40.66	41.66	43.60	
L.S.D. at		5%	1%				5%	1%		
Tryptophan		N.S.	N.S.				2.70	4.09		
Micronutrients		0.79	1.06				2.09	2.81		
Interactions		0.56	0.85				1.04	1.41		
Second season (2007)										
Control (0.0)	16.66	17.33	17.33	18.00	17.33	35.00	35.00	37.33	38.00	36.33
Fe at 150 ppm	19.00	19.66	20.33	20.33	19.83	44.33	46.33	46.00	45.66	45.58
Zn at 150 ppm	18.33	19.33	19.33	19.66	19.16	42.00	40.33	42.66	44.33	42.33
Mn at 150 ppm	17.66	18.33	19.33	19.66	18.75	38.33	39.66	41.33	42.33	40.41
Fe+Zn+Mn at 150 ppm	19.33	20.33	21.33	21.66	20.66	45.66	47.66	49.66	50.00	48.25
Mean	18.20	19.00	19.53	19.86		41.06	41.80	43.40	44.06	
L.S.D. at		5%	1%				5%	1%		
Tryptophan		N.S.	N.S.				2.60	N.S.		
Micronutrients		1.66	2.23				1.89	2.54		
Interactions		0.83	1.11				0.94	1.27		

Table (9): Effect of tryptophan and micronutrients (Fe, Zn and Mn) foliar application on total carbohydrates% and sepals acidity of *Hibiscus sabdariffa* plant during 2006 and 2007 seasons.

Parameter / Treatments	Total carbohydrates %					Sepals acidity (pH value)				
	Tryptophan									
	0.0 Control	50 ppm	100 ppm	150 ppm	Mean	0.0 Control	50 ppm	100 ppm	150 ppm	Mean
First season (2006)										
Control (0.0)	13.00	13.66	13.66	14.33	13.66	1.86	1.86	1.88	1.89	1.87
Fe at 150 ppm	14.33	14.66	15.00	16.00	15.00	1.90	1.92	1.94	1.95	1.92
Zn at 150 ppm	14.33	14.33	14.66	16.00	14.83	1.88	1.89	1.92	1.93	1.90
Mn at 150 ppm	13.66	14.33	14.66	15.33	14.50	1.87	1.88	1.89	1.91	1.88
Fe+Zn+Mn at 150 ppm	15.00	15.33	15.66	16.66	15.66	1.91	1.93	1.95	1.96	1.94
Mean	14.06	14.46	14.73	15.66		1.88	1.90	1.91	1.93	
L.S.D. at		5%	1%				5%	1%		
Tryptophan		0.97	1.47				0.005	0.008		
Micronutrients		0.71	0.96				0.004	0.005		
Interactions		0.35	0.48				0.002	0.003		
Second season (2007)										
Control (0.0)	13.66	14.00	14.33	14.66	14.16	1.88	1.89	1.92	1.93	1.90
Fe at 150 ppm	14.33	15.33	15.33	16.00	15.25	1.92	1.94	1.96	1.97	1.95
Zn at 150 ppm	14.33	14.66	15.33	15.66	15.00	1.91	1.93	1.95	1.96	1.94
Mn at 150 ppm	13.66	14.33	14.66	15.33	14.50	1.91	1.92	1.94	1.95	1.93
Fe+Zn+Mn at 150 ppm	15.33	15.66	16.00	16.33	15.83	1.93	1.96	1.98	1.99	1.96
Mean	14.26	14.80	15.13	15.60		1.91	1.93	1.95	1.96	
L.S.D. at		5%	1%				5%	1%		
Tryptophan		0.91	0.93				0.034	N.S.		
Micronutrients		0.72	0.68				0.004	0.005		
Interactions		0.36	0.49				0.002	0.003		

Table (10): Effect of tryptophan and micronutrients (Fe, Zn and Mn) foliar application on N%, P% and K% in leaves of *Hibiscus sabdariffa* plant during 2006 and 2007 seasons.

Parameter / Treatments	N%					P%					K%				
	Tryptophan														
	0.0 Control	50 ppm	100 ppm	150 ppm	Mean	0.0 Control	50 ppm	100 ppm	150 ppm	Mean	0.0 Control	50 ppm	100 ppm	150 ppm	Mean
First season (2006)															
Control (0.0)	1.247	1.297	1.303	1.327	1.293	0.423	0.430	0.437	0.437	0.432	1.527	1.533	1.547	1.553	1.540
Fe at 150 ppm	1.383	1.393	1.407	1.440	1.406	0.460	0.467	0.473	0.490	0.473	1.563	1.570	1.577	1.607	1.579
Zn at 150 ppm	1.327	1.347	1.390	1.397	1.365	0.453	0.460	0.467	0.480	0.465	1.550	1.557	1.577	1.580	1.566
Mn at 150 ppm	1.287	1.307	1.343	1.373	1.327	0.440	0.450	0.467	0.473	0.457	1.537	1.540	1.563	1.567	1.552
Fe+Zn+Mn at 150 ppm	1.417	1.467	1.483	1.507	1.468	0.467	0.483	0.507	0.513	0.492	1.590	1.613	1.617	1.627	1.612
Mean	1.332	1.362	1.385	1.409		0.449	0.458	0.470	0.479		1.553	1.563	1.576	1.587	
L.S.D. at		5%	1%				5%	1%				5%	1%		
Tryptophan		0.005	0.008				0.005	0.008				0.005	0.008		
Micronutrients		0.004	0.005				0.004	0.005				0.004	0.005		
Interactions		0.002	0.003				0.002	0.003				0.002	0.003		
Second season (2007)															
Control (0.0)	1.287	1.327	1.373	1.393	1.345	0.437	0.440	0.447	0.457	0.445	1.547	1.560	1.560	1.563	1.557
Fe at 150 ppm	1.423	1.497	1.570	1.593	1.521	0.473	0.473	0.487	0.503	0.484	1.597	1.617	1.630	1.630	1.618
Zn at 150 ppm	1.370	1.447	1.473	1.490	1.445	0.460	0.473	0.480	0.483	0.474	1.580	1.583	1.593	1.607	1.591
Mn at 150 ppm	1.333	1.397	1.407	1.417	1.388	0.453	0.457	0.467	0.473	0.462	1.563	1.567	1.570	1.573	1.568
Fe+Zn+Mn at 150 ppm	1.470	1.513	1.597	1.600	1.545	0.497	0.507	0.527	0.530	0.515	1.603	1.627	1.650	1.673	1.638
Mean	1.377	1.436	1.484	1.499		0.464	0.470	0.481	0.489		1.578	1.591	1.601	1.609	
L.S.D. at		5%	1%				5%	1%				5%	1%		
Tryptophan		0.005	0.008				0.005	0.008				0.005	0.008		
Micronutrients		0.004	0.005				0.004	0.005				0.004	0.005		
Interactions		0.002	0.003				0.002	0.003				0.002	0.003		

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تأثير الرش بالتربتوفان والحديد والزنك والمنجنيز علي النمو والإنتاجية والمحتوي الكيماوي لنباتات الكركدية

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أجريت تجربتين حقليتين بمزرعة الزينة بقسم البساتين كلية الزراعة جامعة بنها خلال عامي 2006 & 2007 م وذلك لدراسة تأثير الرش بالحامض الأميني التربتوفان (بتركيزات صفر ، 50 ، 100 ، 150 جزء في المليون) بالتبادل مع التغذية بالحديد والزنك والمنجنيز (بتركيز 150 جزء في المليون لكل منهما منفردا أو معا) علاوة علي معاملة الكنترول وذلك علي النمو والإنتاجية والمحتوي الكيماوي لنباتات الكركدية حيث تم رش نباتات الكركدية بالتربتوفان والحديد والزنك والمنجنيز ثلاث مرات (الرشة الأولي بعد 45 يوم من الزراعة وبين كل رشة و الأخرى ثلاث أسابيع) وأستخدم نظام القطع المنشقة في تصميم التجربة حيث تم وضع جميع معاملات التربتوفان في القطع الرئيسية (Main plot) وتم وضع جميع معاملات التغذية بالعناصر الصغرى في القطع المنشقة (Sub plot) علي النمو والإنتاجية والمحتوي الكيماوي لنباتات الكركدية

ويمكن تلخيص أهم النتائج المتحصل عليها كما يلي:

أدي الرش بكل من التربتوفان مع التغذية بالحديد والزنك والمنجنيز إلي زيادة طول النبات والعدد والوزن الطازج والجاف للأفرع والأوراق لكل نبات وكذلك سبب زيادة في العدد والوزن الطازج للثمار والوزن الطازج والجاف للسبلات لكل نبات بالمقارنة بنباتات الكنترول في كلا الموسمين. كما سبب زيادة نسبة الكربوهيدرات الكلية والنيتروجين والفوسفور والبوتاسيوم في الأوراق وكذلك زيادة محتوي السبلات من فيتامين (C) وال (pH) والأنثوسيانين بالمقارنة بنباتات الكنترول.

كما أدي رش نباتات الكركدية بالتربتوفان بتركيزات 50، 100، 150 جزء في المليون إلي زيادة طول النبات والعدد والوزن الطازج والجاف للأفرع والأوراق لكل نبات وكذلك سبب زيادة في العدد والوزن الطازج للثمار والوزن الطازج والجاف للسبلات لكل نبات بالمقارنة بنباتات الكنترول في كلا الموسمين. كما سبب زيادة نسبة الكربوهيدرات الكلية والنيتروجين والفوسفور والبوتاسيوم في الأوراق وكذلك زيادة محتوي السبلات من فيتامين (C) وال (pH) والأنثوسيانين بالمقارنة بنباتات الكنترول حيث أعطي التركيز المرتفع (150 جزء في المليون) أفضل القياسات بالمقارنة بباقي التركيزات والكنترول في كلا الموسمين. كما أدت معاملات التغذية بالحديد والزنك والمنجنيز بتركيز 150 جزء في المليون رشا علي النبات إلي زيادة في طول النبات والعدد والوزن الطازج والجاف للأفرع والأوراق لكل نبات وكذلك سبب زيادة في العدد والوزن الطازج للثمار والوزن الطازج والجاف للسبلات لكل نبات بالمقارنة بنباتات الكنترول في كلا الموسمين. كما سبب زيادة نسبة الكربوهيدرات الكلية والنيتروجين والفوسفور والبوتاسيوم في الأوراق وكذلك زيادة محتوي السبلات من فيتامين (C) وال (pH) والأنثوسيانين بالمقارنة بنباتات الكنترول وكان أفضل المعاملات هي المعاملة التي جمعت التغذية بالثلاث عناصر معا

(الحديد+الزنك+المنجنيز) بتركيز 150 جزء في المليون بالمقارنة برش كل عنصر منفرداً بتركيز 150 جزء في المليون في كلا الموسمين.

كما أدت جميع التفاعلات بين الرش بالتربتوفان بتركيزات 50، 100، 150 جزء في المليون مع التغذية بالحديد والزنك والمنجنيز بتركيز 150 جزء في المليون رشاً علي النبات إلي زيادة طول النبات والعدد والوزن الطازج والجاف للأفرع والأوراق لكل نبات وكذلك سبب زيادة في العدد والوزن الطازج للثمار والوزن الطازج والجاف للسبلات لكل نبات بالمقارنة بنباتات الكنترول في كلا الموسمين. كما سبب زيادة النسبة المئوية لكل من الكربوهيدرات الكلية والنيتروجين والفوسفور والبوتاسيوم في الأوراق وكذلك زيادة محتوي السبلات من فيتامين (C) وال (pH) والأنثوسيانين بالمقارنة بنباتات الكنترول. وكانت أفضل معاملات التفاعل هي معاملة الرش بالحامض الأميني التربتوفان بتركيزات 150 جزء في المليون مع التغذية بالحديد والزنك والمنجنيز معاً بتركيز 150 جزء في المليون رشاً علي النبات حيث أعطت أعلي القيم لقياسات النمو والمحصول والتركيب الكيماوي بالمقارنة بباقي معاملات التفاعل في كلا الموسمين.

وبناء علي النتائج السابقة فإنة يفضل رش نباتات الكركدية بالحامض الأميني التربتوفان بتركيزات 150 جزء في المليون مع التغذية بالحديد والزنك والمنجنيز معاً بتركيز 150 جزء في المليون لكل منهما رشاً علي النبات للحصول علي أفضل نمو وإنتاجية عالية مع أفضل جودة للبتلات الناتجة. وربما يكون هناك نقص خفي في عناصر الحديد والزنك والمنجنيز مما يفسر استجابة نباتات الكركدية للرش بهذة العناصر.