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Growth, yield and Some Physiological Aspects Of Canola (*Brassica napus* l.) Plants in Response To Treatment With Gibberellic Acid, Vitamin C And Zinc Sulphate .

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Abstract:

This research examines the actual growth, yield and certain metabolic activities of canola plants in response to foliar treatments with GA_3 50 ppm, Asc 50 ppm and Zn 50 ppm. Plants were grown in natural clay loamy soil conditions and treated with every of the aforementioned treatments. The treated plants showed significant responses in most of the growth and yield characteristics (lengths of shoots and roots, number of branches/plant and yield of canola plants and its components). Also, these treatments caused significant increases in the contents of photosynthetic pigments, soluble carbohydrates, soluble proteins, total phenols, oil content and fatty acids composition of the yielded canola oils. This was the case during the entire duration of time period of the experiment.

Key words: canola, foliar treatment, Gibberellic acid, Ascorbic acid and zinc.

1. INTRODUCTION:-

Increasing yield for an ever growing world population has currently become a topic of great concern with regard to food security. Especially in Africa, agricultural productivity has not been able to cope with population growth, leading to increased annual imports and food insecurity **Mugo *et al.* (2005).**

Canola plant (*Brassica napus* L.) is an important oil crop that ranks only behind soybean and palm oil in global production **(Francois, 1994).** Once considered a specialty for Canada, it is now a global crop. Many other countries including the United States, Australia and those in Europe also grow canola. However, Canada and the United States account for most of the global production. In Egypt canola has a bright future to contribute in reducing oil deficiency gap between production and consumption of edible oil. Growing canola oil crop in less fertile and/or salt affected soils may become successful if it could produce a relatively high economic yield with low level of inputs mainly nitrogen fertilizer.

In fact Improvement of crops in both quantity and quality is among the goals of the modern applied science and technology. In this regard, the effects of spray of phytohormones, such as Gibberellic acid (GAs), Gibberellins influence many aspects of plant growth and development. GA3 is an essential growth hormone that is known to be actively involved in various physiological activities such as growth, flowering and ion- transport **Shah (2004).**

Ascorbic acid (vitamin C) has a regulatory role in promoting productivity in many plants, Ascorbic acid acts as a cofactor for several enzymes and regulates the phytohormone-mediating signaling processes [19] and many physiological processes in plants **Smirnoff and Wheeler (2000).** Ascorbic acid is cofactors for enzyme activity, and effects on plant antioxidation capacity, heavy metal evacuation and detoxification and stress defense **Zhang (2012).**

Plant nutrition one of the most important factors that increase plant production. Zinc (Zn) is an essential nutrient required in some fertilizer programs for crop production. While some soils are capable of supplying adequate amounts for crop production, addition of zinc fertilizers is needed for others **Mousavi *et al.* (2012).**

The scope of the present analysis would be to discover the potent results of gibberellins, ascorbic acid and zinc on growth and productivity of canola plant.

.MATERIALS and METHODS:-

2.1. Methods of planting, treatments and collection of samples:

Uniform canola seeds were planted in Botanical garden; Botany and Microbiology Dept., Fac. of Sci., Al-Azhar Univ., Nasr City, Cairo, Egypt, Seeds of canola were sown in plots (4 m width and 10 m length). The plot contained 12 rows, 70 cm apart and the hills were spaced at 20 cm distance. Lit of seeds were sown in each hill, and the stand was later thinned to two plant per hill. Land preparations, agricultural operations followed the normal practices of crops cultivation in the clay loamy soils, the 12 rows divided into 4 groups representing the following treatments:

1. Tap water (control). **2. Gibberellic acid (50 ppm).** **3. Ascorbic acid (50 ppm).** **4. Zinc (50 ppm).**

The plants of *Brassica napus* were treated twice with the above mentioned treatments (as foliage spraying). The first treatment was made when the age of plants was 40 days and the second treatment was made when the age of plants was 90 days. The plant samples were collected for analysis when the plants were 50 (Stage I), and 100 (stage II) days old. At the end of the growth season (160 days), analyses of the seeds yielded from the different treatments as well as the control were done.

***Physical and chemical properties of the soil.**

Table1: Physical properties of the used soil (as percentage %).

Texture class	Sand	Clay	Silt
Clay loamy	29.39	48.61	22

Table 2: Chemical properties of the used soil.

2.2.

TSS Ppm	pH	E.C. mmhos/cm	Cationsmeq/L				Anions meq/L			
738	7.8	2.52	Na^+	K^+	Ca^{++}	Mg^{++}	Cl^-	$SO4^{--}$	$HCO3^-$	$CO3^{--}$
			2.5	0.5	2.02	1	4	1	1	Zero

<u>Measurement of growth parameters:</u>

Shoot length (cm), number of branches per / plant, root length (cm), yield of canola plants and its components were determined at different growth stages.

2.3.<u>Chemical analysis:</u>

Photosynthetic pigments were estimated using the method of **Vernon and Selly (1966).**Contents of soluble carbohydrates were measured according to the method of **Umbriet *et al*. (1969).**Contents of soluble proteins were estimated according to the methods of **Lowery *et al.* (1951).** Phenolic compounds were estimated according to the methods of **Daniel and George (1972),** Seed oil content was determined using soxhlet apparatus and petroleum ether (40-60 oc) according to **AOAC (1990**), and Methyl esters of fatty acids were prepared from an aliquot of total lipid according to **Harborne (1984).** Identification and quantitative determination of fatty acid were performed using Gas Liquid Chromatography.

Statistical methods:

All statistical calculations were done using computer programs.Microsoft excel version 10 and spss (statistica package for the social science version 20.00) statistical program. at 0.05, 0.01 and 0.001 level of probability **(Snedecor and Cochran, 1989)** the One-way ANOVA and Post hoc-LSD tests (the least significant difference) was presented using percentage, mean ±standard erorr. The discrement , pearson corrlation and automatic linear models analysis were estimated to show the relationship of the physiological parameter to each other.(**Härdle and Simar, 2007**).

3. RESULTS AND DISCUSSION:-

3.1. Growth and Yield Responses:

The obtained results (Tables 3-5) revealed that most of investigated growth characteristics (length of shoots and roots, number of branches/plant, and the weight of 1000-seeds) of canola plants were markedly increased in response to the application of GA_3. These effects were stronger at the stages I and II of growth. The stimulative effects of GA_3 on plant growth were also obtained by many workers **Pablo (2005)** reported that GA_3 application significantly affected leaves fresh and dry weight of *Coleus amboinicus* Lour. At the same time, **Gul *et al.* (2006)** noted that GA_3 foliar spray enhanced the height and ornamental wealth of *Araucaria heterophylla* plants. Same results for the positive effects of GA_3 on plant growth and development have been reported by **Santos *et al.* (1998)** in *Ocimum* spp. Furthermore, **Rohamare *et al*. (2013)** working on ajwain (*Trachyspermum ammi* L.) Plants, confirmed that foliar application of GA_3 at 25, 50 and 100 ppm significantly increased plant height, number of leaves, number of brunches and dry biomass/plant as compared to the unsprayed plants. **Abbas (2011)** reported that exogenous application of Gibberellic acid concentration at (50 ppm) on carrot plants led to significantly increased plant height cm and number of branch/ plant when compared with the other concentrations levels 100 ppm and controlling plants.

All the growth attributes like plant height, number of branches/plant, and the weight of 1000-seeds of canola plants were significantly enhanced by exogenous application of ascorbic acid as compared to the unsprayed plants (Table 3-5). The Asc treatment in the current study is in accordance with that of **Mazher *et al.* (2011)** found stimulatory effect of ascorbic acid (100 and 200 ppm) on all growth parameters (plant height, number of branches, number of leaves, stem diameter, root length as well as fresh and dry weights of all plant organs) of *Codiaeum variegatum* L. plants. **Rafique *et al*. (2011)** showed the best results on fresh and dry weight of pumpkin seedlings due to 30 mg L^{-1} ascorbic acid treatments. **Amin (2014)** reported that application of Asc 50 ppm significantly increased shoot length, root length, number of leaves as well as fresh and dry weights of all plant organs) of (*Helianthus annuus*) and (*Sesamum indicum*) plants. **Bolkhina *et al.* (2003)** pointed that ascorbic acid is the most abundant antioxidant which protects plant cells. Ascorbic acid is currently considered to be a regulator on cell division and differentiation and added that ascorbic acid is involved in a wide range of important functions as an antioxidant defense, photo proteins and regulation of photosynthesis.

Table (3-5) also indicates that zinc sulphate treatment recorded at (50) ppm concentration had a significant effect on the plant height, number of branches/plant, root length and weight of 1000-seeds compared with (0) concentrations throughout the stage I and II of growth. These results are in agreement with the results obtained by **Khudsar *et al*. (2004)** studied the effect of Zn (50, 100, 200, 300 and 400 μg/g soil dry mass) on *Artemisia annua* plants. They found that, total leaf area, length and dry mass of shoots and roots were increased with the age of the plant. **El-Sallami and Gad (2005)** found that, Zn sprays at 100 ppm increased the vegetative growth measurements plant height, number of leaves as well as the fresh and dry weights of aster plants. **Seilsepour (2006)** revealed that wheat grain yield, dry matter and 1000 grain weight were increased by use of zinc.

3.2. Photosynthetic Pigments:

Results of the present study (Table 6&7) revealed that, contents of chlorophyll a, b, total chlorophyll (a + b) and carotenoids of canola plants were significantly increased in response to the application of GA_3. These results are in agreement with the results obtained by **Abbas (2011)** reported that exogenous application of Gibberellic acid concentration at (50ppm) on carrot plants led to significantly increased chlorophyll content when compared with the other concentrations levels 100 ppm and controlling plants. **Sardoei *et al.* (2014)** reprted that foliar application (*Schefflera arboricola* L.) plants with GA_3 at 200 mg L^{-1} increased Chl. (a) and Total Chl. a+b content of (*Schefflera arboricola* L.) as compared to control treatment.

Different responses, in the present work, were recorded as regards the studied chlorophylls content of canola plants in response to the application of Asc. In canola plants, treatment with Asc caused, in most cases, highly significant and significant increases in the contents of chlorophyll a, b, total chlorophyll (a + b) and carotenoids. In accordance with the obtained results, **El-Sayed (2013)** mentioned that tomato seeds soaked before planting in ascorbic acid (Asc) at 50 ppm which leads to significantly increase the contents of chlorophyll a, b, a+b and carotenoids as compared with the control (distilled water) of (*Lycopersicon esculentum* Mill.) plants. **Emam *et al.* (2011)** showed that foliar application of these vitamins (vitamin B9, vitamin C and vitamin B12) significantly increased photosynthetic pigments compared with the control plants of flax plants.

Results of the present work (Table 6 & 7) revealed that, contents of chlorophyll a, b and total chlorophyll (a + b) of canola plants were, mostly, significantly increased in response to the application of Zn. These results are in agreement with the results obtained by **Rashed and Ahmed (1997)** on broad bean plants. They found that, chlorophyll contents were increased by using foliar application with Zn (50 ppm). **Hassanein *et al.* (2000)** found that, spraying cow pea (*Vigna sinensis*) plants with 10, 50 and 250 mg/L^{-1} of Zn caused high significant increases in the contents of chlorophyll (a) and chlorophyll b. Also, **Tobbal (2006)** showed that, spraying *Celosia* plants with Zn (400 mg/L^{-1}) increased contents of chlorophyll a, b and total (a + b). The same author reported that, the increase in chlorophyll a, b and total chlorophyll (a + b) could be ascribed to the effect of this element on increasing the biosynthesis of photosynthetic pigments and/or retarding their degradation. **Samreen *et al.* (2013)** found that application of Zn on mung beans plant (*Vigna radiata*) significantly enhanced chlorophyll contents.

3.3. Soluble Carbohydrates:

Results of the present work (Table 8) revealed that, contents of total soluble carbohydrates were significantly increased in shoots, roots and yielded seeds of canola plants in response to the treatment with GA_3. This was the case throughout the two stages of growth. These effects were stronger at the first and second stage of growth. The stimulatory effects of GA_3 as regards contents of total soluble carbohydrates in different plants were recorded by other investigators. **Abdallah and Mohamed (2013)** indicated that cotton plants treated with GA_3 at 100 ppm caused increase in total total sugars in leaves and seeds in the two seasons compared with untreated plants. **Johari and Kumar (2013)** indicated that treating (*Euphorbia antisyphilitica*) plants with GA_3 at 60 μm significantly increased total sugars contents. **Jaskani *et al*. (2014)** found that treating gladiolus plants with GA_3 at the concentration of 1mM (as a foliar application) significantly increased total soluble sugars contents.

The obtained results revealed also that, application of Asc caused variable responses as regards the carbohydrate contents, in canola plants, contents of soluble carbohydrates in shoots, roots and also, in the yielded seeds were markedly increased in response to the treatment with Asc. In this regard **Sally and Mervat (2012)** found that, ascorbic acid caused superior effects on lettuce plant height as well as increased total carbohydrates. **Emam *et al*. (2011)** showed that foliar application of these vitamins (vitamin B9, vitamin C and vitamin B12) significantly increased carbohydrates accumulation in treated flax plants compared with the control plants.**Amin (2014)** reported that treatment of (*Helianthus annuus*) and (*Sesamum indicum*) plants with Asc at concentration 50 ppm increase total water soluble carbohydrates contents .

In the present investigation, it was found (Table 8) that carbohydrate contents in shoots, roots as well as in the yielded seeds of canola plants were significantly increased in response to the treatments with either Zn. In accordance with the obtained results, **Tobbal (2006)** revealed that, contents of total soluble carbohydrates of both *Celosia* and *Zinnia* shoots were significantly increased in response to the treatment with Zn. **Zaky *et al.* (1999)** found that, spraying cow pea plants with Zn at 10 and 50 m/L increased the reducing sugars, sucrose, polysaccharides and total carbohydrates contents.

3.4. Soluble Proteins:

In the present study, it was found (Table 9) that protein contents in shoots, roots as well as in the yielded seeds of canola plants were significantly increased in response to the treatments with GA_3. In accordance with the obtained results, **Mukhtar, (2008)** reported that treating (*Hibiscus sabdariffa* L.) plants with GA_3 at 100 ppm increased total proteins percentage compared with untreated plants. **Abdallah and Mohamed (2013)** indicated that cotton plants treated with GA_3 at 100 ppm caused increase in protein percentage in cotton seeds in the two seasons compared with untreated plants. **Reda *et al.* (2010)** reported that treating (*chamomile recutita* L.) plants with GA_3 at (25, 50 and 100 ppm) significantly increased crude protein content compared with untreated control plants.

The obtained results revealed also that, application of Asc caused variable responses as regards the protein contents, in canola plants, contents of soluble proteins in shoots, roots and also, in the yielded seeds were markedly increased in response to the treatment with Asc. In this regard, **Gad El-Hak *et al.* (2012)** reported that foliar spray with ascorbic acid at 200 ppm increased protein % of seeds of pea cv. Master plants in the two growing seasons comparing with untreated plants. **Emam *et al.* (2011)** showed that foliar application of these vitamins (vitamin B9, vitamin C and vitamin B12) significantly increased proteins accumulation in vitamins treated flax plants compared with the control plants.

In the present investigation, it was found (Table 9) that protein contents in shoots, roots as well as in the yielded seeds of canola plants were significantly increased in response to the treatments with either Zn. In accordance with the obtained results, **Samreen *et al.* (2013)** found that application of Zn on mung beans plant (*Vigna radiata*) significantly enhanced crude protein contents. **Tajlil *et al*. (2014)** investigate the effect of different levels of zinc on biochemical activity of chickpea seeds (*Cicer ariegtinum*) and found that the effect of zinc on the seed protein levels was significant increased. **Gamal El-Din (2005)** reported that, Zn treatments (100 and 200 mg/L) increased protein contents of fenugreek seeds. Also, **Tobbal (1999)** found that, the contents of soluble proteins in shoots, roots and yielded seeds of fenugreek and chickpea plants were increased in response to the treatment with Zn (100 ppm) as foliar spraying.

3.5. Soluble Phenols:

Results of the present work (Table 10) revealed that, contents of total phenols were significantly increased in shoots, roots and yielded seeds of canola plants in response to the treatment with GA_3. This was the case throughout the two stages of growth. The stimulatory effects of GA_3 as regards contents of total phenols in different plants were recorded by other investigators. **Abdallah and Mohamed (2013)** indicated that cotton plants treated with GA_3 at 100 ppm caused increase in total phenols contents in leaves in the two seasons compared with untreated control plants. **Farahat *et al.* (2010)** indicated that spraying croton plants with GA_3 at 100, 150 and 200 ppm stimulated the content of total soluble phenols in croton plants compared with the control treatment.

The obtained results revealed also that, application of Asc caused variable responses as regards the total phenols contents, in canola plants, contents of total phenols contents in shoots, roots and also, in the yielded seeds were markedly increased in response to the treatment with Asc. In this regard, **Emam, *et al.* (2011)** showed that foliar application of these vitamins (vitamin B9, vitamin C and vitamin B12) significantly increased total phenols compared with the control of flax plants. **El-Lethy *et al.* (2011)** found that foliar application of Ascorbic acid at 50, 100 and 150 ppm showed significantly increased total phenols compared with the control of Geranium plants. **El-Awadi *et al.* (2014)** reported that treating two wheat cultivars with Asc at two concentrations 50 and 100 ppm indicated significant increases total phenols concentration comparing with control. **Amin (2014)** reported that treatment of (*Helianthus annuus*) plants with Asc at concentration 50 ppm increase total phenol contents.

In the present investigation, it was found (Table 10) those total phenols contents in shoots, roots as well as in the yielded seeds of canola plants were significantly increased in response to the treatments with either Zn. In accordance with the obtained results, **Reda *et al.* (2014)** reported that treatment of faba bean plants with Zn at concentrations 30, 60 mg/l increase total phenolic contents. The increases in total phenols as a result of adverse conditions were found by **Mishra *et al.* (2009)** on chick pea and **Gacche *et al.* (2010)** on vitis. However, research has conclusively shown that the majority of Zinc antioxidant activity may be attributed to phenolic compounds **Rice *et al.* (1997). Tavallali *et al.* (2010)** indicated that phenolic contents in *Pistacia vera* L. plant was highest in the leaves of Zn treatment plants.

3.6. Oil content:

The contents of oil in the yielded canola seeds (Tab11) increased according to treatment with GA_3, Asc and Zn. It is worthily to mention that treatment with gibberellin at 50ppm showed the highest increases in the chemical constituents of yielded seeds than the other treatments. Data presented in (Tab11) show significant increase in the oil content of the yielded canola seeds. These results are in agreement with those obtained by **Nurettin, T. and Tanko, K. (2005)** who pointed that foliar application of ascorbic acid significantly increased sunflower seed yield, oil content. In the present investigation, it was found (Table 11) oil content in yielded seeds of canola plants were significantly increased in response to the treatments with either Asc . In accordance with the obtained results, **Osman et *al.* (2014)** reported that treatment of sun flower plants with Asc increase total oil content.

3.7. Total fatty acids:

The results of the gas chromatographic analysis of the methyl esters of fatty acids of the yielded canola oil are shown in (Tab12). The obtained data revealed that all treatments caused a decrease in total saturated fatty acids (Ts) accompanied by an increase in total unsaturated fatty acids (Tu). Thus, ratio Tu/Ts also increased. Palmitic acid was the most predominant saturated fatty acid while oleic acid was the major unsaturated fatty acid. The distinct advantage of canola oil is its low saturated fatty acid content. Cytokinins may play a role in fatty acid synthesis, as well as desaturation and chain elongation reaction as mentioned by **Ibrahim et al., (2001)** who stated that the kinetin treatment increased unsaturated fatty acid at the expense of saturated fatty acids in *Helianthus annuus*.

The fat quality is usually valued according to the essential fatty acids since human nutrition required some of these fatty acids in the diet to prevent fatty acid deficiency diseases. All treatments used in this investigation caused an increase in essential fatty acids (C18:2+C18:3). The absence of low molecular weight of fatty acids(less than C12) from the yielded oilseeds of untreated and differently treated plants was known to enhance oil stability **Watson and Ramstad, (1987)**. Erucic acid in the yielded seeds was noticeably decreased with the two compounds. The decrease percentage due to zinc was 25.9% using 50 ppm, whereas using ascorbic acid with 50 ppm decreased the amount of erucic acid to 23.5% respectively. Higher concentration from the two compounds approximately had no effect. Since the quality of canola oil for human consumption is generally evaluated by its low erucic acid content as well as its low saturated fatty acid coupled with about 8-10% alpha linolenic acid, the present results in this work showed clearly that all treatments did not change this criteria.

4. Conclusion:

From the preceding results and discussion, it can be concluded that foliar application of canola plants with gibberellic acid at 50 ppm, ascorbic acid at 50 ppm, and zinc at 50 ppm, individually at elongation stage, stimulate the growth of canola plants via the enhancement of the biosynthesis of photosynthetic pigments; improved yield by increasing seed yield/plant seeds index as well as carbohydrate, proteins, phenols, oil content and fatty acids content of canola seeds and thus all last treatments improved canola seed quality and nutritional value.

Table (3): Effect of GA_3, Asc and Zn on shoot length (Cm. /plant) and number of branches / plant of (*Brassica napus*) plants. Values given are means of eight replicates. LSD (P<0.05) values are indicated in the data differing significantly are indicated with different letters.

Shoot length (cm)	Number of branches Stage (II)

Treatments (ppm)	Stage (I)	Stage (II)	
Control	15.82±0.17 c	122.12±0.73 d	4.20±0.36 c
GA_3	18.92±0.24 a	138.06±0.57 a	5.66±0.49 b
Asc	17.67±0.22 b	130.05±0.96 b	6.16±0.47 a
Zn	16.92±0.15 c	125.04±0.78 c	5.46±0.71 b
LSD at 0.05	0.545	2.059	0.919

Table (4) Effect of GA_3, Asc and Zn on root length (Cm. /plant) / plant of (*Brassica napus* L.) plants. Values given are means of eight replicates. LSD ($P<0.05$) values are indicated in the data differing significantly are indicated with different letters.

Root length (cm)		
Treatments (ppm)	Stage (I)	Stage (II)
Control	3.91±0.14 c	14.41±0.23 d
GA_3	5.42±0.11 a	15.31±0.40 c
Asc	5.37±0.07 a	16.80±0.27 a
Zn	4.44±0.16 b	15.93±0.18 b
LSD at 0.05	0.460	0.866

Table (5): Effect of GA_3, Asc and Zn on the yield of canola plants and its components. Values given are means of eight replicates. LSD (P<0.05) values are indicated in the data differing significantly are indicated with different letters.

Treatments (ppm)	Number of pods/plant	Weight of pods(g)/ plant	Number of seeds/ pod	Weight of seeds(g)/plant	Weight of 1000 seeds(g)
Control	165.12±0.20 d	19.41±0.23 **c**	20.41±0.23 **d**	8.21±0.14 **c**	3.21±0.14 **d**
GA_3	208.8±0.31 a	25.31±0.40 **a**	25.51±0.40 **a**	10.12±0.11 **a**	5.12±0.11 **a**
Asc	198.01±0.42 b	22.80±0.27 **b**	23.60±0.27 **b**	9.37±0.07 **b**	4.87±0.07 **b**
Zn	188.50±0.25 c	22.93±0.18 **b**	22.93±0.18 **c**	9.04±0.16 **b**	4.04±0.16 **c**
LSD at 0.05	**1.045**	**0.866**	**0.786**	**0.521**	**0.451**

Table (6): Effect of GA_3, Asc and Zn on chlorophyll contents (mg/g. fresh weight) of (*Brassica napus* L.) plants. Values given are means of three replicates.

Treatments (ppm)	Chlorophyll a		Chlorophyll b		Chlorophyll a+b	
	I	II	I	II	I	II
Control	5.40 ± 0.02 d	5.16 ± 0.00 b	4.18 ± 0.03 b	4.80 ± 0.00 d	8.66 ± 0.01 d	9.96 ± 0.00 d
GA_3	12.50 ± 0.01 b	5.01 ± 0.00 b	5.44 ± 0.02 a	6.98 ± 0.00 b	14.95 ± 0.03 b	12.00 ± 0.00 b
Asc	13.65 ± 0.37 a	4.68± 0.00 c	3.62 ± 0.17 c	9.14 ± 0.01 a	17.27 ± 0.21 a	13.82 ± 00.01 a
Zn	10.83 ± 0.00 c	5.81 ± 0.00 a	5.09 ± 0.02 a	5.45 ± 0.02 c	13.02 ± 0.02 c	11.26 ± 0.02 c
LSD at 0.05	**0.456**	**0.019**	**0.235**	**0.049**	**0.278**	**0.042**

Table (7): Effect of GA_3, Asc and Zn on carotenoids content of (*Brassica napus* L.) plants. Values given are means of three replicates. LSD (P<0.05) values are indicated in the data differing significantly are indicated with different letters.

Carotenoids mg/g fresh weight		
Treatments (ppm)	**Stage (I)**	**Stage (II)**
Control	2.11 ± 0.01 **d**	2.27 ± 0.00 **c**
GA_3 50	3.19 ± 0.02 **c**	2.27 ± 0.00 **c**
Asc 50	4.08 ± 0.02 **a**	3.62 ± 0.00 **a**
Zn 50	3.65 ± 0.01 **b**	3.52 ± 0.01 **b**
LSD at 0.05	**0.088**	**0.095**

Table (8): Effect of GA_3, Asc and Zn on total water soluble carbohydrates contents (mg/g.dry weight) of (*Brassica napus* L.) plants. Values given are means of three replicates. LSD (P<0.05) values are indicated in the data differing significantly are indicated with different letters.

Treatments	Shoots		Roots	
(ppm)	(I)	(II)	(I)	(II)
Control	30.30 ± 0.18 **d**	49.53 ± 0.11 **e**	13.98 ± 0.12 **d**	40.03 ± 0.09 **c**
GA_3	51.25 ± 0.18 **a**	77.33 ± 0.08 **c**	38.70 ± 0.18 **a**	56.98 ± 0.14 **b**
Asc	48.34 ± 0.20 **b**	102.98± 0.11 **a**	35.42 ± 0.18 **b**	64.73 ± 0.21 **a**
Zn	45.85 ± 0.31 **c**	104.66 ±0.12 **b**	22.33 ± 0.26 **c**	56.56 ± 0.10 **b**
LSD at 0.05	**0.465**	**0.422**	**0.511**	**1.334**

Table (9): Effect of GA_3, Asc and Zn on total water soluble proteins contents (mg/g.dry weight) of (*Brassica napus* L.) plants. Values given are means of three replicates. LSD (P<0.05) values are indicated in the data differing significantly are indicated with different letters.

Treatments (ppm)	Shoots (I)	Shoots (II)	Roots (I)	Roots (II)
Control	24.96 ± 0.08 **c**	23.58 ± 0.06 **d**	11.90 ± 0.13 **c**	32.40 ± 0.14 **d**
GA_3	40.52 ± 0.19 **a**	41.42 ± 0.16 **a**	20.06 ± 0.14 **a**	48.70 ± 0.16 **b**
Asc	40.40 ± 0.08 **a**	34.24 ± 0.08 **c**	16.90 ± 0.03 **b**	53.66 ± 0.03 **a**
Zn	31.64 ± 0.01 **b**	36.48 ± 0.11 **b**	18.22 ± 0.16 **b**	41.30 ± 0.08 **c**
LSD at 0.05	**0.565**	**0.828**	**0.711**	**1.130**

Table (10): Effect of GA_3, Asc and Zn on total phenol contents (mg/g.dry weight) of (*Brassica napus* L.) plants. Values given are means of three replicates. LSD (P<0.05) values are indicated in the data differing significantly are indicated with different letters.

Treatments (ppm)	Shoots		Roots	
	(I)	(II)	(I)	(II)
Control	0.285 ± 0.002 c	0.420 ± 0.002 c	0.388 ± 0.001 d	0.464 ± 0.001 d
GA_3	0.538 ± 0.002 a	0.501 ± 0.000 b	0.512 ± 0.002 b	0.725 ± 0.001 a
Asc	0.478 ± 0.002 b	0.435 ± 0.001 c	0.415 ± 0.003 c	0.490 ± 0.005 c
Zn	0.484 ± 0.001 b	0.542 ± 0.000 a	0.580 ± 0.009 a	0.541 ± 0.004 b
LSD at 0.05	0.015	0.007	0.014	0.011

Table (11): Effect of GA_3, Asc and Zn on total soluble carbohydrates contents (mg/g.dry weight), total soluble proteins contents (mg/g.dry weight), total phenols contents (mg/100g.dry weight) and oil content % of (*Brassica napus* L.) plants.

Treatments (ppm)	**Seeds**			
	Carbohydrates	**Proteins**	**Phenols**	**Oil %**
Control	83.81 ± 0.31 **d**	100.92 ± 0.35 **d**	0.327 ± 0.00 **c**	30.30 ± 0.18 **d**
GA_3 50	96.42 ± 0.31 **b**	113.07 ± 0.34 **c**	0.476 ± 0.00 **a**	41.25 ± 0.18 **a**
Asc 50	95.20 ± 0.28 **c**	116.26 ± 0.31 **b**	0.425 ± 0.00 **b**	38.34 ± 0.20 **c**
	101.80 ± 0.21	120.29 ± 0.34	0.488 ± 0.00	40.85 ± 0.31

Values given are means of three replicates. LSD (P<0.05) values are indicated in the data differing significantly are indicated with different letters.

Zn 50	**a**	**a**	**a**	**b**
LSD at 0.05	**0.537**	**0.880**	**0.001**	**0.465**

Table (12): Effect of GA_3, Asc and Zn on contents of fatty acids percent (%) of seed yield of (*Brassica napus* L.) plants.

Fatty acids	**Treatments**			
	Untreated plant	**GA_3 50 ppm**	**Asc 50 ppm**	**Zn 50 ppm**
Palmitic(C16:0)	4.88	5.12	4.04	3.92
Stearic(C18:0)	3.55	2.12	2.00	2.05
Oleic(C18:1)	50.42	55.25	56.34	57.23
Linoleic(C18:2)	13.22	16.02	15.64	14.92
Linolenic(C18:3)	6.88	7.12	7.52	7.12
Arachidic(C20:0)	.99	.89	1.01	.98
Gadoleic(C20:1)	11.02	13.15	11.41	12.55
Behenic(C22:0)	.52	.85	.36	.85
Erucic(C22:1)	.88	.66	.80	.80
Total saturated fatty acids(Ts)	8.16	8.15	7.98	6.36
Total unsaturated fatty acids(Tu)	91.20	93.12	91.55	90.52
Tu/Ts	12.12	13.05	11.52	13.01
Total essential fatty acids(C18:2+C18:3)	22.12	25.12	23.55	22.50

References

Abdallah, A. M. and Mohamed, H. F.Y.(2013): Effect of foliar application of some micronutrients and growth regulators on some Egyptian cotton cultivars. Journal of Applied Sciences Research, 9(6): 3497-3507.

Abbas, E. D. (2011): Effect of GA_3 on Growth and Some Physiological Characterizes in Carrot Plant (*Daucus Carota* L.). Ibn AL- Haitham J. for Pure and Appl. Sci. Vol.24 (3).

Amin, M.A. (2014): Comparative studies on growth, metabolism and yield of certain plants. Ph.D. Thesis, Bot. Dep., Fac. Sci., Al-Azhar Univ., Cairo, Egypt.

Amin, P. S. and Shahsavar, A. R. (2012): The Influence of Urea, Boric Acid and Zinc Sulphate on Vegetative Traits of Olive. J. Biol. Environ. Sci., 6(16): 109-113.

AOAC, (1990): Official methods of analysis.20th_edition.Association of official analytical chemists, Arlington, Virginia, U.S.A.

Daniel, H.D. and George, C.M. (1972): Peach seed dormancy in relation to endogenous inhibitors and applied growth substances. J. Amer. Soc. Hort. Sci. 97:651-654.

Bolkhina, O.; Virolainen, E. and Fagerstedt, K. (2003): Antioxidant, oxidative damage and oxygen deprivations stress. A Review Ann. Bot., 91:179-194.

El-Awadi,M.E.; El-Lethy,S.R. and Gad El-Rokiek,K.(2014): Effect of the two antioxidants; Glutathione and ascorbic acid on vegetative growth, yield and some biochemical changes in two wheat cultivars. Journal of Plant Sciences. Vol. 2, No. 5, pp. 215-221.

El-Lethy, S.R.; Ayad,H.S.and Reda, F.(2011): Effect of Riboflavin, Ascorbic acid and dry Yeast on vegetative growth, essential oil pattern and antioxidant activity of Geranium(*Pelargonium graveolens* L.). American-Eurasian J.Agri. And Environ, Sci., 10(5):781-786.

El- Sayed,H.A.E. (2013): Exogenous Application of Ascorbic Acid for Improve Germination, Growth, Water Relations, Organic and Inorganic Components in Tomato (*Lycopersicon esculentum* Mill.) Plant under Salt-Stress. New York Science Journal 2013; 6(10).

El-Sallami, I.H. and Gad, M.M. (2005): Growth and flowering responses of New York aster (*Aster novi-belgii* L.) to a slow release fertilizer and foliar applied zinc. Assuit J. Agric. Sci., 36(2): 121-136.

Emam, M. M.; El-Sweify, A. H. and Helal, N. M. (2011): Efficiencies of some vitamins in improving yield and quality of flax plant. African Journal of Agricultural Research, 6(18): 4362-4369.

Farahat, M.M.; Soad, M.M.; Ibrahim and Lobna, S. T. (2010): Vegetative Growth and Chemical Constituents of Croton Plants as Affected by Foliar Application of Benzyl adenine and Gibberellic Acid. J. American Sci., 6(7).

Francois, L.E. (1994): Growth seed yield and oil content of canola grown under saline conditions Agron. J., 86, pp. 233-237.

Gacche, R.N.; Potlawar, S.G.; Shegokar, H.D. and Jadhav, A.D. (2010): Evaluation of enzumatic and non enzymatic antioxidant potential of *vitis vinifera* L. Asian J. Exp. Biol. Sci. SPL. 45-49.

Gad El-Hak, S.H.; Ahmed, A.M.and Moustafa, Y.M.M. (2012): Effect of Foliar Application with Two Antioxidants and Humic Acid on Growth, Yield and Yield Components of Peas (*Pisum sativum* L.). J. Horticultural Sci. and Ornamental Plants 4 (3): 318-328.

Gamal El-Din, K.M. and Abd El-Wahed, M.S.A., (2005). Effect of some amino scids on growth and essential oil content of chamomile plant. Inter. J. of Agric. Biol., 7, 376-380.

Gul, H.; Khattak, A.M. and Amin,N.(2006): Accelerating the growth of (*Araucaria heterophylla*) seedlings through different gibberellic acid concentrations and nitrogen levels. J. Agric. Biol. Sci., 1, 25-29.

Harborne, J.B. (1984): Phytochemical methods: A guide to modern techniques of plant analysis2nd_Edition, London, N.Y., P.15.

Härdle, W. and Simar, L. (2007): Applied Multivariate Statistical Analysis. 2nd ed, Springer, 420pp.

Hassanein, M.S.; Shalaby, M.A.F. and Rashad, E.M. (2000): Improving growth and yield of some faba bean cultivars by using some plant growth promoters in newly cultivated land. Annals of Agricultural Science, Moshtohor, 38(4): 2141-2155.

Ibrahim, S.I., Zaghlool, S.A., El-Shamy ,I.Z., Eisa, S.S. (2001) : The effect of kinetin or thidiazuron in combination with ABA or JA on regulating growth ,yield and seed lipids composition of sunflower (*Helianthus annuus* L.).Annals Agric. Sci., Ain Shams Univ., Cairo.46:465-483.

Jaskani,M.J.; Muhammad, Y. A.; Yasar, S.; Muhammad, Q. and Rashid, A.(2014): Response of morphological and physiological growth attributes to foliar application of plant growth regulators in gladiolus " White prosperity". Pak. J. Agri. Sci., Vol. 51(1), 123-129.

Johari,S. and Kumar,A.(2013): Effect of growth regulators in improving growth and productivity of hydrocarbon yielding plant. Research Article Vol3/Issue4/OCT-DE.

Khudsar, T.; Mahmood, Z.; Iqbal and Sairam, R. K. (2004): Zinc-induced changes in morpho-physiological and biochemical parameters in *Artemisia annua*. Biologia Plantarum, 48(2): 255-260.

Lowery, O. H.; Rosebrough, N. J.; Farr, A. L. and Randall, R. J. (1951): Protein measurement with the folin reagent. J. Biol.Chem.193:265-275.

Mazher, A. A.M.; Sahar, M.; Zaghloul, Safaa, A.; Mahmoud, and Hanan, S. S. (2011): Stimulatory Effect of Kinetin, Ascorbic acid and Glutamic Acid on Growth and Chemical Constituents of *Codiaeum variegatum* L. Plants. American-Eurasian J. Agric. & Environ. Sci., 10 (3): 318-323.

Mishra, M.; Mishra, P.K.; Kumar, V. and Prakash, U. (2009): Nacl phyto toxicity induces Oxidative stress and response of Antioxidant systems in *Cicer arietinum* L. CV. Abrodhi. Bot. Res. Intern., 2(2): 74-82.

Mousavi1, S.R.; Galavi,M. and Rezaei,M.(2012): The interaction of zinc with other elements in plants. Intl, J. Agri. Crop. Sci. Vol., 4 (24), 1881-1884.

Mugo, S.; De Groote, H.;Bergvinson, D.;Mulaa, M.;Songa, J. and Gichuki, S. (2005): DevelopingBt maize for resource-poor farmers – recent advances in the IRMA project. African J.Biotec., 4: 1490–1504.

Mukhtar, F. B. (2008): Effect of Some Plant Growth Regulators on the Growth and Nutritional Value of *Hibiscus sabdariffa* L. (Red sorrel). Int. Jor. P. App. Scs., 2(3):70-75.

Nurettin, T. and Tanko, K. (2005): Investigation on the effect of some plant growth regulators on sunflower (*Helianthus annuus* L.). J. Cent. Eur. Agric. (2005) 6:4, 589-592.

Osman, E.A.M, El- Galad, M.A. , Khatab, K.A. and El-Sherif, M. A. B. (2014): Effect of compost rates and foliar application of ascorbic acid on yield and nutritional status of sunflower plants irrigated with saline water. Glob. J. Sci. Res., 2 (6): 193-200.

Pablo, J. and Morales, P. (2005): Growth of aromatic coleus (*Coleus amboinicus* Lour.) as affected by biostimulators. Proceedings of 33rd PGRSA Annual Meeting, 210-212.

Rafique, N.; Raza; S. H.; Qasim, M. and Iqbal, N. (2011): Pre-sowing application of ascorbhc acid and salicylic acid to seed of pumpkin and seedling to salt. Pak. J. Bot., 43(6): 2677-2682.

Rashed, M.H. and Ahmed, H.A. (1997): Physiological studied on the effect of iron and zinc supplied on faba bean plant. J. Agric. Sci., Mansoura Univ., 22(3): 729-743.

Reda,F.; Abdelhamid,M.T. and El-Lethy,S.R.(2014): The Role of Zn and B for Improving Vicia faba L. Tolerance to Salinity Stress. Middle East J. Agric. Research, 3(4): 707-714.

Reda, F.;Abd El-Wahed,M.S.A. and Gamal El din, K.M.(2010): Effect of indol acetic acid, gibberellic acid and kinetin on vegetative growth,flowering,essential oil pattern of Chamomile plant (*Chamomile recutita* L. Rausch).World Journal of Agricultural Sciences 6(5): 595-600.

Rice-Evans, A.C.; Miller, N.J. and Pagaga, G. (1997): Antioxidant properties of phenolic compounds. New Trends plant Sci Rev., 2: 152-159.

Rohamare, Y.; Nikam, T. D. and Dhumal, K. N. (2013): Effect of foliar application of plant growth regulators on growth, yield and essential oil components of Ajwain (*Trachyspermum ammi* L.). International J. Seed Spices 3(2):34-41.

Sally, A. M. and Mervat, E. S. (2012): Some Antioxidants Application in Relation to Lettuce Growth, Chemical Constituents and Yield. Australian Journal of Basic and Applied Sciences, 5(6): 127-135.

Samreen,T.; Humaira, Hamid Ullah, S.; Saleem Ullah. and Muhammad, J. (2013): Zinc effect on growth rate, chlorophyll, protein and mineral contents of hydroponically grown mungbeans plant (*Vigna radiata*). Arabian J. Chem., xxx, xxx–xxx.

Santos, B.; Morales, M.J.P.; Stall, W.M. and Dusky, J.A. (1998): Effects of nitrogen and gibberellic acid combination on basil growth. Soil Crop Sci. Soc. Florida Pro, 57, 99-10.

Sardoei1, A.S.; Ali, R.; Fatemeh, S.; Tayyebeh, S. and Tayyebeh, S. M. (2014): Endogenous gibberellic acid and benzyladenine effects on stem elongation and leaf in *Schefflera arboricola* L. plants. Int. J. Plant, Animal and Environmental Sci., ISSN 2231-4490.

Seilsepour, M. (2006): Study of zinc effects on quantitative and qualitative traits of winter wheat in saline soil condition. Desert . J. 11(2): 17-23.

Shah, S.H. (2004): Morphophysiological response of black cumin *Nigella sativa L* to nitrogen, gibberellic acid and kinetin application. PhD Thesis. Aligarh Muslim University, Aligarh, India.

Smirnoff, N. and Wheeler, G.L. (2000): Ascorbic acid in plants: biosynthesis and function. Crit Rev Biochem. Mol Biol 35: 291-314.

Snedecor, G. M. and Cochran, W. G. (1989): Statistical methods-7th edition, lowa state Univ., Press, Ames., loww3a, USA., pp. 325-330.

Tajlil1, A.H.; Alireza,P. and Davood, E.A. (2014): Effects of seed priming by mannitol and zinc sulfate on biochemical parameters and seed germination of chickpea. Intl J Farm & Alli Sci. Vol., 3 (3): 294-298.

Tobbal, Y.F.M. (1999): Physiological studies on the effect of some micronutrients on growth and metabolism of some plants. M. Sc. Thesis, Fac. Sci. Al-Azhar Univ.

Tobbal, Y.F.M. (2006): Physiological studies on the effect of some nutrients and growth regulators on plant growth and metabolism. Ph. D. Thesis, Fac. Sci. Al-Azhar Univ.

Tavallali, V.; Rahemi, M.; Eshghi, S.; Kholdebarin, B. and Ramezavian, A. (2010): Zinc alleviates salt stress and increases antioxidant enzyme activity in the leaves of pistachio (*Pistacia vera* L. Badami') seedlings. Turk. J. Agric., 34: 349-359.

Umbriet, W. W.; Burris, R. H.; Stauffer, J. F.; Cohen, P. P.; Johsen, W. J.; Lee page, G. A.; Patter, V. R. and Schneicter, W. C. (1969): Manometric techniques, manual describing methods applicable to the studs of tissue metabolism. Burgess publishing co., U.S.A; P.P.239.

Vernon, L.P. and Selly, G.R. (1966): The chlorophylls. Academic press. New York and London.

Watson, S.A., Ramstad, P.E. (1987): Corn, chemistry and technology. St. Paul. Am .Assoc. of Cereal Chemists.

Zaky, L.M.; Hassanein, R.A.; Dowidar, A.E. and El-Mashad, A.A. (1999): Effect of foliar treatment with Boron and Zinc on physiologicalresponses of cowpea (*Vigna sinesis* cv. Cream 7) II- Metabolic activities during growth and development. Egypt. J. Physiol. Sci., 23(3): 443-469.

Zhang, Y. (2012): Ascorbic Acid in Plants: Biosynthesis, Regulation and Enhancement. Dordrecht.