J. Agric. Sci. Mansoura Univ., 25 (6): 3427 - 3447, 2000.

EFFECT OF NITROGEN FERTILIZATION AND SPRAYING GIBBERELLIC ACID (GA_3) ON GROWTH, SEED YIELD AND ITS OIL CONTENT OF SOME LETTUCE CULTIVARS

Farrag, Amal M.* and H.M.A. Mohamed **
*** Vegetable Crops Dept., Faculty of Agric., Cairo Univ. Giza, Egypt.**
**** Food Science Dept., Faculty of Agric., Minia Univ. El-Minia, Egypt.**

ABSTRACT

In the present investigation, three cultivars of lettuce (Balady, Dark Green and Great Lakes) were fertilized with 30, 60 or 90 kg N/fed. and sprayed 2 times with GA_3 at 0, 50 or 100 ppm. The height of Dark Green plants exhibited significant increase, whereas Balady plants gaved significant increase in plant fresh weight, number of leaves, seed yield/fed. and average weight of 1000 seeds. Great Lakes was the earliest cultivar and had the highest number of seed stalks and the maximal percentage of bolting plants.

Increasing N levels significantly enhanced the plant height, fresh weight and number of leaves/plant. Application of 60 kg. N/fed. increased the percentage of dry matter of leaves and resulted in the highest percentage of bolting plants, seed stalks number/plant, seed yield/fed., weight of 1000 seeds and germination percentage of produced seeds. The seed oil percentage was also increased when the nitrogen application rate was raised. Balady seeds exhibited considerable increase in its oil content when fertilized with 90 kg N/fed.

Using GA_3 at 50 ppm increased seed stalks number/plant, percentage of bolting plants, seed yield, weight of 1000 seed and germination percentage of seed. However, the seed oil percentage decreased with the application of GA_3.

In general Balady plants fertilized with 60 kg N/fed. and sprayed with 50 ppm GA_3 produced the highest seed yield.

The results also revealed that lettuce seed oil (Balady cv.) could supplement or substitute the conventional oil types in terms of its fatty acid composition and other physicochemical properties.

INTRODUCTION

Lettuce is considered one of the most important leafy vegetables grown as salad crops. Such plants need high requirements of nitrogen fertilizers. Weier and Scharpf (1989) stated that lettuce yields increased as total available nitrogen increased up to 135 kg/ha. Besides, cultivars have a considerable effect on plant growth and seed yield (Cox *et al*, 1976 and Archila *et al*, 1996). Growth regulators were found to affect also the growth of root and shoot (Tanimoto, 1991).

Lettuce seed production is largely dependent on plant productivity which is affected by some managements, i.e., cultivars, fertilization, growth regulators application. Spraying plants with gibberellic acid (GA_3) increased seed yield by promoting bolting and producing larger seed stalks (Sumiati, 1988).

The seed of lettuce (*Lactuca sativa*) was used in folk medicine to treat coughs, rhinitis, asthma, pertussis, insomnia, rheumatism and insanity (Said *et al*, 1996). Moreover, it was found that the seed of *Lactuca sativa* was reach in lipid, 30.41% (Nazik *et al*, 1980). They mentioned also that the meal was a good source of protein (43.70%). A survey of the literature reveals only very spare information on the characteristics of lettuce seed oil (Foda *et al*, 1979 and Said *et al*, 1996). Therefore, to achieve the most economical and efficient utilization of these seeds more information is required.

The purpose of this work was to study the effects of nitrogen fertilization and growth regulator GA_3 on seed production and oil yield of some different cultivars of lettuce. This work was also aimed to throw some lights upon the suitability and efficiency of lettuce seed to be a new variety of edible oil.

MATERIALS AND METHODS

Experiments were carried out at Agricultural Experimental Station, Faculty of Agriculture, University of Cairo, Giza, during the two successive winter seasons of 1997 – 1998 and 1998- 1999. Seeds were sown on November 11^{th} and 14^{th} for two seasons, respectively. Transplanting was carried out 40 days after seeding. Seedlings were set at 30cm. apart on both sides of ridges 4 m long and 70 cm wide. The experimental unit was consisted of 5 ridges ($14m^2$).

The used cultivars were Dark green, Balady *(Lactuca sativa var. longifolia)* and Great lakes *(Lactuca sativa var capitata)*. Three levels of nitrogen: i.e 30, 60 and 90 kg N/fed were used as ammonium sulphate (20.5%). All nitrogen levels were devided into two equal parts and applied at 3 and 6 weeks after transplanting. All plots were fertilized with calcium super phosphate (15% P_2O_5) at 200 kg/fed, and potassium sulphate (48% k_2O) at 50 kg fed. Plants were sprayed with gibberllic acidd (GA_3) at 0, 50 or 100 ppm at 3 and 6 weeks after transplanting.

A split split plot design with three replicates was used in both experiments. Cultivars were situated at the main plots, while sub plots represented nitrogen rates and GA_3 treatments were randomly distributed in sub – sub plots.

Characters studied were : plant height (cm), plant fresh weight (g), number of leaves / plant and dry matter of leaves were determined at 12 weeks after transplanting. Plant height (cm), prcentage of bolting plants and seed stalk number / plant, were detected at 17 weeks after transplanting.

Seed yield was determined as kg per plot, then calculated as kg per Feddan. Weight of 1000 seeds and germination percentage of seeds were also determined.

Total N, P and k percentages of leaves were estimated according to Pregl (1945), Murphy and Riley (1962) and Brown and Lilleland (1946) respectively.

All data were subjected to statistical analysis using the method described by Snedecor (1966).

The soil of the experimental field was alluvial clay loam, with a pH of 7.5, 1.9% organie matter, 0.101% available N, 1.75 ppm soluble-P and 0.28 meq /l.k. in the first season and 7.6, 1.7% 0.10% 1.20 and 0.30 in the second season, respectively.

Oil extraction and analysis :

Moisture and oil contents of seeds were measured according to AOCS (1981) methods Ac 2-41 and Ac 3-44 respectively.

Lettuce seed oil were extracted with n-hexane for 48 hours then filtered. This process was repeated 3 times using fresh solvent each time to extract most of the oils from the ground seeds. The miscella was collected, mixed and evaporated at 60°C under vacuum. Then the extracted oils were dried over anhydous sodium sulphate. Prior analysis, oils were cooled at 3± 1°C for 48 hr. to remove waxes. The extracted oils were kept at –20 °C till analysis.

Iodine value, reflactive index, acid value, specific gravity, saponification number, and Lovibond colour were determined using AOCS methods (1981). Phospholipids content in oil were calculated by multiplying phosphorus content by a conversion factor of 25 (Weihrauch and Son, 1983). Total tocopherol was analyzed according to the colorimetric method of Wong *et al* (1988) in which tocopherols reduce ferric ions to ferrous, which reacts to form a coloured complex with dipyridyl.

Gas liquid chromatography analysis of fatty acids

The fatty acids methyl esters were prepared using benzene: methanol: concentrated sulfuric acid (10:86:4) and methylation was carried out for one hour at 80-90°C according to Stahl, (1967). The composition of fatty acids were achieved by Gas liquid chromatography analysis using PYE Unicam model PV 4550 capillary Gas chromatography fitted with flame ionization detector, the column (1.5 m x 4 mm) packed with diatomite C (100-120 mesh) and coated with 10% polyethylene glycol adipate (PEGA). The column oven temperature was programmed at 8 °C/min from 70°C to 190 °C then isothermally at this temperature for 20 mm and nitrogen flow rates was 30ml/mm. Detector, injection temperatures, hydrogen and air flow rates and chart speed were 300 °C, 250 °C, 33 ml/mm, 330 ml/mm and 2 cm/mm respectively. The presented fatty acids were identified according to an authentic sample of fatty acids chromatographed under the same conditions. Methyl heptadecanoate was used as an internal standard.

Gas liquid chromatography analysis of unsaponifiable matters

The unsaponifiable matter were extracted after saponification of oil at room temperature according to the method outlined by Mordret (1968). The unsaponifiables constituents were analysed directly using the Unicam capillary Gas chromatography PV 4550 fitted with flame ionization detector on a coilled glass column (2.8 m x 4 mm) packed with diatomite C (100-120 mesh) and coated with 1% OV-17 as stationary phase. The oven temperature was programmed at 10 °C /min from 70 °C to 270 °C, then isothermally at this temperature for 15 min and nitrogen flow rate was 30 ml/mm). Detector, injection temperatures, hydrogen and air flow rates and chart speed were 300 °C, 250 °C, 33 ml/mm, 330 ml/mm and 2 cm/mm respectively. The various fractions separated were identified according to an authentic sample of hydrocarbons and sterols chromatographed under the same conditions. Quantitative analysis were performed with squalane as the internal standard and adopting the corrected area normalization method.

RESULTS AND DISCUSSION

Plant hight: Data shown in Table (1) indicate that Dark Green cv. plants were significantly taller than those of Great Lakes and Balady cvs. With respect to nitrogen levels, in general, plant height was significantly increased by increasing nitrogen levels. Plant hieght was clearly affected by GA_3, Plants treated with 100 ppm were significantly the tallest ones. The interaction between cultivars and nitrogen levels showed significant differences in the second season. Plants of Dark green cv fertilized with 90Kg N/ fed were the tallest ones. These results agree with those of Hosna and Agwah (1993). Regarding the interaction between cultivars and GA_3, Dark Green plants were sprayed with GA_3 at 100 ppm were the tallest ones.The interaction between nitrogen level and GA_3 showed that 90 Kg N/fed and GA_3 at 100 ppm gave the mixmal plant height.

Table 1: Effect of lettuce cultivar, nitrogen level and GA_3 concentration on plant height(Cm)

Cultivar / N	Nitrogen level (kg/Fed)	1997-1998				1998-1999			
		Gibberellic acid concentration (ppm)				Gibberellic acid concentration (ppm)			
		0	50	100	Means	0	50	100	Means
Dark Green	30	44.0	63.3	74.8	60.7	41.4	72.9	77.6	64.0
	60	46.5	64.5	74.0	63.0	43.4	90.1	112.7	82.1
	90	47.2	71.2	87.3	68.6	43.4	99.3	121.3	88.0
	Means	45.9	67.7	78.7	64.1	42.8	78.5	103.9	78.0
Great Lakes	30	20.7	41.0	44.3	35.3	22.7	39.6	42.4	34.9
	60	24.5	42.5	45.0	37.3	25.4	44.4	45.9	38.4
	90	25.3	44.3	49.3	38.7	27.2	45.9	48.9	40.5
	Means	23.5	41.6	46.2	37.1	24.9	43.3	45.5	37.9
Balady	30	40.7	63.5	71.2	58.5	43.3	64.4	73.8	61.5
	60	44.2	63.5	70.0	59.2	45.1	67.9	81.4	64.8
	90	47.0	68.7	79.7	65.1	47.8	70.6	80.7	66.2
	Means	43.9	65.3	73.6	61.0	45.2	68.6	78.7	64.2
Means		37.7	58.2	66.2		37.7	66.5	76.0	
		Interaction between Nitrogen × GA_3							
	30	35.1	56.0	63.5	51.5	35.8	59.9	64.6	53.5
	60	38.4	58.2	63.0	53.2	37.7	67.5	79.9	61.8
	90	39.6	60.4	72.1	57.4	39.3	71.9	83.5	64.9
Means		37.8	58.2	66.2		37.7	66.5	76.0	

L.S.D. 0.05	
V: 3.0 N: 2.1 G:2. 1	V: 1.3 N: 1.3 G:1. 0
V* N : ns	2N at 1V : 2.2 2V at 1N : 2.1
2G at 1V : 3.6 2V at 1G : 4.1	2G at 1V : 1.7 2V at 1G: 1.9
2G at 1N : 3.6 2N at 1G : 3.0	2G at 1N : 1.7 2N at 1G: 1.9
V* N * G: ns	V* N * G: 3.1

V: Cultivar **N: Nitrogen** **G: Gibberellic acid**

These results are in line with those obtained by Delvin and Witham (1986) who mentioned that high nitrogen concentration tended to increase cell number and cell size. They added that GA_3 promoted cell elongation.

Number of leaves / plant: Data presented in Table (2) showed that Balady cv significantly attained higher number of leaves than Dark Green and

Great lakes cvs in both seasons. Regarding nitrogen rates, significant increase in the number of leaves were obtained as a result of increasing nitrogen rates. Number of leaves/plant significantly affected by GA_3, plants treated with 100 ppm had higher number of leaves than those of 50 ppm in both seasons. The interaction between nitrogen levels and cultivars showed significant differences, plants of Balady cv fertilized with 90 Kg/fed had the highest number of leaves. These results agree with those of Hosna and Agwah (1993). With respect to the interaction between cultivars and GA_3 concentration, plants of Balady cv. sprayed with 100 ppm of GA_3 had the highest number of leaves. Significant differences were observed in the interaction between nitrogen level and GA_3 concentration, plants were fertilized with 90 KN/fed and sprayed with GA_3 at 100 ppm had the highest number of leaves.

Table 2: Effect of lettuce cultivar, nitrogen level and GA_3 concentration on number of leaves

Cultivar / N	Nitrogen level (kg/Fed)	1997-1998 Gibberellic acid concentration (ppm)				1998-1999 Gibberellic acid concentration (ppm)			
		0	50	100	Means	0	50	100	Means
Dark Green	30	43.3	74.5	56.8	49.2	37.1	41.4	44.6	40.9
	60	46.5	56.7	62.3	55.2	42.2	63.4	78.3	61.3
	90	46.5	60.3	70.3	59.0	42.6	71.2	81.5	65.1
	Means	45.4	54.8	63.2	54.4	40.6	58.6	69.1	55.8
Great Lakes	30	34.8	43.8	46.5	41.6	35.1	42.4	49.9	42.5
	60	36.0	42.8	44.0	40.9	38.5	46.0	48.8	44.8
	90	37.5	44.7	45.2	42.4	39.9	48.1	49.0	45.7
	Means	36.1	43.8	45.1	41.4	37.9	45.5	49.3	44.2
Balady	30	59.7	122.3	137.8	106.6	55.4	82.2	102.5	80.0
	60	70.3	120.0	141.2	110.5	64.3	97.0	125.3	95.6
	90	92.5	122.0	153.8	122.3	84.2	108.6	135.0	109.3
	Means	74.2	121.4	144.3	113.3	68.0	95.9	120.8	94.9
Means		51.9	73.3	84.2		48.8	66.7	79.4	
		Interaction between Nitrogen × GA_3							
	30	45.9	71.2	80.2	65.8	42.6	55.2	65.7	54.5
	60	50.9	73.1	82.5	68.7	48.4	68.8	84.2	67.1
	90	58.8	75.6	89.8	74.7	55.6	75.9	88.5	73.4
Means		51.9	73.3	84.2		48.6	66.7	79.4	
L.S.D. 0.05									
V: 3.7 N: 2.7 G:2. 3						V: 2.9 N: 2.8 G:2.6			
2N at 1V : 4.7 2V at 1N : 5.3						2N at 1V : 2V at 1N : 4.9			
2G at 1V : 3.9 2V at 1G : 4.8						2G at 1V : 4.5 2V at 1G: 4.7			
2G at 1N : 3.9 2N at 1G : 4.2						2G at 1N :4.5 2N at 1G: 4.6			
V* N * G: ns						V* N * G 9.7			

V: Cultivar N: Nitrogen G: Gibberellic acid

Plant fresh weight: Data presented in Table (3) showed significant differences between cultivars in both seasons, plants of Balady cv. had the heaviest value. The present results agree with those of Schonhof (1995). A steady increase in plant fresh weight was found with increasing nitrogen levels. Applying 90KN/fed resulted in the maximal fresh weight/ plant. These results agree with those of Karacol and Turetken (1992 a), Soundy and Smith

(1992), Cantiffe *et al* (1998) and Rincon *et al* (1998). Spraying GA_3 at 50 ppm or 100 ppm caused significant increase in plant fresh weight. Using GA_3 at 100 ppm resulted in heavier plants as compared with those treated with 50 ppm. Similar trend was observed by Sumiati (1988) and Kochankov *et al* (1996).

Table 3: Effect of lettuce cultivar, nitrogen level and GA_3 concentration on plant fresh weight(g)

Cultivar / N	Nitrogen level (kg/Fed)	1997-1998 Gibberellic acid concentration (ppm)				1998-1999 Gibberellic acid concentration (ppm)			
		0	50	100	Means	0	50	100	Means
Dark Green	30	7683	856.7	1055.0	893.0	757.8	1036.0	1113.3	969.0
	60	814.2	1000.0	1079.2	694.4	870.0	1159.3	1221.6	1083.7
	90	937.5	985.8	1166.7	1030.0	1065.3	1184.7	1296.0	1182.0
	Means	840.0	947.5	1100.3	963.6	897.7	1126.9	1210.3	1078.2
Great Lakes	30	555.0	578.3	638.3	590.6	486.7	527.0	655.3	556.4
	60	523.3	572.5	675.0	590.3	531.8	589.0	698.2	606.3
	90	548.5	687.5	712.5	649.5	535.3	650.6	733.1	639.7
	Means	542.3	612.8	657.3	610.1	517.9	589.0	695.6	600.8
Balady	30	786.7	1045.8	1440.0	1090.8	850.2	1016.8	1152.3	1006.4
	60	1182.5	1619.2	1717.3	1506.3	1090.0	1294.7	1315	1233.2
	90	1285.0	1560.3	1880.0	1575.3	1257.4	1589.3	1751.2	1532.7
	Means	1084.7	1408.6	1679.0	1390.0	1065.9	1300.2	1406.2	1257.4
Means		822.3	989.6	1151.6		827.2	1005.3	1104.0	
		Interaction between Nitrogen × GA_3							
	30	703.3	826.9	1014.4	858.2	698.2	830.6	953.7	843.9
	60	840.0	1063.5	1078.0	1020.3	860.0	1014.3	1141.6	974.4
	90	923.7	1078.1	1253.0	1084.9	973.7	1078.3	1266.1	1118.1
Means		822.3	989.6	1151.6		827.2	1005.3	1104.0	
L.S.D. 0.05 V: 34.6 N: 86.3 G:34.5 2N at 1V : 149.5 2V at 1N : 126.7 2G at 1V : 59.7 2V at 1G : 59.2 N * G:ns V* N * G: ns						V: 94.7 N: 52.7 G:60.4 2N at 1V : 91.3 2V at 1N :119.7 V* G: ns N*G : ns V * N * G : ns			

V: Cultivar N: Nitrogen G: Gibberellic acid

The interaction between cultivars and nitrogen levels was significant, plants of Balady cv. had the heaviest fresh weight when fertilized with 90 kg /fed. The interaction between nitrogen levels and GA_3 was insignificant in both seasons. The interaction between cultivars and GA_3 was significant in the first season. The value of plant fresh weight was the maximal when plants were sprayed with GA_3 at 100 ppm.

Dry matter percentage of leaves: Data presented in Table (4) show significant differences in leaves dry matter percentage of leaves between

Table 4:Effect of lettuce cultivar, nitrogen level and GA_3 concentration on dry matter% of leaves

Cultivar / N	Nitrogen level (kg/Fed)	1997-1998 Gibberellic acid concentration (ppm)				1998-1999 Gibberellic acid concentration (ppm)			
		0	50	100	Means	0	50	100	Means
Dark Green	30	6.17	7.11	7.32	6.87	5.43	6.34	6.87	6.21
	60	6.47	7.14	7.77	7.13	5.60	6.94	7.17	6.57
	90	6.59	6.74	7.25	6.86	5.87	6.73	7.12	6.57
	Means	6.41	7.00	7.45	6.95	5.63	6.67	7.05	6.45
Great Lakes	30	4.83	5.87	7.66	6.12	5.00	5.83	7.33	6.05
	60	4.99	7.23	7.88	6.71	5.55	6.66	7.52	6. 58
	90	5.19	7.17	7.92	6.76	5.92	6.88	7.81	6.87
	Means	5.01	6.77	7.82	6.53	5.49	6.46	7.56	6.50
Balady	30	6.98	7.75	8.15	7.63	6.62	6.86	7.14	6.87
	60	7.31	7.85	7.94	7.69	6.73	7.17	8.12	7.34
	90	7.45	7.65	7.88	7.66	6.96	7.52	8.07	7.51
	Means	7.25	7.75	7.99	7.66	6.77	7.18	7.78	7.24
Means		6.22	7.17	7.76		5.97	6.77	7.46	
		Interaction between Nitrogen × GA_3							
	30	5.99	6.91	7.72	6.87	5.68	6.34	7.11	6.38
	60	6.26	7.42	7.87	7.18	5.69	6.92	7.60	6.83
	90	6.41	7.19	7.68	7.09	6.25	7.04	7.67	6.99
Means		6.22	7.17	7.76		5.96	6.77	7.46	

1997-1998	1998-1999
L.S.D. 0.05	
V: 0.40 N : 0.23 G: 0.21	V: 0.39 N:0.17 G: 0.19
V*N ns	V* N :ns
2G at 1V : 0.37 2V at 1G : 0.49	2G at 1V :0.33 2V at 1G :0.47
N * G: ns V*N * G * : ns	N* G : ns V* N * G: ns

V: Cultivar N: Nitrogen G: Gibberellic acid

cultivars. Balady cv. had the highest value. Besides, dry matter percentage of leaves was significantly increased with increasing nitrogen level. These results agree with those of Masson *et al* (1991). The increase of dry matter content could be attributed to increased vegetative growth.

The interaction between cultivars and nitrogen level was insigificant. Plants treated with GA_3 at 100 ppm attained the highest value. The interaction between nitrogen levels and GA_3 was insignificant, whereas, the interaction of cultivar x GA_3 was significant. Leaves of Balady cv. contained the highest dry matter percentage when plants were sprayed with GA_3 at 100 ppm.

Nutritional status:

Nitrogen: Data presented in Table (5) show clearly significant differences between cultivars in percentage of nitrogen. The maximum value of N was obtained in Great Lakes cv. Moreover, it is clear that higher nitrogen levels significantly increased nitrogen accumulation. It is evident that application of 90 Kg N/fed being the most effective. These results are in harmony with those reported by Karacol and Turetken (1992 b), Brungear *et al* (1994) and Rincon *et al* (1998) who stated that increasing nitrogen rate increased accumulation of N, and protein. Interaction between cultivars and nitrogen levels was significant. Great Lakes cv. and and Balady cv. Plants at 90 Kg N/Fed produced the highest percentage of N.

Table 5: Effect of lettuce cultivar, nitrogen* level and GA_3 concentration on nitrogen percentage of leaves.

Cultivar / N	Nitrogen level (kg / fed.)	1998-1999			
		Gibberellic acid concentration(ppm)			
		0	50	100	Means
Dark Green	30	1.82	1.89	2.07	1.93
	60	2.13	2.31	2.45	2.29
	90	2.14	2.47	2.72	2.44
	Means	2.03	2.22	2.41	2.22
Great Lakes	30	2.29	2.31	2.66	2.42
	60	2.28	2.49	2.79	2.52
	90	2.61	3.20	3.38	3.01
	Means	2.39	2.67	2.94	2.67
Balady	30	2.08	2.18	2.36	2.21
	60	2.33	2.78	3.04	2.72
	90	2.71	2.86	3.06	2.88
	Means	2.38	2.61	2.82	2.60
Means	-	2.27	2.50	2.73	
		Interaction between Nitrogen × GA_3			
	30	2.77	2.13	2.36	2.19
	60	2.25	2.53	2.76	2.51
	90	2.49	2.85	3.05	2.80
Means		2.27	2.50	2.70	

L.S.D. 0.05
V: 0.09 N : 0.06 G: 0.06
2N at 1V : 0.10 2V at 1N : 0.12
V* G: ns
2 G at 1 N : 0.97 2N at 1G: 0.99 V*N * G * : 0.167

V: Cultivar **N: Nitrogen** **G: Gibberellic acid**

Application of GA_3 at 100 ppm caused significant increase of N accumulation as compared with the control.

Regarding interaction between nitrogen level and GA_3, the use of 90 Kg/fed and GA_3 at 100 ppm produced plants with high percentage of N. Interaction of cultivars x GA_3 was insignificant.

Phosphorus and potassium: data shown in Tables (6 and 7) indicate significant differences between cultivars, Dark Green cv plants had the highest P and K percentage. Increasing of N level significantly increared P content, while K content was decreased.

Concerning the effect of GA_3, P and K contents of plants were decreased by GA_3 application.

The interactions of cultivars X Nitrogen, Nitrogen X GA_3 and Cultivars X GA_3 were also significant.

Plant height at 17 weeks after transplanting (at bolting): Data presented in Table (8) show significant differences between cultivars, Dark Green cv. plants were the tallest ones. Plant height was significantly increased by increasing nitrogen level, in the second season, due to the increase of the height of seed stalks at bolting. The interaction between cultivars and nitrogen levels was significant. Plants of Dark Green cv. fertilized with 90 Kg N/fed were the tallest ones, in the first season.

Table 6: Effect of lettuce cultivar, nitrogen level and GA_3 concentration on phosphorus* percentage of leaves.

Cultivar / N	Nitrogen level (kg / fed.)	1998-1999			
		Gibberellic acid concentration(ppm)			
		0	50	100	Means
Dark Green	30	0.349	0.284	0.268	0.300
	60	0.309	0.263	0.290	0.287
	90	0.382	0.285	0.310	0.326
	Means	0.347	0.277	0.289	0.326
Great Lakes	30	0.344	0.293	0.268	0.301
	60	0.321	0.275	0.286	0.294
	90	0.308	0.286	0.300	0.298
	Means	0.324	0.285	0.285	0.298
Balady	30	0.233	0.210	0.196	0.213
	60	0.258	0.212	0.238	0.236
	90	0.280	0.233	0.246	0.253
	Means	0.257	0.218	0.227	0.234
Means	-	0.309	0.260	0.267	
		Interaction between Nitrogen × GA_3			
	30	0.309	0.262	0.244	0.272
	60	0.296	0.250	0.271	0.272
	90	0.323	0.268	0.285	0.290
Means		0.309	0.260	0.267	

L.S.D. 0.05
V: 0. 009 N : 0.007 G: 0.009
2N at 1V : 0.013 2G at 1V: 0.016 2G at 1N: 0.016
2 V at 1 N :0.014 2V at 1G: 0.016 2N at 1G: 0.015
V*N * G * : ns

V: Cultivar **N: Nitrogen** **G: Gibberellic acid**

Besides, plant hight was significantly increased by GA_3 application as compared with control. These results agree with those of Biddington and Dearman (1987) and Kochankov *et al* (1996) who found that a single GA_3 application at 6.25 mg/dm^2 at the 11-or 20 leaf stage accelerated stem formation and favoured early flowering and seed maturation.

The effect of gibberellins on stem elongation by increasing internodes length is previously demonstrated (Stowe and Yamaki (1959) and Van Overbeek (1966).

The interaction between Nitrogen and GA_3 and also between cultivars and GA_3 were significant.

Percentage of bolting plants and seed stalks number per plant: Data presented in Table (9 and 10) indicate that Great Lakes cv. plants were the earliest ones, which gave the highest percentage of bolting plants and the highest number of seed stalks per plant. It is clear that a significant increase in the percentage of bolting plants and seed stalks number per plant was recorded when nitrogen was applied at 60 Kg N/fed, while the values were decreased at 90 Kg N/fed, these resultes could be interpreted by the promotive effect of nitrogen on the vegetative growth.

Application of GA_3 at 50 ppm caused significant increase in the percentage of bolting plants and seed stalks number per plant, while 100 ppm

Table 7: Effect of lettuce cultivar, nitrogen* level and GA_3 concentration on potassium* percentage of leaves.

Cultivar / N	Nitrogen level (kg / fed.)	1998-1999			
		Gibberellic acid concentration(ppm)			
		0	50	100	Means
		0	50	100	Means
Dark Green	30	2.05	1.90	1.98	1.98
	60	2.12	1.86	1.96	1.98
	90	2.00	2.01	2.10	2.04
	Means	2.06	1.92	2.01	2.00
Great Lakes	30	2.08	2.00	1.94	2.01
	60	1.80	1.61	1.69	1.70
	90	1.72	1.65	1.69	1.69
	Means	1.87	1.75	1.77	1.80
Balady	30	2.00	1.78	1.88	1.88
	60	1.90	1.93	2.01	1.95
	90	2.08	2.08	2.14	2.10
	Means	1.99	1.93	2.00	1.98
Means	-	1.97	1.87	1.93	
		Interaction between Nitrogen × GA_3			
	30	2.04	1.89	1.93	1.96
	60	1.94	1.80	1.89	1.88
	90	1.93	1.91	1.98	1.94
Means		1.97	1.87	1.93	

L.S.D. 0.05
V: 0.03 N : 0.03 G: 0.04
2N at 1V : 0.04 2G at 1N : 0.07 V* G: ns
2V at 1 N : 0.04 2N at 1G: 0.06 V*N * G * : ns

V: Cultivar N: Nitrogen G: Gibberellic acid

Table 8:Effect of lettuce cultivar, nitrogen level and GA_3 concentration on height of bolting plants

Cultivar / N	Nitrogen level (kg/Fed)	1997-1998				1998-1999			
		Gibberellic acid concentration (ppm)				Gibberellic acid concentration (ppm)			
		0	50	100	Means	0	50	100	Means
Dark Green	30	96.7	133.3	144.3	124.8	118.1	153.7	163.3	145.1
	60	98.4	137.0	141.6	125.7	124.5	164.3	164.9	151.2
	90	114.2	134.5	141.8	130.2	126.0	160.6	163.1	149.9
	Means	103.1	134.9	142.5	126.9	122.9	153.6	163.8	148.7
Great Lakes	30	84.9	111.6	108.2	101.6	73.2	100.0	104.2	92.5
	60	84.4	107.1	101.6	97.8	80.4	103.9	98.9	94.4
	90	91.3	99.3	96.8	95.9	90.8	108.0	101.2	100.1
	Means	87.0	106.0	102.3	98.4	81.5	104.1	101.4	95.7
Balady	30	101.5	128.7	134.0	121.4	109.7	146.9	148.8	135.1
	60	97.9	126.5	129.1	117.8	126.7	153.0	156.2	145.2
	90	110.2	121.9	136.5	122.8	125.5	154.7	151.2	143.8
	Means	103.2	125.7	133.2	120.6	120.6	151.6	152.0	141.4
Means		970.8	122.2	125.9		108.3	138.3	139.1	
		Interaction between Nitrogen × GA_3							
	30	94.4	124.5	128.8	115.9	100.3	133.6	138.8	124.2
	60	93.5	125.5	124.2	113.8	110.3	140.4	138.9	138.4
	90	105.3	118.6	125.0	116.3	114.1	141.2	138.5	139.1
Means		97.3	122.2	125.9		108.3	139.4	139.1	

L.S.D. 0.05 (1997-1998)	L.S.D. 0.05 (1998-1999)
V: 3.7 N : ns G: 2.5	V: 1.8 N : 2.5 G: 2.2
2N at 1V : 3.8 2V at 1N : 4.8	V * N: ns
2G at 1V : 3.8 2V at 1G : 4.8	2G at 1V : 3.5 2V at 1G : 3.9
2G at 1N : 3.9 2N at 1G : 3.8	2G at 1N : 3.7 2N at 1G : 3.7
V*N * G * : ns	V*N * G * : ns

V: Cultivar N: Nitrogen G: Gibberellic acid

Table 9:Effect of lettuce cultivar, nitrogen level and GA_3 concentration on percentage of bolting plants

Cultivar / N	Nitrogen level (kg/Fed)	1997-1998 Gibberellic acid concentration (ppm) 0	50	100	Means	1998-1999 Gibberellic acid concentration (ppm) 0	50	100	Means
Dark Green	30	39.2	62.2	55.6	52.3	42.9	52.8	58.1	50.9
	60	37.7	56.8	62.7	52.4	34.9	54.3	60.3	49.9
	90	33.9	51.0	49.9	44.9	34.3	48.2	45.6	42.7
	Means	36.9	56.7	56.1	49.9	37.0	51.8	54.7	47.8
Great Lakes	30	34.4	87.9	84.6	68.9	30.7	86.4	80.2	65.8
	60	41.4	89.1	87.0	72.5	39.9	89.9	85.6	71.6
	90	39.1	77.2	79.8	65.3	38.2	78.5	80.0	65.6
	Means	38.3	84.8	83.8	68.9	36.3	84.7	81.9	67.6
Balady	30	27.2	59.6	61.0	49.3	23.7	56.3	68.1	49.4
	60	20.4	67.5	68.3	52.1	22.5	62.1	63.9	49.5
	90	18.3	62.8	65.7	48.9	19.4	63.1	64.6	49.0
	Means	21.9	63.7	65.0	50.1	21.8	60.5	65.5	49.3
Means		32.4	68.3	68.2		31.7	65.7	67.4	
		Interaction between Nitrogen × GA_3							
	30	33.6	69.9	67.1	59.9	32.1	65.2	68.8	55.4
	60	33.2	71.2	72.6	59.0	32.4	68.6	69.9	56.9
	90	30.5	63.6	65.1	53.1	30.6	63.3	63.4	52.4
Means		32.4	68.3	68.2		31.7	65.7	67.4	

L.S.D. 0.05 1997-1998	1998-1999
V: 0.7 N : 1.2 G: 1.1	V: 1.2 N : 1.0 G: 1.3
2N at 1V : 2.1 2V at 1N : 1.9	2N at 1V : 1.7 2V at 1N : 1.8
2G at 1V : 1.8 2V at 1G : 1.6	2G at 1V : 2.3 2V at 1G : 2.2
2G at 1N : 1.8 2N at 1G : 1.9	2G at 1N : 2.3 2N at 1G : 2.1
V*N * G * : 3.3	V*N*G * : 4.0

V: Cultivar N: Nitrogen G: Gibberellic acid

Table 10:Effect of lettuce cultivar, nitrogen level and GA_3 concentration on number of seed stalks/plant

Cultivar / N	Nitrogen level (kg/Fed)	1997-1998 Gibberellic acid concentration (ppm) 0	50	100	Means	1998-1999 Gibberellic acid concentration (ppm) 0	50	100	Means
Dark Green	30	17.4	25.3	26.7	23.1	14.7	18.7	16.1	18.9
	60	22.5	26.2	28.6	25.8	22.8	26.1	19.0	21.7
	90	24.3	29.4	23.7	25.8	19.0	27.1	21.4	22.5
	Means	21.4	26.9	26.3	24.9	16.6	22.9	23.6	21.0
	30	24.8	30.3	29.3	28.1	23.2	28.5	27.1	26.3
	60	27.1	33.9	29.4	30.1	25.7	32.4	30.8	29.7
	90	25.3	27.3	28.7	27.1	30.4	31.6	26.5	29.5
	Means	25.7	30.5	29.1	28.4	26.4	30.8	28.1	28.5
Balady	30	14.8	32.5	31.3	26.2	18.5	21.6	26.8	22.3
	60	17.9	33.3	31.2	27.4	19.3	25.9	22.7	22.6
	90	16.3	29.0	28.2	25.5	18.8	21.1	19.9	19.9
	Means	16.3	31.6	29.2	25.7	18.9	22.9	23.1	21.6
Means		21.2	29.7	28.2		20.6	25.5	24.9	
		Interaction between Nitrogen × GA_3							
	30	18.9	29.4	29.1	25.8	18.8	22.9	25.8	22.5
	60	22.5	31.1	29.7	27.8	20.3	27.0	26.6	24.6
	90	21.9	28.6	25.8	25.4	22.7	26.6	22.6	23.9
Means		21.2	29.7	28.2		20.6	25.5	24.9	

L.S.D. 0.05 1997-1998	1998-1999
V: ns N : 1.1 G: 1.3	V: 0.7 N : 0.9 G: 0.8
2N at 1V : 1.8 2V at 1N : 3.3	2N at 1V : 1.6 2V at 1N : 1.5
2G at 1V : 2.2 2V at 1G : 3.4	2G at 1V : 1.5 2V at 1G: 1.3
2G at 1N : 2.2 2N at 1G : 2.0	2G at 1N : 1.4 2N at 1G: 1.5
V*N * G * : ns	V*N * G * : ns

V: Cultivar N: Nitrogen G: Gibberellic acid

decreased such values. Aguiar (1982), Tei and Ciriciofolo (1991), Miccolis *et al* (1993) found that bolting occurred earlier in GA_3 treated plants than in untreated ones and also promoted seed stalk formation.

The interaction of cultivars x Nitrogen level was significant. Great Lakes fertilized with 60 Kg N/fed had the highest percentage of bolting plants and seed stalk number per plant. There were also significant differences due to the interaction between Nitrogen level and concentration of GA_3. This interaction revealed that applying 60 Kg N/fed combined with GA_3 at 50 ppm produced the earliest plants which had the highest percentages of bolting plants and seed stalks number per plant. Regarding the interaction between cultivars and GA_3, significant differences were obtained. Great Lakes was the earliest one with GA_3 at 50 ppm and had the highest values

Seed yield and weight of 1000 seeds: Data shown in (Table 11, 12) indicate that the yield and 1000 seed weight of Balady cv. were higher than those of Dark Green and Great Lakes cvs. Malfa and Ruggeri (1987) found that the effect of cultivars on seed yield and 1000 seeds weight were significant. Yield of seed and weight of 1000 seeds significantly increased with increasing nitrogen level up to 60 kg N/fed but decreased with 90 kg N/fed.

Table 11:Effect of lettuce cultivar, nitrogen level and GA_3 concentration on seed yield (kg/Fed)

Cultivar / N	Nitrogen level (kg/Fed)	1997-1998				1998-1999			
		Gibberellic acid concentration (ppm)				Gibberellic acid concentration (ppm)			
		0	**50**	**100**	**Means**	**0**	**50**	**100**	**Means**
Dark Green	30	106.2	158.0	205.9	156.7	100.2	164.0	210.5	158.2
	60	134.4	181.9	233.2	183.2	135.3	172.2	250.6	186.0
	90	153.0	269.4	179.1	200.5	143.1	290.6	197.9	210.5
	Means	131.2	203.1	206.1	180.1	126.2	208.9	219.7	184.9
Great Lakes	30	41.3	106.7	94.3	80.8	50.7	99.3	91.0	80.3
	60	61.0	125.6	97.3	94.7	63.4	129.2	100.8	97.8
	90	65.0	86.3	81.4	80.9	79.7	92.1	87.5	86.4
	Means	59.2	106.2	91.0	85.5	64.6	106.9	93.1	88.2
Balady	30	160.9	280.6	297.5	246.4	172.0	290.6	300.2	254.3
	60	209.0	324.5	338.3	290.6	221.5	339.4	315.1	292.0
	90	188.6	290.1	249.6	242.7	195.3	312.3	264.8	257.4
	Means	186.2	298.4	295.1	259.9	196.2	314.1	293.4	267.9
Means		125.5	207.6	197.4		129.0	210.0	202.0	
		Interaction between Nitrogen × GA_3							
	30	102.8	181.8	199.2	161.3	107.6	184.6	200.6	164.3
	60	134.9	210.7	222.9	189.5	140.1	213.0	222.0	191.9
	90	138.9	215.3	170.0	174.7	139.3	231.7	183.4	184.8
Means		125.5	207.6	197.4		129.0	210.0	202.0	

L.S.D. 0.05 (1997-1998)			L.S.D. 0.05 (1998-1999)		
V: 9.5	N : 8.1	G: 7.4	V: 4.5	N : 3.2	G: 2.8
2N at 1V : 14.0	2V at 1N : 14.8		2N at 1V : 5.6	2V at 1N : 6.4	
2G at 1V : 12.8	2V at 1G : 13.9		2G at 1V : 3.6	2V at 1G : 5.3	
2G at 1N : 12.8	2N at 1G : 13.2		2G at 1N : 3.6	2N at 1G : 4.4	
V*N * G * : 22.2			V*N*G * : 6.2		

V: Cultivar **N: Nitrogen** **G: Gibberellic acid**

Table 12:Effect of lettuce cultivar, nitrogen level and GA_3 concentration on weight of 1000 seeds (g)

Cultivar / N	Nitrogen level (kg/Fed)	1997-1998 Gibberellic acid concentration (ppm)				1998-1999 Gibberellic acid concentration (ppm)			
		0	50	100	Means	0	50	100	Means
Dark Green	30	0.839	0.898	1.069	0.935	0.845	0.924	1.100	0.950
	60	0.973	1.035	1.116	1.041	0.992	1.081	1.163	1.079
	90	1.000	1.231	1.001	1.077	1.030	1.282	1.051	1.121
	Means	0.937	1.055	1.062	1. 018	0.956	1.096	1.105	1.052
	30	0.752	1.230	1.070	1.017	0.741	1.272	1.100	1.038
	60	0.769	1.300	1.100	1.056	0.800	1.351	1.120	1.090
	90	0.780	0.900	0.800	0.827	0.800	0.945	0.811	0.852
	Means	0.767	1.143	0.990	0.967	0.780	1.189	1.010	0.993
Balady	30	0.913	1.125	1.163	1.067	0.952	1.141	1.200	1.098
	60	1.042	1.413	1.213	1.223	1.068	1.470	1.220	1.253
	90	0.968	1.125	1.000	1.031	0.998	1.150	1.090	1.079
	Means	0.974	1.221	1.125	1.107	1.006	1.254	1.170	1.143
Means		0.893	1.140	1.059		0.914	1.180	1.095	
		Interaction between Nitrogen × GA_3							
	30	0.835	1.084	1.101	1.007	0.846	1.112	1.133	1.031
	60	0.928	1.249	1.143	1.107	0.953	1.301	1.168	1.141
	90	0.916	1.085	0.934	0.978	0.943	1.126	0.984	1.017
Means		0.893	1.140	1.059		0.914	1.180	1.095	

L.S.D. 0.05 (1997-1998)			L.S.D. 0.05 (1998-1999)
V: 0.008	N : 0.011	G: 0.009	V: 0.048 N : 0.014 G: 0.019
2N at 1V : 0.019	2V at 1N : 0.018		2N at 1V : 0.025 2V at 1N : 0.052
2G at 1V : 0.016	2V at 1G : 0.016		2G at 1V : 0.052 2V at 1G: 0.054
2G at 1N : 0.016	2N at 1G : 0.018		2G at 1N : 0.032 2N at 1G: 0.029
V*N * G * : 0.028			V*N * G * : 0.056

V: Cultivar N: Nitrogen G: Gibberellic acid

The interaction between cultivars and nitrogen levels was significant, Balady cv. Plants were fertilized with 60 kg N/fed. gave the highest values. Regarding the effect of GA_3, the use of 50 and 100 ppm produced higher yield and 1000 seed weight than those of the control. The values with 100 ppm GA_3 were lower than those with 50 ppm. Tei and Ciriciofolo (1991) found that parris Island cv was the most sensitve to GA_3 at 20 ppm and produced 45% higher yield and 1000 seed weights, as compared with untreated control. Also Kochankov *et al* (1996) found that application of GA_3 at 6.25 mg/dm^2 increased seed yield 2-3 times higher than that of untreated plants.

Interactions of nitrogen X GA_3 and cultivars X GA_3 were also significant. Balady cv. plants were fertilized with 60 Kg N/fed and sprayed with 50 ppm GA_3 produced the highest values.

Seed germination percentage: Data presented in Table (13) show that seed germination percentage was not affected by cultivars. Increasing nitrogen level up to 60 Kg N/Fed significantly increased seed germination percentage, but decreased with 90 kg N/fed in the second season. Application of GA_3 at 50 and 100 ppm significantly increased seed germination percentage as compared with control. Germination percentage with 100 ppm was lower than with 50 ppm. The present results agree with those of Agwah *et al*. (1994). The interaction of cultivars x nitrogen was significant only in the second season. Seed germination percentage of Dark Green cv. with 90 kg N/fed and Balady with 60 kg N/fed had the highest values. The interaction between nitrogen levels and GA_3 concentrations was significant. Germination percentage of seeds was the highest with 60 kg N/fed and 50 ppm of GA_3. Interaction of cultivars x GA_3 was also significant.

Oil content : The effect of nitrogen fertilization and GA_3 on lettuce seed oil content is presented in Table (14). It is interest to notice that lettuce seed is high enough in extractable lipids to be classified as an oil seed. In general oil yield was increased by elevating the level of nitrogen fertilization. In this connection, Osborne and Batten (1978) found that oil and protein yield of rapeseed were higher on the high nitrogen level. Good agreement was also achieved with the results obtained by Al-Gharbi and Yousif (1989) for sunflower seeds. The opposite trend was found by Gendy and Marquard (1989) and Smith *et al* (1998). They reported th at the oil content decreased

Table 13:Effect of lettuce cultivar, nitrogen level and GA_3 concentration on seed germination percentage

Cultivar / N	Nitrogen level (kg/Fed)	1997-1998				1998-1999			
		Gibberellic acid concentration (ppm)				Gibberellic acid concentration (ppm)			
		0	50	100	Means	0	50	100	Means
Dark Green	30	70.1	82.2	86.4	79.6	71.9	80.4	86.0	79.4
	60	73.5	84.3	86.6	81.5	75.5	83.6	87.1	82.1
	90	78.0	88.1	83.5	83.2	79.3	89.9	83.2	84.1
	Means	73.9	84.9	85.5	81.4	75.6	84.6	85.4	82.0
	30	76.6	85.3	82.5	81.5	75.2	86.6	81.1	80.9
	60	78.1	87.0	81.2	82.1	78.3	87.4	83.5	83.1
	90	79.8	80.6	82.7	81.0	78.9	80.0	79.2	79.4
	Means	78.2	84.3	82.1	81.5	77.5	84.7	81.3	81.1
Balady	30	72.3	81.9	81.9	78.7	74.0	80.7	84.3	79.7
	60	75.5	86.9	85.1	82.5	76.9	88.1	86.9	84.0
	90	76.3	80.8	77.1	78.1	77.2	83.1	78.8	79.7
	Means	74.7	83.2	81.4	79.8	76.0	83.9	83.3	81.1
Means		75.6	84.1	83.0		76.4	84.4	83.3	
		Interaction between Nitrogen × GA_3							
	30	73.0	83.1	83.6	79.9	73.7	82.6	83.8	80.0
	60	75.7	86.1	84.3	82.0	76.9	86.4	85.8	83.0
	90	78.0	83.2	81.1	80.8	76.5	84.3	80.4	81.1
Means		75.6	84.1	93.0		76.4	84.4	83.3	

1997-1998	1998-1999
L.S.D. 0.05	
V: ns N : ns G: 1.3	V: ns N : 1.4 G: 0.7
V* N : ns	2N at 1V : 2.4 2V at 1N : 2.4
2G at 1V : 2.3 2V at 1G : 2.5	2G at 1V : 1.2 2V at 1G: 1.8
2G at 1N : 2.3 2N at 1G : 2.7	2G at 1N : 1.2 2N at 1G: 1.7
V*N * G * : 3.9	V*N * G * : 2.1

V: Cultivar : Nitrogen G: Gibberellic acid

Table 14: Effect of nitrogen fertilization and growth regulators on lettuce seed oil content*

Variety	Nitrogen level (kg/Fed)	GA_3 concentration	Moisture %	Oil yield** %
Balady	30	0	8.9 ±0.2	31.2 ±0.2
	30	50	8.5 ±0.2	27.9 ±0.4
	30	100	9.5 ±0.3	26.8 ±0.3
	60	0	9.0 ±0.2	33.6 ±0.3
	60	50	9.2 ±0.3	31.9 ±0.7
	60	100	9.2 ±0.2	28.3 ±0.4
	90	0	9.3 ±0.4	35.5 ±0.3
	90	50	9.1 ±0.1	34.6 ±0.1
	90	100	9.4 ±0.3	34.3 ±0.2
Dark Green	30	0	9.1 ±0.2	29.9 ±0.4
	30	50	8.7 ±0.1	29.1 ±0.2
	30	100	9.4 ±0.3	28.5 ±0.4
	60	0	8.8 ±0.2	33.0 ±0.3
	60	50	9.6 ±0.3	32.5 ±0.2
	60	100	8.5 ±0.1	31.8 ±0.3
	90	0	8.7 ±0.3	33.7±0.4
	90	50	9.9 ±0.2	32.6 ±0.1
	90	100	8.3 ±0.2	29.2 ±0.5
Great Lakes	30	0	8.7 ±0.4	28.2 ±0.1
	30	50	8.8 ±0.2	26.3 ±0.3
	30	100	8.6 ±0.1	24.6 ±0.6
	60	0	8.6 ±0.3	31.6 ±0.2
	60	50	9.1 ±0.3	30.7 ±0.5
	60	100	8.9 ±0.3	27.2 ±0.2
	90	0	8.8 ±0.2	33.9 ±0.5
	90	50	8.6 ±0.2	32.2 ±0.4
	90	100	8.5 ±0.1	30.7 ±0.3

*** Calculated as dry weight basis**
**** Mean ±SD (combined data for the two season analyses)**

Table 15: Physicochemical characteristics of lettuce seed (cv. Balady) oil

Character	Value *
Refractive index (25/25 ° C)	1.473 ± 0.0
Specific gravity (at 25 ° C)	0.9116 ± 0.0
Saponification number	193.71 ± 1.24
Iodine value	126.89 ± 2.07
Acid Value (mg KOH/g oil)	4.83 ± 0.28
Unsaponifiable matter(%)	0.96 ± 0.88
Phospholipids (mg/kg oil)	582.5 ± 33.5
Tocopherols (mg / 100g oil)	105.8 ± 26.9
Total Lovibond color (Y+10R)	157 ±2.0

***Mean ± SD**

under increasing the application of nitrogen. However, Balady cv. contains more amounts of glyceride oils reached 35.5% (dry wt.) on the high nitrogen level (90 kg/fed.) than the other two cultivars.

On the other hand, application of GA_3 generally reduced the seed oil content. Increasing the concentration of GA_3 to 100 ppm resulting also more decrease in the seed oil contents. It is worthy to notice that both growth regulators and a high nitrogen level increased seed oil percentage. Al-Gharbi and Yousif (1989) found significant interaction between nitrogen levels and growth regulators.

Oil Characteristics as mentioned above, that Balady cv. was higher in fat than the other two cultivars particularly at the high nitrogen level. Therefore, it was selected for investigation oil characterization. The physical and chemical properties of lettuce seed oil Table (15) being higher in iodine value (126.89). Thus, this oil could be categorized as semidrying oil. Saponification value, refractive index, specific gravity and acid value showed the following values 193.71, 1.4738, 0.9116 and 4.83, respectively. These results are in accordance with those reported for crude prickly lettuce seed oil (*Lactuca scariola*) by Foda *et al* (1979). In addition, the oil contains 0.96% unsaponifiables and 582.5 mg/kg phospholipids. The total tocopherols content recorded 105.8 mg/100g. This value is close to the content of tocopherols in some germ oils which are the richest sources (Speek *et al*, 1985). Moreover, the total Lovibond color of the crude oil was 157.

Table (16) shows the fatty acid composition of crude lettuce oil. In general, lettuce seed oil contained small amounts (13.51%) of total saturated fatty acids, which may be an advantage in view of the fact that diets low in saturated fats may benefit patients with cardiovascular diseases. The results of the fatty acids composition are in agreement with Foda *et al* (1979) and Nasipullah *et al* (1984) and compare favorably with those reported for some conventional oil seeds (Carpenter *et al*, 1976).

Data in Table (17) indicated that the hydrocarbons represented 27.74% of total unsaponifiable matter. Results were also mentioned that squalene was the major hydrocarbon in lettuce seed oil as it constitutes 6.27% of the unsaponifiables fraction.

The sterol composition are listed in Table (18). Among the six sterols identified β-sitosterol constituted the dominant component (43.18%). Also, Said *et al* (1996) reported that β-sitosterol was the major sterol in Lactuca sativa seed oil. Campesterol and Stigmasterol comprised 9.31% and 2.62% respectively of total unsaponifiable matters. Δ^7-stigmasterol and Δ^7-Avenasterol was also detected in 5.74% and 8.82% respectively. Δ^7-sterols has been previously detected in other compositae seed oils (Itoh *et al*, 1973).

In general, it could be deduced that lettuce (Balady cv.) plants fertilized with 60 kg N/fed. and sprayed with 50 ppm GA_3 produced the highest seed yield. The seeds contained considerable amounts of oil with a unique fatty acid composition which may serve as a new source for supplying oil for specific industrial uses or nutritional needs. Nutritional and toxicological evaluations should carried out to determine whether it might be safe for human nutrition.

Table 16: Fatty acid composition of lettuce seed (cv. Balady) oil*

Fatty acid	(Wt %)
Caproic (C6 : 0)	0.16
Caprylic (C 8 : 0)	0.03
Capric (C 10 : 0)	0.30
Lauric (C 12 : 0)	0.32
Myristic (C 14 : 0)	0.27
Palmitic (C16:0)	10.43
Stearic (C 18 : 0)	1.38
Oleic (C 18 :1 ω 9)	38.08
Linoleic (C 18 : 2 ω 6)	86.49
Linolenic (C 18 : 3 ω 3)	1.50
Arachidic (C 20 : 0)	0.62
Total saturated	13.51
Total unsaturated	86.49

*Each value is the mean of GC analyses of two replicates extraction

Table 17: The relative concentration of the Hydrocarbons in the unsaponifiable matters of lettuce seed (cv Balady) Oil *

Hydrocarbons	RRT**	% of unsaponifiable matter
Hydrocarbon C14	0.13	0.26
Hydrocarbon C16	0.17	0.74
Hydrocarbon C18	0.25	0.45
Hydrocarbon C 20	0.38	1.12
Hydrocarbon C 22	0.40	0.32
Hydrocarbon C 24	0.48	1.07
Hydrocarbon C 26	0.57	1.83
Hydrocarbon C 28	0.65	2.39
Squalene	0.69	6.27
Hydrocarbon C 30	0.73	3.41
Hydrocarbon C 32	0.78	3.95
Others	--	5.93
Total Hydrocarbons	--	27.74

* Each value is the mean of GC analyses of two replicates extraction

** relative retention time to β-sitosterol (25.10 min) which was taken as 1.00

Table 18:The relative concentration of the sterols in the unsaponifiable matters of lettuce seed (cv Balady) Oil *

Sterols	RRT**	% of unsaponifiable matter
Campesterol	0.84	9.13
Stigmasterol	0.92	2.62
β sitosterol	1.00	43.18
Δ 5- Avenasterol	1.06	0.45
Δ 7- stigmasterol	1.12	5.74
Δ 7- Avenasterol	1.17	8.82
others	--	2.32
Total sterols	--	72.26

* Each value is the mean of GC analyses of two replicates extraction

** relative retention time to β-sitosterol (25.10 min) which was taken as 1.00

REFERENCES

Aguiar, P. A. A. (1982). Influence of gibberellic acid on lettuce seed production revista-Brasileira- desementes, 4:198-195.

Agwah, E. M. R.; Shehata, S. A. and El-Sayed, S. F. (1994). Effect of some chemical regulators on seed production of onion. Bull. Fac. Agric., Univ. Cairo, 45 : 469 – 482.

Al-Gharbi, A. S. and Yousif, I. R. (1989). Effect of different nitrogen sources and the interaction between nitrogen levels and growth regulators on the protein and oil percentage in sunflower (*Helianthus annus* J.) seeds. Zanco-(Scientific Journal of Salahaddin University, Iraq), 2(4): 51-68.

AOCS. (1981). Official and Tentative Methods of the American Oil Chemists Society, 3rd edn., edited by R. O. Walker, AOCS, Champaign, IL.

Archila P. J. A; Contreras N., U. H; Pinzon, T.L.; and Laverde P. H. (1996). Evaluation of the growth and development of two lettuce cultivars. Agronomia Colombiana, 13 (1): 23-29.

Biddington, N. L. and Dearman, A. S. (1987). The effects of mechanically-induced stress and plant growth regulators on the growth of lettuce. Plant Growth- Regulation, 5 (3): 183 – 194.

Brown. J. D. and Lilleland, O. (1946). Rapid Determination of potassium and sodium in plant material and soil extract by flame photometry. Proc. Amer. Soc. Hort. Sci., 48 : 341-346.

Brungear D. G; Kidmose, U.; Sorensens J. N.; Kaack, K. and Eggum, B. O (1994). Influence of growth condition on the value of crisphead lettuce. 3. Protein quality and energy density. Plant foods for Human Nutrition, 46 (3): 255 – 265.

Cantiffe, D. J; Hochmuth, G. J; karchi, Z; Secker, I. and Ben- Yehoshua, S. (1998). Nitrogen fertility requirement for iceberg lettuce grown on sand L and with plastic mulch and drip irrigation, 14th international congress on plastics in agriculture, Tel Aviv, Israel, March, 421-427.

Carpenter, D. L.; Lehmann, J.; Masson, B. S. and Slover, H. T. (1976). Lipid composition of selected vegetable oils. J. Amer. Oil Chem. Soc., 53: 713-718.

Cox, E. F.; Mckee, J. M. T. and Dearman, A. S. (1976). The effect of growth rate on tip burn occurrence in lettuce J. Hort. Sci, 51: 297- 309.

Delvin, R. M. and F. H. Witham (1986). Plant Physiology, 4th ed Publishers and Distributors, Delhi- 110032, Indian, 577P.

Foda, Y. H.; Dabash, A. S. and Shams El-Din, M. H. A. (1979). Physical and chemical properties of crude and hydrogenated Prickly lettuce seed oil. Bulletin of Ain Shams University, Research 1213, December, 1-12.

Gendy, N. and Marquard, A. (1989). Studies on the effect of nitrogen fertilization and growth regulators on seed yield and some quality criteria of oilseed-rape (*Brassica napus* L.). Fett-Wisenschaft-Technologie, 91(9): 353-357.

Hosna, A. F. Mahmoud and Agwah, E. M. R. (1993). Response of lettuce plant grown in calcareous soil to plant spacing and N Fertilizer level. Egypt. J. Appl. Sci., 8(7): 222-236.

Itoh, T.; Tamura, T. and Matsumoto, T. (1973). Sterol composition of 19 vegetable oils. J Amer. Oil Chem. Soc., 50: 122-125.

Karacol, I. and Turetken, I. (1992 a). Effect of application of increasing rates of ammonium sulphate fertilizer on yield and nutrient uptake in the lettuce plant. Yiizuncu yil universitesi zizaat Fakultesi, Dergisi 2(2): 95 – 106.

Karacol, I. and Turetken, L. (1992b). Effects of nitrogen from and phosphorus dose on the Yield and quality of lettuce in van conditions, Yuzuncu, Yil Universitesi Zizaat Fakultesi Dergisi. 2(2): 85 – 93.

Kochankov, V. G.; Zhivukhina, E. A.; Bor Kowski, J.; Gorecki, R. and Jankiewicz, L. S (1996). Effect of gibberellic acid on growth, flowering, and seed production in crihead lettuce. Folia Horticulture 8 (1): 11-18.

Malfa, G. L. A. and Ruggeri, A. (1987). Biological factors and environmental Conditions in seed production of *Lactuca sativa*, Rivista di Agronomia 22 (3): 208 –213.

Masson, J.; Tremblay, N., and Grosselin, A (1991) Effects of nitrogen Ferlilization and HPS supplementary lighting on vegetable transplant production II Yield. J. of the Amer. Soc. Hort. Sc., 116 (4): 594-598.

Miccolis, V.; Lombrdi, A. and Binco, V (1993). Tranplanting date, gibberellic acid and yield of lettuce, Aannali-della- Facolta- di- Agraria,- Universita- di Bari.Pubi., 34: 101-110.

Mordert, F. (1968). Comparison and study of methods of obtaining un-saponifiable matter. J. Crops Grass, 6: 389-397.

Murphy, J. and Riley, J.P.C (1962). A modified single solution method for the determination of phosphorus in natural water. Anal. Chem. Acta 27 : 31-36.

Nasipullah, N., Werner, G. and Seher, A. (1984). Fatty acid composition of lipids from edible parts and seeds of vegetables. Fette Seifen-Anstrichmittel, 86(7): 267-268.

Nazik, D.; El-Nahry, F. and Zahran, E. (1980). Comparative studies on the nutritive value of some local seeds. Annals Agric., Sci. Fac. Agric. Ain Shams Univ., 25(1&2): 253-263.

Osborne, G. A. and Batten, G. D. (1978). Yield, oil and protein content of oilseed rape as affected by soil and fertilizer nitrogen and phosphorus. Australian-Journal of Experimental Agriculture and Animal Husbandry 18(90): 107-111.

Pregl, E (1945). Quantitative Organic micro analysis (4^{th} Ed. Chundil, London).

Rincon L.; Pellicer, C. and Saez (1998). Effect of different nitrogen application rates on the yield and nitrates concentration of lettuces. Agronchimica, 42(6): 304-312.

Said, S. A. El-Kashef, H. A.; El-Mazar, M. M. and Salama, O. (1996). Phytochemical and pharmacological studies on Lactuca sativa seed oil. Fitoterapia, 67(3):215-219.

Schonhof, I. (1995). Large Yield difference, but no difference in nitrate content. Gratenbaumagazin., 4 (8): 10 - 11.

Smith, C. J., Wright, G. C. and Woodroofe, M. R. (1998). The effect of irrigation and nitrogen fertilizer on rapeseed (*Brassica napus*) production in South-Eastern Australia. II-Nitrogen accumalation and oil yield. Irrigation Science, 9(1): 15-25.

Snedecor, G. W. (1966). Statistical Method. The Iowa State Univ. Press, Ames, Iowa U.A.A 5th ed., 534p.

Soundy, P. and Smith, I. E. (1992). Response of Lettuce to nitrogen and phosphorus fertilization. J. of the South. Afr. Soc. for Hort. Sci., 2(2) 82-85.

Speek, A. J.; Schrijver, J. and Schreus, W. H. P. (1985). Vitamin E composition of some seed oils as determined by High-Performance Liquid Chromatography with fluorometric detection. J. of Food Sci., 50: 121-124.

Stahl, E. (1967). Thin layer chromatography. A laboratory Handbook, Ed. Springer Verloag, Berlin, p.359. Heidelberg, New York.

Stowe, B. B. and Yamaki, T.(1959) Gibberllins: Stimulants of plant growth. Science, 129 : 807-816.

Sumiati, E. (1988). Effect of application date and concentration of gibberellic acid and triacontanol on yield of lettuce. Buletin Penelitian Horlikultura, 17(1): 48-57.

Tanimoto, E. (1991). Gibberellin requirement for the normal growth of roots. In Gibberellins (edt. by Takahashi, N; Phinney, B.O.; Mac Millan, J. Berlin, Germany; Springer verlag, 229-240.

Tei, F., Ciriciofolo, E. (1991). Effects sowing date and gibberellic acid on lettuce seed production sementi Elette, 37 (2): 15-22.

Van Overbeek, J. (1966). Plant hormones and regulators. Science, 152: 721-731

Weier, U. and scharpf, H. C. (1989). Nitrogen fertilization of butterhead on iceberg lettuce. Gemuse, 25 (2): 70-72. (C. F. Hort. Abstr 60: 7, 5157 ,1990).

Weihrauch, J. L. and Son, Y. S. (1983). The Phospholipid content of Foods. J. Amer oil chem. Soc., 60(12): 1971-1978.

Wong, M. L.; Timms, R. S. and Goh, E. M. (1988). Colorimetric determination of total tocopherols in palm oil : olein and stearin. J. Amer. Oil Chem. Soc., 65 (2): 258-261.

J. Agric. Sci. Mansoura Univ., 25 (6), June, 2000.

تأثير التسميد النيتروجينى والرش بالجبرالين على النمو ومحصول البذرة ومحتواها من الزيت لبعض أصناف الخس

أمل محمد أحمد فراج * ، هانى مصطفى على محمد **
*** قسم الخضر - كلية الزراعة - جامعة القاهرة**
**** قسم علوم الأغذية - كلية الزراعة - جامعة المنيا**

فى هذه الدراسة زرعت ثلاثة أصناف من الخس هى البلدى ، دارك جرين ، وجريت لاكس ، وسمدت بمعدلات 30 ، 60 ، 90 كجم نيتروجين / للفدان . كما رشت النباتات مرتين بالجبرالين بتركيزات صفر ، 50 ، 100 جزء فى المليون . وقد أظهرت النتائج تفوق معنوى لنباتات الصنف دارك جرين فى الطول ، بينما تفوق الصنف البلدى فى الوزن الطازج وعدد الأوراق ومحصول البذرة ووزن الألف بذرة ، فى حين أن الصنف جريت لاكس قد تفوق فى عدد الحوامل النورية والنسبة المئوية للنباتات المزهرة .

عند زيادة مستويات التسميد النتروجينى المضافة وجدت زيادة معنوية فى كل من طول النبات والوزن الطازج وعدد الأوراق ، كذلك فإن إضافة النيتروجين بمعدل 60 كجم / للفدان أعطى أعلى نسبة مئوية من المادة الجافة للأوراق وأكبر عدد من الحوامل النورية وأعلى نسبة مئوية للنباتات المزهرة وأعلى محصول بذرة ووزن ألف بذرة والنسبة المئوية للإنبات . كما وجد أن محتوى البذور من الزيت يزداد أيضاً بزيادة معدل التسميد النيتروجينى، فبذور الصنف البلدى تصل محتواها من الزيت إلى أعلى نسبة (35.5% على الوزن الجاف) عندما سمدت بمعدل 90 كجم نيتروجين / للفدان .

وأوضحت النتائج أيضاً أن الرش بالجبرالين بمعدل 50 جزء فى المليون أعطى أكبر عدد من الحوامل النورية للنبات ، أعلى نسبة مئوية للنباتات المزهرة ، محصول البذور ، وزن الألف بذرة والنسبة المئوية للإنبات . ومن ناحية أخرى فإن الرش بالجبرالين يقلل محتوى البذور من الزيت بدرجة واضحة .

وعموماً نباتات الصنف البلدى التى سمدت بمعدل 60 كجم نيتروجين للفدان ورشت بالجبرالين بمعدل 50 جزء فى المليون أعطت أعلى محصول بذرة .

هذا وقد أثبتت النتائج أن زيت بذور الخس (الصنف البلدى) من ناحية خصائصه الفيزيوكيميائية وتركيبه من الأحماض الدهنية يمكن أن يدعم أو يحل محل الأنواع المعتادة من الزيوت الغذائية .