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EFFECT OF FOLIAR APPLICATION WITH GIBBERELLIC ACID AND UREA ON GROWTH, YIELD, SEED OIL CONTENT AND ITS FATTY ACIDS OF RAPESEED

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ABSTRACT

The present investigation was carried out at Giza Experimental Station, Agricultural Research Center (ARC), during the two successive winter seasons, 2004/2005 and 2005/2006 in order to investigate the influence of foliar spraying at 40 and 60 days after sowing (DAS) with concentrations of gibberellic acid (0, 50 and 100 ppm) and rates of urea (0, 4 and 8%) on growth, leaf area index (LAI), yield and yield components as well as some seed chemical constituents of rapeseed c.v. Pactol.

Results indicated that increasing the concentration of gibberellic acid (GA_3) from 0 up to 100 ppm caused significant increase in plant height, number of branches/plant, shoot dry weight/plant and LAI at 77, 98 and 119 DAS (except number of branches / plant at 119 days did not reach the level of significance with 50 ppm GA_3 in both seasons). Also, number of siliques/plant, 1000-seed weight, seed weight/plant and seed yield/feddan as well as seed oil percentage and yield of oil/feddan were significantly increased by increasing GA_3 from 0 up to 100 ppm. Generally, the difference between 50 and 100 ppm of GA_3 did not reach the level of significance in most of the investigated traits. The increments due to spraying 100 ppm GA_3 were estimated by 17.1 and 18.7% for seed weight per plant and 12.4 and 12.5% for seed yield per feddan compared with control in the first and second season, respectively. Likewise, 100 ppm GA_3 enhanced oleic acid, the first main component of fatty acids (unsaturated), being 56.828% against 53.974% in seed of control plants.

A steady and progressive increase in all studied growth traits, LAI and all investigated yield traits were observed with each increment in applied urea rates up to 8% in both seasons. Spraying urea with 8% induced significant increments of 26.2 and 28.9% for seed weight/plant and 18.4 and 20.0 % for seed yield/feddan in the first and second season, respectively. Whereas, seed oil percentage was decreased due to foliar application with urea. Nevertheless, oil yield/feddan was significantly increased due only to the increase induced in seed yield/feddan. Sprayed plants of *Brassica napus* L. with 8% urea produced oil free from euricic acid and had higher percentage of oleic acid (66.086% of the total fatty acids of the seed).

The interaction among levels of GA_3 and urea proved significant in most of the investigated growth traits, LAI and yield traits. The most effective treatment which gave the highest values of yield and its components (except that of 1000-seed weight) in both studied seasons was that of 50 ppm GA_3 with 8% urea which gave significant increase of 36.8 and 39.7% for seed yield / feddan more than the control in the first and second season, respectively. Such treatment was not significantly differed with that of 50 ppm GA_3 + 4% urea.

Keywords: Rapeseed, *Brassica napus* L., Gibberellic acid, Urea, Growth, yield, Oil, Fatty acids.

INTRODUCTION

Brassica napus L., commonly known as oilseed rape, rapeseed or canola, is the world's third most important edible oil source following soybean and palm oil. The main rapeseed – producing regions of the world are China, Canada, the Indian subcontinent and Nortern Europe.

Canola seeds yielded 40 to 44% oil, being nutritions, easy to digest, and is reported to improve the function of the gall-bladder. In addition, its fatty acids can normally be metabolized without any liver disorders, while fatty acids of animal origin cannot. Following oil extraction, a nutritionally well balanced high protein (36-37%) meal is produced rich in nitrogen, phosphorus and potassium. Traditional and other uses have been for lamp oils, soapmaking, high-temperature and tenacious high-euricic acid lubricating oils, and plastics manufacturing (Robbelen *et al.*, 1989).

In Egypt, rapeseed crop is still in the research phase and has not grown commercially till now in spite of the wide gap (90%) between the local production and national consumption of edible oil (Taha, 2001). However, rapeseed crop was subjected to various investigations in Egypt since late 1970's where several cultivars of canola were imported from European countries and Canada to be justified under local conditions.

Several advantages are favouring rapeseed to be grown in Egypt such as: annual winter crop with short duration period (4-5 months), limited water requirements, high seed yield in new reclaimed soils and relatively high oil content.

It was found that gibberellins and other growth regulators are effectively used for controlling the size of plants, flowering, fruit set and enhanced chemical constituents of the seed.

Application of these substances are found useful and are extensively employed for promoting certain beneficial characters. So far, 55 different gibberellins are known to occur in plants as native plant hormones. One of the most widespread gibberellins, and the most potent in numerous assays, is GA_3, gibberellic acid, the first gibberellin to be discovered (Street and Opik, 1984). In this concern, many investigators found that GA_3 induced beneficial promotive effects on growth and yield attributes of various oil crops, for instance, Castro *et al.* (1989) and Ghallab and El-Yazal (2006) on canola plants as well as Khan *et al.* (1998 and 2002), Hayat *et al.* (2001) and Akter *et al.* (2007) on mustard plants and Deotale *et al.* (1998) and Anton *et al.* (2001) on soybean plants. At the same time, Anton *et al.* (1995) stated that GA_3 at 50 or 100 ppm increased significantly plant height of sunflower and decreased oil and protein percentages of the seed. Also, they recorded a linear increase in oil yield/feddan with increasing nitrogen rates from 30 up to 90 kg N/feddan under the application of GA_3 at 50 or 100 ppm. On the other hand, Anton *et al.* (2001) found that GA_3 at 100 ppm increased oil and protein contents of soybean seeds.

Cultural practices especially N-fertilization that may affect rapeseed growth and production under local conditions is an important task to under take. N application caused significant increase in LA, dry matter, number of pods, seed weight/plant, plant height and seed yield/feddan (Kandil, 1983).

Increasing nitrogenous fertilization level significantly increased plant height (Kandil, 1983; Badr, 1987; Noureldin *et al.,* 1993 a; Hassan and El-Hakeem, 1996; Said and Keshta, 1999; Sharief and Keshta, 2000 and Ali and Hassan, 2002), number of branches/plant (Badr, 1987; Noureldin *et al.*, 1994 a; Hammad and El-Shebiny, 1999; Said and Keshta, 1999; Sharief and Keshta, 2000 and Ali and Hassan, 2002), number of pods/plant (Kandil, 1983; Noureldin *et al.*, 1994 b and Ali and Hassan, 2002), 1000-seed weight (Noureldin *et al.,* 1994b; Hassan and El-Hakeem, 1996; Sharief and Keshta, 2000 and Ali and Hassan, 2002), seed yield/plant and seed yield / feddan (Kandil, 1983; Noureldin *et al.*, 1993 b and 1994 b; Hassan and El-Hakeem, 1996; Hammad and El-Shebiny, 1999; Said and Keshta, 1999 and Ali and Hassan 2002), oil yield/feddan (Noureldin *et al.*, 1993 b and 1994 b; Said and Keshta, 1999; Sharief and Keshta, 2000 and Ali and Hassan, 2002). On the other hand, increasing N level up to 60 kg/feddan did not influence seed oil content (Kandil, 1983). In this connection, Ibrahim *et al.* (1989) stated that rapeseed oil content and its fatty acids (palmetic, stearic, oleic, linoleic, linolenic, arachidic and euricic acids) percentages were not significantly affected by nitrogen rates (71, 142 and 213 kg/ha). However, (Hassan and El-Hakeem (1996) and Sharief and Keshta 2000) reported that increasing N level up to 75 or 90 kg/fed decreased seed oil content.

Thus, the present research was designed to disclose the influence of nitrogen fertilization and GA_3 on growth, yield and some chemical constituents of oilseed rape (*Brassica napus* L.).

MATERIALS AND METHODS

A field experiment was conducted at Giza Experimental Station, Agricultural Research Center (ARC), during 2004/2005 and replicated during 2005/2006 season to study the effect of foliar application with gibberellic acid (GA_3) and urea on vegetative growth, growth analysis, yield and its components as well as some seed chemical constituents of rapeseed (*Brassica napus* L. cv. Pactol).

Soil physical and chemical properties of both experimental seasons were determined according to Ryan *et al.* (1996) and presented in Table (1).

Seed of rapeseed was kindly supplied by the Oil Crop Research Department, FCRI, ARC, Giza, Egypt. The experiment was laid out in a split plot design with three replicates. The foliar application of GA_3 (0, 50 and 100 ppm) occupied the main plots, while subplots were devoted to foliar spraying with 4 and 8% urea (46.5% N). Subplot area was 21 m^2 (seven ridges, five meters long and 60 cm apart). The foliar applications for both GA_3 and urea were carried out 40 and 60 days after sowing (DAS).

Seed was sown in hills 15 cm apart on one side of ridges. Sowing took place on 14 December in the two seasons. Three weeks after sowing, seedlings were thinned at the rate of two per hill to achieve the recommended population density. Phosporus fertilizer at the rate of 30 kg P_2O_5/fed was applied to the soil just before sowing in the form of calcium superphosphate (15.5% P_2O_5). Nitrogen fertilizer at the rate of 22.5 kg N/fed (half of the recommended dose) was applied in three equal doses (before sowing, after thinning and at floral bud initiation) and potassium fertilizer at the rate of 24 kg K_2O/fed in the form of potassium sulphate (48% K_2O) was added just after thinning. All other cultural practices were carried out as recommended.

Table (1): Physical and Chemical analysis of the experimental site in 2004/2005 and 2005/2006 seasons.

Soil properties	First season	Second season
Physical %:		
Coarse sand	3.4	3.5
Fine sand	28.3	28.2
Silt	30.9	31.6
Clay	37.4	36.7
Texture class	Clay loam	Clay loam
Chemical:		
pH	7.5	7.6
Organic matter (%)	1.4	1.5
Available nutrients (ppm):		
N	50.0	52.0
P	8.5	9.0
K	488.0	483.0

Data recorded:

A random sample of five plants was taken from the second and sixth ridges of each sub-plot at 77, 98 and 119 DAS to measure:

A- Growth traits:

Including plant height (cm), number of branches per plant and shoot dry weight (g) per plant. For dry weight determination, plant shoot was dried at 70°C in an electric oven to a constant weight.

B- Growth analysis:

Leaf area index (LAI) represented growth analysis was determined according to Hunt (1990).

LAI = Leaf area (LA) in cm^2 /plant / Ground area occupied by the plant in cm^2.

where:

LA = (Disc area x No. of discs) x dry weight of leaves per plant / dry weight of leaf discs.

C- Yield traits:

At harvest (150 days after sowing) a random sample of ten plants was taken from the three central ridges in each subplot to estimate number of siliques per plant, 1000-seed weight (g) and seed weight (g) per plant. In addition, seed yield (kg) per feddan was estimated on subplot basis from the same three central ridges.

D- Seed chemical constituents:

At harvest time, sample of mature seed (in the second season only) was preparated to chemical analysis in three replicates. The following determinations were conducted:

1- Oil content was determined by using soxhelt extraction apparatus using petroleum either as a solvent, and then the oil percentage was calculated on dry weight basis (AOAC 1990), oil yield/feddan was also calculated.
2- Analysis of fatty acids was carried out in Centeral Laboratory of Faculty of Agriculture, Cairo University, Giza, Egypt, according to Vogel (1975). GLC was carried out under the same condition mentioned by Ghaleb (2005).

Statistical analysis:

Data were statistically analyzed according to Steel and Torrie (1980). The least significant difference (LSD) at 5% level for each determined trait was calculated.

RESULTS AND DISCUSSION

I- Growth traits:

1- Plant height:

Data presented in Table (2) indicate that foliar spray of GA_3 or urea as well as their interaction had significant effects on plant height of rapeseed at 77, 98 and 119 days after sowing (DAS) in both studied seasons.

Plant height significantly increased with increasing GA_3 concentration from 0 up to 100 ppm. Worthy to note that the difference between the two sprayed concentrations of GA_3 (50 and 100 ppm) was significant at all studied growth ages in both seasons. The obtained results are in agreement with those reported by Castro *et al.* (1989) on rape and Akter *et al.* (2007) on mustard.

The stimulative effect of GA_3 can be explained on the basis that it affects either cell division or its elongation. In this respect, Anton *et al.* (1995) concluded that the functional role of GA_3 is directed on stem elongation which associated with endogenous changes leading to visible changes in whole plant growth behavior, being controlled by the tested substance.

Spraying with urea had also positive significant effect on height of rapeseed plants. Data indicated that there were gradual increases in height with increasing the rate of foliar spray with urea up to 8% at all ages in both studied seasons. Similar results were also obtained by Kandil (1983), Badr (1987), Noureldin *et al.* (1993 a), Hassan and El-Hakeem (1996), Said and Keshta (1999), Sharief and Keshta (2000) and Ali and Hassan (2002) on canola plants. Likewise, Haggag *et al.* (1984), Okaz *et al.* (1987), Salwau and Hassanien (1994) and Hassanein *et al.* (1996) conformed these findings using soybean plants.

The interaction among levels of GA_3 and urea had significant effect on plant height. At all growth ages, plant height increased with increasing foliar spraying GA_3 concentration either alone or along with urea, being maximal from the combination of 100 ppm GA_3 with 8% urea. The present results are in accordance with those obtained by **Anton *et al.* (1995)** on sunflower plants. They reported that plant height increased significantly with applying GA_3 at 50 or 100 ppm with 30 kg N/fed.

Table (2). Growth traits of rapeseed at 77, 98 and 119 days after sowing as affected by GA_3 and urea in 2004/2005 and 2005/2006 seasons.

Treatment		Plant height (cm)						No. of branches / plant						Shoot dry weight (g) / plant					
GA_3 ppm	Urea %	77 days		98 days		119 days		77 days		98 days		119 days		77 days		98 days		119 days	
		2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
0	0	54.8	60.3	123.4	136.8	149.5	166.2	1.67	1.83	7.26	6.83	8.33	8.50	12.44	13.67	47.46	52.61	61.14	67.97
	4	59.6	66.5	134.1	149.9	161.8	179.1	1.99	2.17	8.14	8.00	10.67	10.83	16.65	18.58	63.05	70.48	78.03	86.37
	8	62.1	69.2	138.3	155.6	166.4	186.5	2.17	2.33	9.27	9.33	11.83	11.67	18.39	20.50	68.60	77.18	87.43	97.99
Mean		58.8	65.3	131.9	147.4	159.2	177.3	1.94	2.11	8.22	8.05	10.28	10.33	15.83	17.58	59.70	66.76	75.53	84.11
50	0	60.9	66.7	136.8	151.4	163.2	181.9	2.50	2.83	8.95	9.17	10.83	10.67	18.89	20.70	63.69	70.49	84.76	94.47
	4	64.6	72.4	142.1	160.3	167.9	188.7	3.33	3.67	10.21	10.17	11.67	11.33	20.50	22.98	70.08	79.06	107.40	120.71
	8	69.3	78.9	148.2	168.4	177.6	198.2	4.17	4.50	11.42	11.33	12.00	11.83	22.12	25.18	72.87	82.80	126.78	141.49
Mean		64.9	72.7	142.4	160.0	169.6	189.6	3.33	3.67	10.19	10.22	11.50	11.28	20.50	22.95	68.88	77.45	106.31	118.89
100	0	65.9	74.3	142.7	163.2	171.4	191.7	3.33	3.83	10.41	10.17	11.50	11.67	20.99	23.66	65.50	74.91	95.65	106.98
	4	69.8	79.2	150.4	173.5	178.8	200.5	5.67	7.00	11.57	11.66	13.00	13.50	26.74	30.33	81.44	93.95	132.93	149.09
	8	72.9	84.6	156.4	181.9	182.4	205.3	6.17	6.89	11.85	11.83	12.67	12.50	25.95	28.93	76.95	89.49	127.16	143.11
Mean		69.5	79.4	149.8	172.9	177.5	199.2	5.06	5.91	11.28	11.22	12.39	12.56	24.56	27.64	74.63	86.12	118.58	133.06
General mean of urea	0	60.5	67.1	134.3	150.5	161.4	179.9	2.50	2.83	8.87	8.72	10.22	10.28	17.44	19.34	58.88	66.00	80.52	89.81
	4	64.7	72.7	142.2	161.2	169.5	189.4	3.66	4.28	9.97	9.94	11.78	11.89	21.30	23.96	71.52	81.16	106.12	118.72
	8	68.1	77.6	147.6	168.6	175.5	196.7	4.17	4.57	10.85	10.83	12.17	12.00	22.15	24.87	72.81	83.16	113.79	127.53
LSD (0.05)for:	GA_3	4.22	3.88	6.07	6.11	7.67	8.39	0.67	0.82	1.06	1.85	1.24	0.97	4.51	3.10	6.16	7.73	10.23	11.98
	Urea	2.48	2.55	4.02	4.19	4.53	5.78	0.54	0.52	0.87	1.12	1.52	0.95	2.67	2.31	4.88	5.11	6.52	7.01
	Interaction GA_3 x Urea	4.28	4.39	6.92	7.24	7.81	9.97	NS	NS	NS	NS	NS	NS	4.59	3.98	8.43	8.82	11.22	12.05

2. Number of branches:

Results in Table (2) clearly show that increasing GA_3 concentration from 0 up to 100 ppm induced significant increase in number of branches per plant at 77 and 98 DAS. However at 119 DAS the number of branches did not reach the level of significance with 50 ppm GA_3 compared to control in both seasons. The difference between the two sprayed concentrations of GA_3 was significant at 77 DAS in both seasons, and at 98 DAS in the first season as well as at 119 DAS in second season. Similar results were previously reported by Akter *et al.* (2007) on mustard plants. They reported that the highest number of branches / plant was found with the application of 75 ppm GA_3.

As to the effect of urea, it is evident that all rates surpassed control. This held true for all growth ages in both studied seasons. In general, the difference between the two rates was not significant in all growth ages in both seasons (except at 98 DAS in first season). These results are generally in agreement with those obtained by Said and Keshta (1999), Sharief and Keshta (2000) and Ali and Hassan (2002) on canola.

The interaction between GA_3 and urea was not significant for all growth ages in both seasons.

3. Shoot dry weight:

Data in Table (2) show that, in both seasons, shoot dry weight increased with increasing plant age up to 119 DAS. Increasing GA_3 concentration from 0 up to 100 ppm significantly increased shoot dry weight at 77, 98 and 119 DAS in both seasons. Similar results were reported by Khan *et al.* (1998 and 2002) and Akter *et al.* (2007) on mustard.

Regarding the effect of urea, results revealed that spraying with urea gave significant increases in dry weight of shoot per plant at all growth ages in both seasons. The difference between the two rates of urea (4 and 8%) was not significant at 77 and 98 DAS in both seasons, and it was significant at 119 DAS in both seasons. These results are in agreement with those obtained by Kandil (1983) on canola. The interaction effect between GA_3 and urea (Table 2) had significant effect on shoot dry weight per plant at all growth ages in both seasons. Highest values for shoot dry weight were recorded at 100 ppm GA_3 combined with 4% urea. Such treatment was not significantly differed with those of 100 ppm GA_3 with 8% urea at all ages in both seasons and 50 ppm GA_3 with 8% urea only at 119 DAS in both seasons.

II- Leaf area index (LAI)

Growth analysis was represented by leaf area index (Table 3). It is clear that in both seasons, LAI increased with increasing plant age from 77 to 98 DAS however, at later age (119 DAS) LAI was decreased. This is mainly due to the production of new leaves and leaves expansion through 77 and 98 DAS. Significant increase in LAI induced by different concentrations of GA_3 was observed in rapeseed plants compared with non-sprayed plants (control). Also, it was found that increasing GA_3 concentration 50 up to 100 ppm did not result in a significant increase in LAI at 77 and 98 DAS of rapeseed growth. Whereas, the difference between these two concentrations proved significant at 119 DAS. In this connection, Anton *et al.* (2001) stated that foliar application of gibberellin to soybean plants tended to increase leaf area.

Increasing the rate of urea from 4 to 8% increased significantly LAI compared with untreated plants at all ages in both studied seasons. The difference between the two rates was significant in all growth ages in both seasons (except at 98 DAS).

The interaction effect between GA_3 and urea had significant effect on LAI at all growth ages in both seasons. The most effective treatment was that of 100 ppm GA_3 with 4% urea which in turn being indifferent with those of 100 ppm GA_3 with 8% urea and 50 ppm GA_3 with 8% urea in most ages of plant growth in both seasons.

Table (3). Leaf area index of rapeseed at 77, 98 and 119 days after sowing as affected by GA_3 and urea in 2004/2005 and 2005/2006 seasons.

Treatment		Leaf area index					
GA_3 ppm	Urea %	77 days		98 days		119 days	
		2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006
0	0	5.19	5.36	9.24	9.53	5.69	5.17
	4	5.78	5.71	10.63	10.75	6.03	6.21
	8	6.65	6.89	11.71	11.77	7.48	7.27
Mean		5.87	5.99	10.53	10.68	6.40	6.22
50	0	6.21	6.45	11.18	11.09	6.26	6.25
	4	7.39	7.53	12.53	13.61	7.55	7.72
	8	8.01	7.91	13.77	13.79	9.66	9.64
Mean		7.20	7.30	12.49	12.83	7.82	7.87
100	0	7.16	7.05	12.99	13.28	7.96	7.60
	4	7.92	7.76	14.85	15.71	10.68	10.06
	8	8.22	8.13	14.27	14.46	9.44	9.76
Mean		7.77	7.65	14.04	14.48	9.36	9.14
General mean of urea	0	6.19	6.29	11.14	11.30	6.64	6.34
	4	7.03	7.00	12.67	13.36	8.09	8.00
	8	7.63	7.64	13.25	13.34	8.86	8.89
LSD (0.05) for:	GA_3	0.79	0.85	1.62	1.75	0.88	0.99
	Urea	0.53	0.56	1.04	1.14	0.59	0.68
	Interaction GA_3 x Urea	0.91	0.96	1.78	1.95	1.02	1.17

III- Yield and yield components:

Results in Table (4) show that increasing the concentration of GA_3 up to 100 ppm resulted in remarkable increases in all yield traits under investigation in both seasons, but the difference between 50 and 100 ppm of GA_3 did not reach the level of significance. The increments due to spraying 100 ppm GA_3 were estimated by 23.7 and 24.6% for number of siliques per plant, 10.1 and 11.0% for 1000-seed weight, 17.1 and 18.7% for seed weight per plant and 12.4 and 12.5% for seed yield per feddan (compared with control) in the first and second season, respectively. These findings could be ascribed to stimulative effect of GA_3 on plant growth and its modification on many physiological processes. Similar results were also reported by Castro *et al.* (1989) and Ghallab and El-Yazal (2006) on canola plants as well as Khan *et al.* (1998 and 2002), Hayat *et al.* (2001) and Akter *et al.* (2007) on mustard plants and Anton *et al.* (2001) on soybean plants.

Table (4). Yield traits of rapeseed as affected by GA_3 and urea in 2004/2005 and 2005/2006 seasons.

Treatment		Number of siliques/plant		1000 /seed weight (g)		Seed weight (g) / plant		Seed yield (kg) /feddan	
GA_3 ppm	Urea %	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006
0	0	426.3	435.7	2.96	2.93	20.74	23.39	1244.6	1403.4
	4	513.7	538.3	3.01	3.12	23.89	27.53	1395.2	1598.5
	8	635.3	649.7	3.28	3.26	29.35	34.61	1609.3	1860.9
Mean		525.1	541.2	3.08	3.10	24.66	28.51	1416.4	1620.9
50	0	544.0	557.3	3.19	3.23	25.49	29.73	1452.2	1667.2
	4	663.3	691.3	3.34	3.39	30.03	35.62	1636.7	1897.4
	8	715.7	740.7	3.38	3.47	31.42	37.48	1702.6	1960.5
Mean		641.0	663.1	3.30	3.36	28.98	34.28	1597.2	1841.7
100	0	572.7	590.3	3.26	3.29	26.17	30.17	1479.8	1678.5
	4	694.3	720.7	3.49	3.55	29.82	36.02	1662.8	1915.6
	8	681.7	712.7	3.43	3.48	30.61	35.29	1631.7	1877.8
Mean		649.6	674.6	3.39	3.44	28.87	33.83	1591.4	1824.0
General mean of urea	0	514.3	527.8	3.14	3.15	24.13	27.76	1392.2	1583.0
	4	623.8	650.1	3.28	3.35	27.91	33.06	1564.9	1803.8
	8	677.6	701.0	3.36	3.40	30.46	35.79	1647.9	1899.7
LSD (0.05) for:	GA_3	57.94	62.18	0.171	0.139	3.27	3.64	122.9	137.4
	Urea	38.69	41.66	0.104	0.085	2.04	2.29	79.5	88.7
	Interaction GA_3 X Urea	66.53	70.59	0.180	0.146	3.51	3.94	136.7	152.6

Regarding the effect of urea, data indicated that spraying any of the two assigned rates (4 and 8%) induced significant promotive effect on all investigated yield traits in both seasons. The best rate in this respect was the relatively high used one. Such treatment induced significant increments of 31.8 and 32.8% for number of siliques per plant, 7.0 and 7.9% for 1000-seed weight, 26.2 and 28.9% for seed weight per plant as well as 18.4 and 20.0% for seed yield per feddan in the first and second season, respectively.

Foliar spraying with urea significantly increased yield and its components of canola due to promotive effect on all growth traits under investigation. Also, urea is readily absorbed by the leaves and not lost through decomposition or leaching from soil. Urea as a nitrogen source is characterized by high percentage of N, high water solubility and is less toxic to plants. Similar findings were reported by Kandil (1983), Ibrahim *et al.* (1989), Noureldin *et al.* (1993 b and 1994 b), Hassan and El-Hakeem (1996), Said and Keshta (1999) Sharief and Keshta (2000) and Ali and Hassan (2002) on rapeseed plants. Likewise, Salwau and Hassanein (1994) and Hassanein *et al.* (1996) reached to similar results on soybean plants. Also, Anton *et al.* (1995) conformed these findings on sunflower plants.

The interaction between GA_3 and urea had significant effect on all yield components and seed yield per feddan. The most effective treatment which gave the highest values of yield and its components (except that of 1000-seed weight) in both seasons was that of 50 ppm GA_3 with 8% urea. Such treatment was not significantly differed with those of 50 ppm GA_3 with 4% urea, 100 ppm GA_3 with 4% urea and 100 ppm GA_3 with 8% urea.

These results are in line with those reported by Anton *et al.* (1995). They found that combined treatment of 90 kg N/fed + 50 ppm GA_3 induced significant increase in seed yield per feddan of sunflower plants.

IV- Seed chemical constituents:

1- Oil content and oil yield:

Data in Table (5) indicate that seed oil content (%) and oil yield (kg/feddan) were significantly increased with increasing GA_3 concentration from 0 up to 100 ppm. The increments attained 4.0% at 50 ppm GA_3 and 8.9% at 100 ppm GA_3 for seed oil content as well as 18.4% at 50 ppm GA_3 and 22.7% at 100 ppm for oil yield per feddan compared with untreated plants. The difference between the two concentrations of GA_3 (50 and 100 ppm) was significant for seed oil content, but for oil yield per feddan did not reach the level of significance. These results are in harmony with those of Anton *et al* (2001). They found that 100 ppm GA_3 increased seed oil content of soybean.

Table (5): Seed oil content and oil yield per feddan of rapeseed as affected by GA_3 and urea in 2005/2006 season.

Treatment		Oil %	Oil yield kg/feddan)
GA_3 ppm	Urea %		
0 ppm	0	44.47	624.09
	4	42.15	673.77
	8	41.03	763.53
Mean		42.55	687.13
50 ppm	0	45.55	759.41
	4	43.85	832.01
	8	43.29	848.70
Mean		44.23	813.37
100 ppm	0	48.69	817.26
	4	45.42	870.07
	8	44.86	842.38
Mean		46.32	843.24
General mean of urea	0	46.24	733.59
	4	43.81	791.95
	8	43.06	818.20
LSD (0.05) for:	GA_3	1.57	56.93
	Urea	1.03	37.58
	Interaction GA_3 x Urea	1.76	64.62

Concerning the effect of urea, results revealed that spraying canola plants with either 4 or 8% significantly decreased seed oil content compared with control. In this connection, Hassan and El-Hakeem (1996) and Sharief and Keshta (2000) stated that increasing N level up to 75 or 90 kg / feddan decreased seed oil content of canola plants. However, oil yield per feddan was significantly increased. Such increase in oil yield per feddan may be due to the increase of seed yield per feddan. Similar results were obtained by Noureldin *et al.* (1993 b and 1994 b), Said and Keshta (1999), Sharief and Keshta (2000) and Ali and Hassan (2002) as well as Abd El-Mottaleb and Hafiz (2006).

The interaction effect between GA_3 and urea proved significant. Highest value for seed oil content was recorded at 100 ppm GA_3. Whereas, maximum oil yield per feddan was obtained when plants were sprayed with 100 ppm GA_3 combined with 4% urea. Such treatment was not significantly differed with those of 100 ppm GA_3 + 8% urea, 50 ppm GA_3 + 4% urea and 50 ppm GA_3 + 8% urea. In this connection, Anton *et al.* (1995) recorded a linear increase in oil yield/feddan with increasing nitrogen rates from 30 up to 90 kg N/feddan under the foliar application of GA_3 at 50 or 100 ppm on sunflower plants.

2- GLC- analysis of fatty acids:

Fatty acid methyl esters of seed of oilseed rape plants as affected by spraying with GA_3 or urea were subjected to gas chromatographic analysis (Figs. 1,2,3,4 and 5). It was possible to detect 11 components of fatty acids in the seed samples. The relative percentage of each detected fatty acid was calculated (Table 6).

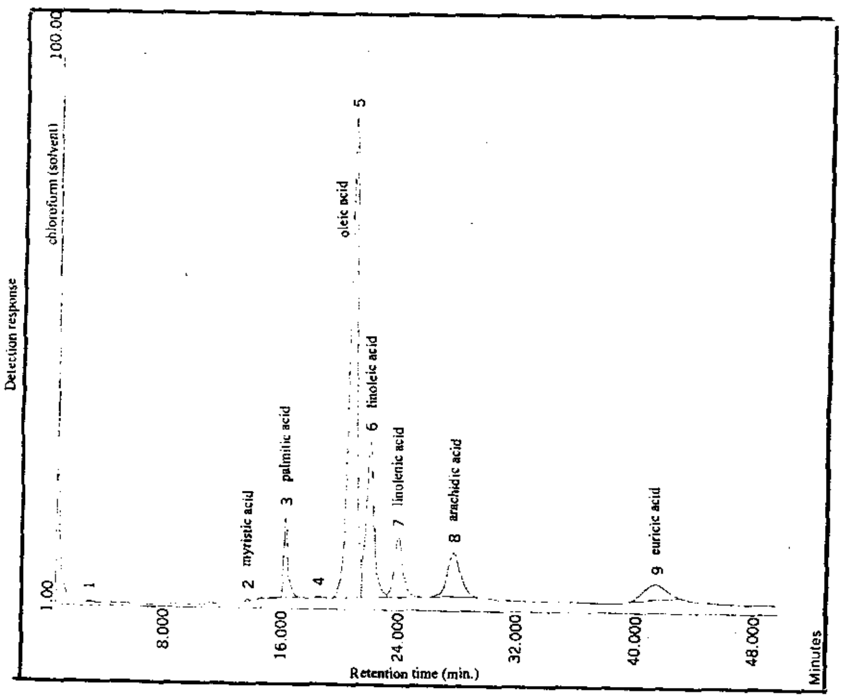

Fig. (1): Gas chromatogram of fatty acid methyl esters of *Brassica napus* L. seeds obtained from untreated plants.

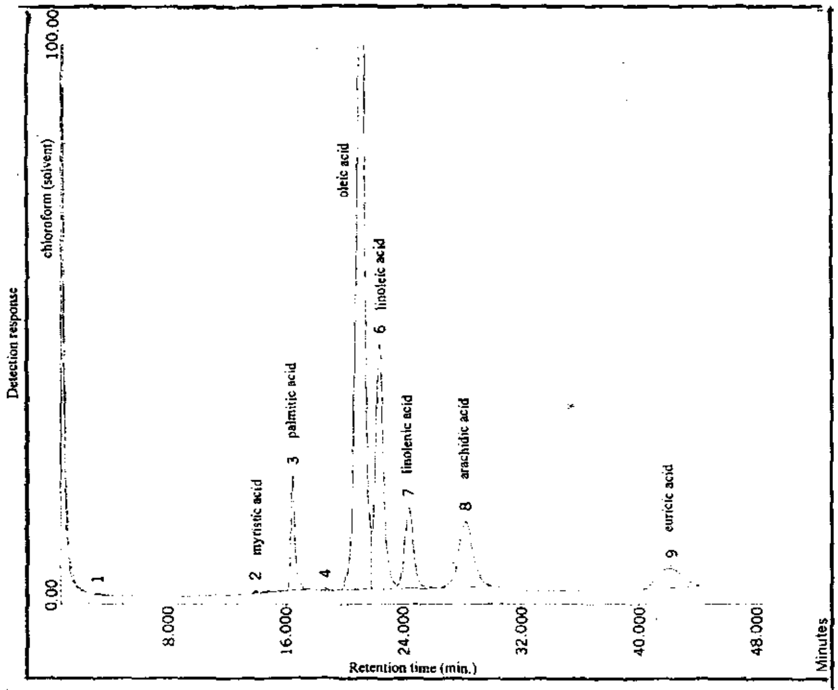

Fig. (2): Gas chromatogram of fatty acid methyl esters of *Brassica napus* L. seeds obtained from plants sprayed with 50 ppm GA_3.

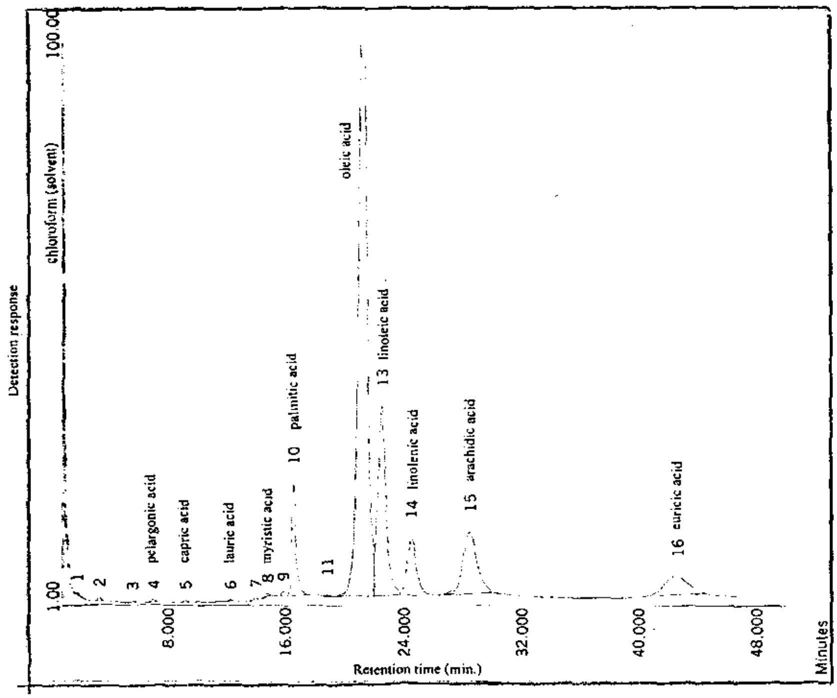

Fig. (3): Gas chromatogram of fatty acid methyl esters of *Brassica napus* L. seeds obtained from plants sprayed with 100 ppm GA_3.

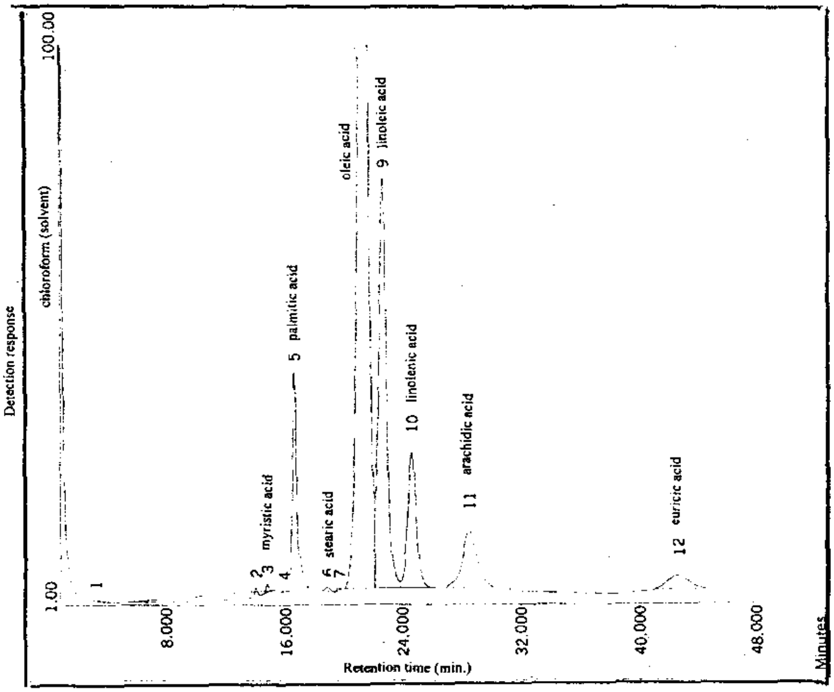

Fig. (4): Gas chromatogram of fatty acid methyl esters of *Brassica napus* L. seeds obtained from plants sprayed with 4% urea.

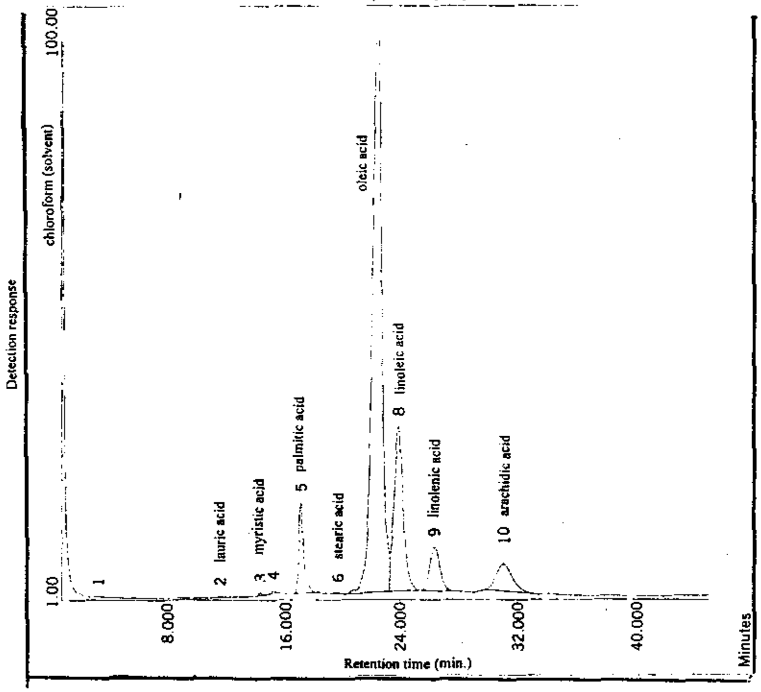

Fig. (5): Gas chromatogram of fatty acid methyl esters of *Brassica napus* L. seeds obtained from plants sprayed with 8% urea.

Table (6): Retention time (Rt) and percentage of each component from fatty acid methyl esters of *Brassica napus* L. seeds obtained from plants sprayed with GA_3 or urea as well as from untreated plants (control)

Components from fatty acids		Rt (min.)	% of each component from fatty acids for the assigned treatments				
			Control	GA_3 (ppm)		Urea (%)	
				50	100	4	8
Pelargonic	(C 9:0)	7.000	-	-	0.102	-	-
Capric	(C 10:0)	9.167	-	-	0.087	-	-
Lauric	(C 12:0)	11.983	-	-	0.056	-	0.026
Myristic	(C 14:0)	13.967	0.080	0.060	0.055	2.036	0.107
Palmitic	(C 16:0)	16.533	5.145	4.933	5.097	6.564	5.208
Stearic	(C 18:0)	19.643	-	-	-	0.048	0.052
Oleic	(C 18:1)	21.217	53.974	53.732	56.828	50.659	66.086
Linoleic	(C 18:2)	22.333	18.891	19.685	17.034	22.840	18.070
Linolenic	(C 18:3)	24.517	7.946	7.329	5.975	8.390	5.130
Arachidic	(C 20:0)	27.750	8.735	9.306	9.534	5.890	5.162
Euricic	(C 22:1)	41.417	4.101	3.830	3.630	1.812	-

Data presented in Table (6) and Figure (1) reveal that oil extracted from seed of untreated plants comprised of seven identified fatty acid methyl esters of which oleic acid (C18:1) came on top, being 53.974% of the total fatty acids of the seed. Linoleic acid (C18:2) came second and comprised 18.891%, followed by arachidic acid (C20:0) with 8.735% and Linolenic acid (C18 : 3) with 7.946%. Two of the other three fatty acids were present in relatively low concentrations, palmitic acid (C16 :0) with 5.145% and euricic acid (C22 : 1) with 4.101%. The rest, myristic acid (C14 :0), was present in traces, being 0.08%. These results are in general agreement with those obtained by Auld *et al.* (1992), Pallot *et al.* (1999), and Ghaleb (2005).

As to the effect of spraying GA_3 (Table 6 and Figs. 2 and 3), it is clear that 50 ppm GA_3 had no effect neither on the components of fatty acids nor on their percentages, although a negligible decrease or increase in the percentage of each component was observed. At the same time, spraying GA_3 at the relatively high used concentration of 100 ppm showed enhancement of oleic acid (the first main component), being 56.828% against 53.974% in control. Moreover, such treatment showed the presence of three fatty acids, in trace percentage, not recorded in control; *i.e.*, pelargonic acid (C9:0) with 0.102%, capric acid (C10:0) with 0.087% and lauric acid (C12:0) with 0.056% .

With respect to the effect of spraying urea (Table 6 and Figs. 4 and 5), it is realized that any of the two assigned rates induced prominent effect on the percentage of each component especially on the first main component (oleic acid).

It is obvious that spraying urea at the rate of 4% decreased the percentage of oleic acid which recorded 50.659% against 53.974% for the control. Also, such treatment induced prominent decreases in arachidic and euricic acids. Arachidic acid recorded 5.89% of the total fatty acids of the seed against 8.735% for the control. Euricic acid recorded 1.812% of the total fatty acids of the seed against 4.101% for the control. By contrast, the other components of fatty acids showed prominent increases in their percentages due to application of 4% urea. Myristic acid, palmitic acid, linoleic acid and linolenic acid recorded percentages of 2.036, 6.564, 22.840 and 8.390%; respectively against 0.080, 5.145, 18.891 and 7.946% for the same fatty acids of the control; respectively. Moreover, such treatment showed the presence of stearic acid in negligible concentration of 0.048% which was not found in the oil of seed obtained from untreated plants.

Worthy to note that, sprayed plants of *Brassica napus* L. with urea at the rate of 8% might produced oil completely free from euricic acid and had higher percentage of oleic acid, being 66.086% against 53.974% for control. The previous report of Ibrahim *et al.* (1989) stated that percentages of fatty acids of rapeseed oil (palmetic, stearic, oleic, linoleic, linolenic, arachidic and euricic) were not significantly affected by nitrogen rates (71, 142 and 213 kg/ha.), being in contradiction with the present findings.

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تأثير الرش بحامض الجبريلليك واليوريا على النمو والمحصول ومحتوى البــذور من الزيت وأحماضه الدهنية للكانولا

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أجريت هذه الدراسة بمحطة التجارب الزراعية بالجيزة – مركز البحوث الزراعية خــلال موسمى شتاء ٢٠٠٤/٢٠٠٥ و ٢٠٠٥/٢٠٠٦ لدراسة تأثير الرش الورقى عند عمــر ٤٠ و ٦٠ يوما من الزراعة بتركيزات صفر و ٥٠ و ١٠٠ جزء فى المليون من حمض الجبريلليك وصفر و ٤ و ٨ % من اليوريا على النمو ودليل مساحة الأوراق والمحصول ومكوناته وبعض المكونــات الكيميائية لبذرة نبات الكانولا صنف باكتول. أشارت النتائج أن توالى زيادة الرش بالجبريللين من صفر حتى ١٠٠ جزء فى المليون أحدثت زيادة معنوية لارتفاع النبات وعــدد الأفــرع للنبــات والوزن الجاف للمجموع الخضرى للنبات ودليل مساحة الأوراق فى الاعمــار ٧٧ و ٩٨ و ١١٩ يوما من الزراعة فيما عدا عدد الأفرع للنبات عند عمر ١١٩ يوما حيث لم تُظهر زيادة معنويــة عند ٥٠ جزء فى المليون جبريللين. كما زاد عدد الثمار الخردلة للنبات ووزن الــ ١٠٠٠ بــذرة ووزن بذور النبات ومحصول الفدان من البذور وكذلك نسبة الزيت فى البذرة ومحصول الفدان من الزيت زيادة معنوية بزيادة تركيز الجبريللين من صفر حتى ١٠٠ جزء فى المليون. كذلك شجعت معاملة الرش بـــ ١٠٠ جزء فى المليون من الجبريللين حدوث زيادة فى نسبة حمــض الأوليــك المكون الرئيسى للأحماض الدهنية (غير المشبعة) حيث وصلت نسبته إلــى ٥٦,٨٢٨% بالبــذرة مقارنة ببذور النباتات غير المعاملة والتى سجلت ٥٣,٩٧٤% حمض أوليك.

بالنسبة لتأثير الرش باليوريا أوضحت النتائج حدوث زيادة ملموسة فى جميع صفات النمو ودليل مساحة الأوراق وصفات المحصول. وكانت أقصى زيادة مصحوبة برش اليوريــا بتركيــز ٨% حيث أدت هذه المعاملة إلى حدوث زيادة معنوية بمقدار ٢٦,٢ و ٢٨,٩% فــى وزن بــذور النبات وبمقدار ١٨,٤ و ٢٠% فى محصول الفدان من البذور فى الموســم الاول والثــانى علــى التوالى. على الجانب الآخر كان هناك نقص فى نسبة الزيت فى بذور النباتات المعاملة باليوريــا على الرغم من حدوث زيادةٍ فى محصول الفدان من الزيت والتى ترجع أصلا إلى الزيادة الحادثة فى محصول الفدان من البذور. ثبت أن رش النبات بمعدل ٨% يوريا أنتج زيتا خاليا من حمــض الاورسيك ذو محتوى عالى من حمض الأوليك حيث وصلت نسبته إلى ٦٦,٨٦% مقارنــة بـــ ٥٣,٩٧٤% حمض أوليك فى بذور النباتات غير المعاملة.

أوضح التفاعل بين الجبريللين واليوريا تحسن معنوى فى جميع الصفات المدروسة وكانت أفضل المعاملات والتى أعطت أعلى القيم هى الرش بتركيز ٥٠ جزء فى المليون جبريللين مــع ٨% يوريا والتى أحدثت زيادة فى محصول الفدان من البذور بمقدار ٣٦,٨ و ٣٩,٧% فى الموسم الاول والثانى على التوالى. لم تختلف هذه المعاملة معنويا عن معاملة الرش بتركيز ٥٠ جزء فى المليون مع ٤% يوريا.