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Response of Two Sunflower Cultivars to Foliar Application of Morphactin CF_{125} and Thiourea

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A FIELD experiment was carried out for two successive seasons during 2005 and 2006 at the Experimental Station of National Research Centre, Shalakan, Kalubia Governorate, Egypt. The effects of morphactin (CF_{125}) at the concentrations of 0.0, 2.5, 5 and 10 mg/l, thiourea at 0.0, 500 and 1000 mg/l and their interactions, on vegetative growth, photosynthetic pigments, yield and its components as well as oil content of two Sunflower cultivars (Erolfor and Vedock) were studied. Vedock cultivar recorded significantly increased growth characters (plant height, stem diameter, number of leaves/plant, leaf area, leaf area index, head diameter total dry weight/plant), photosynthetic pigments, yield and yield components (*i.e.* number of seed/head, seed index, seed yield/plant, seed yield/fed., straw yield/plant, straw yield/fed. and harvest index) as well as oil content compared with Erolfor cultivar at different growth stages.

Foliar application of morphactin up to 5 mg/l or thiourea up to 1000 mg/l had significant effects in increasing vegetative growth. photosynthetic pigments, yield and yield components (i.e. number of seed/head, 100 seed weight, seed yield/plant, seed yield/fed, straw yield/plant, straw yield/fed and harvest index) as well as oil content compared with those of the control at the three physiological growth stages.

Generally, foliar application of morphactin at 5 mg/l and thiourea at 1000 mg/l singly or together were the most effective treatments to get better results in increasing growth characteristics, yield and its components, oil percent and increased total seed yield/fed (1.72, 1.74), straw yield/fed (3.06, 3.12) and oil yield/fed (4.33, 4.30) of these two cultivars. The increase in growth processes associated with these treatments are the consequence of a number of effects on the major physiological processes like photosynthesis.

Keywords : Sunflower cultivars (Erolfor and Vedock), Morphactin CF_{125} , Thiourea, Growth characters , Photosynthesis , Yield , Oil content.

Sunflower plant (*Helianthus annuus* L.) is one of the most important oil crops in the world. It is grown in Egypt mainly for edible oil production. It is used in an attempt to reduce cardiovascular diseases. Some sunflower seeds are rich with oleic acid. Besides, the levels of anti-oxidant (tocopherols) and phytosterols are naturally high in the traditional sunflower oils (Maiti *et al.*, 2005). At the present

time, to face the continuous gap between production and consumption of edible oils, many efforts are being taken to increase the yield of cultivated oil crops either through increasing the cultivated area or by increasing the yield per unit area. This must be supported by numerous studies searching for higher yielding ability, adaptable cultivars and their ideal agronomic needs in each similar area. Using suitable plant growth regulators can help in this respect. Morphactins are new group of synthetic plant growth regulators which have been used in many field crops to control the vegetative growth and reduce the risk of logging by shortening the culm base when applied early (Lovett & Campbell, 1973 and Kust, 1985) or by decreasing the length of upper internodes when applied at late growth stages (Sanvicente *et al.*, 1999). However, higher doses of morphactin inhibited shoots and internodes elongation and resulted in stunted shoots but the inhibition could be counteracted either partly or completely by simultaneous application of gibberellin. On the other hand, thiourea play several bioregulatory roles in crop plants, as the sulfhydryl group has diverse biological activities (Jocelyn, 1972). It involves in phloem transport of sucrose and substrate binding site of the amino acid carrier (Giaquinta, 1977 and Mc Cormick & Johnstone, 1990). Thiourea enhance formation of the ternary complex, sucrose H^+ carrier, thus improving translocation of photosynthate. It increases the photosynthetically active leaf surface during grain filling in cereals. Thiourea stimulates dark fixation of CO_2 in chick pea embryonic (Hernandez *et al.*, 1983).

The uses of morphactin and thiourea to improve growth and yield of various crops have yielded very encouraging results with some plants. Morphactin affected positively stem diameter, fresh and dry weight, number of shoots/plant, photosynthetic pigments as well as seed yield, protein, carbohydrate and oil content of sunflower (El-Bassiouny, 1992 and Koutrobas *et al.*, 2006) and maize plants (Ali *et al.*, 2003 and Amin *et al.*, 2006). Moreover, thiourea significantly increased vegetative growth, protein content and yield of maize (Sahu *et al.*, 1993), onion (Hbdul Hye *et al.*, 2002), clusterbean (Burman *et al.*, 2004 and Garg *et al.*, 2006) and potato (Siemion *et al.*, 2005) via improvement of photosynthetic efficiency and canopy photosynthesis.

Thus, the present work was undertaken to study the effect of spraying sunflower cultivars (Erolfor and Vedock) at elongation stage with morphactin and thiourea, individually or in combination on some morphological criteria, photosynthetic pigments, yield and its components, as well as oil content of seeds.

Material and Methods

Two field experiments were carried out at the Experimental Station of National Research Centre, Shalakan Kalubia Governorate during the two successive seasons of 2005 and 2006. The effects of foliar application of morphactin (CF_{125}), thiourea and their interaction on vegetative growth, photosynthetic pigment content, yield and its component as well as seed oil content of two sunflower cultivars (Erolfor and Vedock) were examined.

The experimental design was split-split-plot design with four replications. Two sunflower cultivars were planted as the main plots, morphactin treatments were allocated at random in sub-plots and thiourea treatments occupied in sub-sub-plots. Plot area was 10.5 m^2 (3.0 m x 3.5 m) and consisted of five ridges 3.5 m in length at 60 cm apart. Seeds of two sunflower cultivars were sown on the May 30^{th} in both seasons in rows and the distance between hills along the row was 15 cm apart. Calcium super-phosphate (15.5 % P_2O_5) was applied at 100 kg/fed to the soil. While, nitrogen fertilizer at 100 kg N/fed as ammonium nitrate (33.5 % N) was applied in two equal doses before the first and second irrigation, respectively.

Sunflower plants were foliar sprayed with morphactin CF_{125} (2-Chloro-9-hydroxyfluorene-9-carboxylic acid) supplied by E-Merck Co., German at the concentration of 2.5, 5 and 10.0 mg /l and/or thiourea at 500 and 1000 mg /l. Interaction treatments of the different concentrations of the two factors were also carried out. Control plants were foliar sprayed with distilled water and the volume of the spraying solution was maintained just to cover completely the plant foliage.

In both seasons, foliar spray of morphactin as well as thiourea were applied at 30 and 45 days from sowing. After 15 days from each spray, photosynthetic pigments content were determined in fresh leaves samples. Growth characters were measured at beginning of flowering stage (50 DAS), seed filling stage (65 DAS) and ripening stage (80 DAS).

Plant growth parameter were recorded in terms of plant height, stem diameter, number of leaves/plant, leaf area (cm^2/plant) according to (Bremner & Taha, 1966), leaf area index (LAI) (Watson, 1952), head diameter (cm) and dry weight/plant (g). At the harvesting time, the mean values of yield and yield characters, i.e., plant height, stem diameter, number of seeds/head, seed yield/plant (g), seed yield (ton/fed), straw yield/plant, 1000-seed weight (seed index g), straw yield (ton/fed), harvest index, oil percentage and oil yield of seeds were determined. Plant samples were dried in an electric oven with drift fan at 70°C for 48 hr till constant dry weight was achieved. Representative fresh samples of seeds were taken from each treatment for determination of oil percentage by Soxhlet apparatus according to A.O.A.C. (1984) and oil yield/fed were calculated. Photosynthetic pigments of fresh leaves; chlorophylls a, b, carotenoides and total pigments were determined and calculated according to Saric *et al.* (1967) at three stages of sunflower growth.

Combined analysis of data for two growing seasons was carried out according to Snedecor and Cochran (1990) and the values of least significant differences (L. S. D. at 5% level) were calculated to compare the means of different treatments.

Results and Discussion

Growth parameters

Data presented in Table 1 show that there was significant difference in plant growth parameters between two sunflower cultivars at different stages of growth. Generally, Velock variety significantly surpassed Eroflor variety in plant height, stem diameter, number of leaves/plant, leaf area (cm^2/plant), leaf area index, head diameter and dry weight/plant (g). The differences in dry matter production may be due to height and thickness of plants, the higher number of leaves as well as leaf area and photosynthetic pigments. This in turn increased the capacity of the dry matter accumulation in different plant parts. It is note worthy to mention that the difference between the two sunflower cultivars confirmed with the results obtained by several researches (Sary *et al.*, 1995; Bader 1998; El-Essawy & Mohamed 1998; Hassanien *et al.*, 2001; Ibrahim *et al.*, 2003 and Galal & Hassanein, 2006).

Foliar application of morphactin up to 5 mg/l at the three physiological stages of growth promoted growth criteria (plant height, stem diameter, number of leaves/plant, leaf area, leaf area index, head diameter and total dry weight/plant) compared to corresponding untreated plants and decreased thereafter. In all cases, the increments in growth parameters were often highly significant in comparison with untreated ones. It could also be observed that morphactin alone caused moderate effects in increasing growth characters, as compared to other applied treatments or the control plants, especially at 5 mg/l. These results were true at different stages of growth. Many investigators suggested that foliar application of morphactin greatly promote the vegetative growth due to increase in the dry matter production through the enhancement of cell division and chlorophyll accumulation of plants like sunflower (El-Bassiouny, 1992), *Vicia faba* L. (El-Masry *et al.*, 1994), *Boronia megastigma* (Day *et al.*, 1994) and maize (Ali *et al.*, 2003). However, growth characters were decreased by increasing morphactin up to 10 mg/l in sunflower plants. Similarly, high concentration of morphactin decreased plant height, number of leaves/plant, dry weight/plant and shoot length of sunflower, soybean and tea plants, respectively (Lord *et al.*, 1985, Bruce 1990 and Mahanta & Sarma 1996).

Furthermore, thiourea was more effective than morphactin treatments in increasing vegetative growth of sunflower plants at the different stages of growth (Table, 1). The increment in growth characters (*i.e.* plant height, stem diameter, number of leaves/plant, leaf area, leaf area index, head diameter and total dry weight/plant) reached its maximum values with 1000 mg/l thiourea treatment compared to control plants. This could be due to the stimulatory effect of thiourea in enhancement of cell division and chlorophyll accumulation, increasing nitrogen uptake. The effect of thiourea in turn reflected in increasing metabolic processed and hence caused an increase in the growth which reflect on the accumulation in the dry matter (Burman *et al.*, 2004, Siemion *et al.*, 2005 and Garg *et al.*, 2006).

TABLE 1. Effect of morphactin and thiourea on growth characters of two sunflower cultivars at different stages of growth (Combined analysis of two seasons).

Treatments (mg /l)		Plant height (cm)			Stem diameter (cm)			Number of leaves plant^{-1}			Leaf area (LA) (cm^2)		
		A	B	C	A	B	C	A	B	C	A	B	C
Eroflor cultivar		80.24	97.70	185.37	1.67	1.89	2.34	17.59	20.53	23.09	708.29	989.36	1253.12
Vedock cultivar		85.65	109.41	196.76	1.74	1.99	2.56	19.21	23.68	26.50	859.86	1131.17	1469.83
LSD at 5%		0.73	0.78	2.51	0.04	0.06	0.11	1.34	1.23	2.43	28.69	59.90	64.50
Morphactin	0.0	79.35	98.78	186.13	1.58	1.78	1.99	17.62	19.96	23.01	715.13	997.66	1232.71
	2.5	83.62	102.92	192.93	1.69	1.98	2.59	19.50	22.46	25.21	861.83	1162.37	1389.26
	5.0	86.94	113.88	197.68	1.82	2.11	2.76	19.76	23.76	26.66	804.67	1047.69	1344.53
	10.0	80.48	96.86	187.96	1. 76	1.89	2.44	18.43	21.98	24.64	694.48	969.10	1157.46
LSD at 5%		0.56	0.76	1.02	0.09	0.07	0.19	0.53	0.35	1.01	47.96	23.86	55.87
Thiourea	0.0	78.99	96.99	186.04	1.60	1.79	2.03	17.90	20.11	23.51	728.18	1027.92	1262.72
	500	82.35	103.34	189.56	1.72	1.94	2.58	18.69	22.64	25.44	822.26	1059.77	1375.40
	1000	87.24	110.29	199.78	1.80	2.09	2.73	19.86	23.78	26.01	847.04	1152.42	1461.86
L.S.D. at 5%		0.97	1.44	1.29	0.11	0.09	0.17	0.44	1.56	1.36	58.09	17.09	34.50

TABLE 1. Cont.

Treatments (mg /l)		Leaf area index (LAI)			Head diameter (cm)			Dry weight (g) plant^{-1}		
		A	B	C	A	B	C	A	B	C
Eroflor cultivar		1.74	2.41	2.69	10.79	16.32	18.09	54.73	103.79	179.90
Vedock cultivar		1.90	2.72	2.88	12.85	17.89	19.43	59.44	119.66	195.45
LSD at 5%		N.S.	0.12	N.S.	1.02	0.67	0.78	1.30	2.43	5.89
Morphactin	0.0	1.73	2.42	2.54	10.64	16.09	17.47	53.08	102.27	180.87
	2.5	1.91	2.76	2.89	11.79	17.34	18.79	59.67	116.36	189.55
	5.0	1.87	2.51	2.83	12.56	17.86	19.53	61.77	119.59	196.69
	10.0	1.82	2.45	2.75	10.95	16.90	17.69	54.94	109.46	184.40
LSD at 5%		0.08	0.07	0.13	0.24	0.62	0.12	1.08	2.76	2.56
Thiourea	0.0	1.72	2.44	2.56	10.68	16.29	17.64	53.63	102.09	180.31
	500	1.84	2.67	2.84	11.79	17.49	18.84	58.29	112.77	186.62
	1000	1.90	2.75	2.89	12.94	17.93	19.68	62.04	120.31	196.07
L.S.D. at 5%		0.05	0.15	0.21	0.39	0.70	0.29	2.01	5.86	5.44

A= Beginning of flowering stage, B= Seed filling stage and C=Ripining stage.

Concerning the interaction between the two sunflower cultivars and morphactin on vegetative growth, significant increases have been obtained in plant height, stem diameter and number of leaves/plant (at different stages of growth), head diameter and dry weight/plant (at 50 and 65 DAS). Moreover, the interaction between two sunflower cultivars and thiourea extensively increases the same mentioned characteristics of growth. The most promising results of growth was obtained in velock cultivar by morphactin treatment at 5 mg/l or thiourea treatment at 1000 mg/l (Tables 4 & 5). Regarding, the combined effect of morphactin and thiourea similar significant increases have been obtained in plant height, stem diameter and number of leaves/plant (at different stages of growth), head diameter, leaf area, leaf area index and dry weight/plant using different concentrations of morphactin and thiourea compared to control plants. Thiourea at 1000 mg/l + morphactin at 5 mg/l was the most effective treatment in enhancing growth parameters (Table 6).

Photosynthetic pigment content

Data presented in Table 2 show that there was a gradual decrease in chl. b, carotenoids and total pigments with increasing age of plant, reaching a minimum value of photosynthetic pigments at 80 DAS after sowing. Generally, there was significant difference in photosynthetic pigments between the two sunflower cultivars; Velock variety was more effective than Eroflor variety in increasing photosynthetic pigments at different stages of growth. Similar results were obtained on sunflower by (Badr, 1998; Hassanein *et al.*, 2001 and Ibrahim *et al.*, 2003).

Foliar spray of sunflower plants with morphactin significantly increased photosynthetic pigments compared to untreated plants at 50, 65 and 80 DAS (Table 2). The highest recorded value of chl a, chl. b, carotenoid and total pigments in sunflower was obtained in leaves of the plants treated with 5 mg/l morphactin. This may be due to stimulation of biosynthesis of chl a at early stages and delay its breakdown at mature stage. Similarly, lower concentration of morphactin stimulated chlorophylls a, b and carotenoids synthesis, while, the higher concentrations had no effect on sunflower plants (El-Bassiouny, 1992 and Ali *et al.*, 2003) .

Furthermore, results achieved indicate that different photosynthetic pigments (chl. a; chl. b, carotenoids as well as total pigments) were significantly increased with increasing applied concentration of thiourea up to 1000 mg/l in the leaves of sunflower plants over their corresponding control at different stages of growth (Table 2). In accordance, Garg *et al.* (2006) found that thiourea at 50 mg/l gave the highest photosynthetic pigments content due to the stimulatory effect on the amount of metabolites synthesized through enhancement of cell division and chlorophyll accumulation which leads to higher rate of photosynthesis.

TABLE 2. Effect of morphactin and thiourea on photosynthetic pigments contents (mg/g dry weight) of two sunflower cultivars at different stages of growth (Combined analysis of two seasons).

Treatments (mg /l)		50 days after sowing				65 days after sowing				80 days after sowing			
		Chl.a	Chl.b	Carotenoids	Total pigments	Chl.a	Chl.b	Carotenoids	Total pigments	Chl.a	Chl.b	Carotenoids	Total pigments
Eroflor cultivar		3.64	2.93	2.69	9.26	4.29	2.79	2.46	9.54	3.09	1.77	1.74	6.6
Vedock cultivar		4.82	3.43	2.89	11.14	4.59	3.51	2.71	10.81	4.39	1.89	1.86	8.14
LSD at 5%		0.08	0.06	0.03	0.08	N.S.	0.09	0.02	0.09	1.01	N.S.	0.02	0.02
Morphactin	0.0	3.56	2.96	2.45	8.97	4.23	2.37	2.27	8.87	3.03	1.19	1.51	5.73
	2.5	4.34	3.28	2.62	10.24	4.46	3.56	2.45	10.47	3.54	1.41	1.71	6.66
	5.0	4.84	4.29	2.99	12.12	5.38	3.96	2.79	12.13	4.34	2.76	2.21	9.31
	10.0	3.91	3.22	2.33	9.46	4.29	2.93	2.39	9.61	3.30	1.47	1.60	6.37
LSD at 5%		0.06	0.07	0.05	0.07	0.03	0.08	0.04	0.08	0.09	0.03	0.04	0.09
Thiourea	0.0	3.43	2.97	2.39	8.79	4.33	2.42	2.05	8.8	2.99	1.06	1.49	5.54
	500	4.53	3.46	2.57	10.56	4.63	3.49	2.49	10.61	3.52	1.43	1.67	6.62
	1000	4.76	4.09	2.95	11.80	4.76	3.69	2.61	11.06	4.27	2.38	1.74	8.39
LSD at 5%		0.09	0.08	0.06	0.08	0.04	0.07	0.05	0.07	0.08	0.04	0.08	0.08

Concerning the interaction between two sunflower cultivars and morphactin on photosynthetic pigments are shown in (Fig. 1). The interaction between two sunflower cultivars and morphactin significantly increased chlorophyll a, chl. b, carotenoids and total pigments at 65 DAS but had no significant effect at 50 and 80 DAS. Morphactin treatment at 5 mg/l in velock cultivar was more effective than in Eroflor cultivar in increasing photosynthetic pigments at 65 DAS.

Moreover, the interaction between morphactin and thiourea significantly increased chlorophyll a, b, carotenoids and total pigments at 65 DAS in sunflower plants but had no significant effect at 50 and 80 DAS. The most effective treatment in increasing photosynthetic pigments was thiourea at 1000 mg/l+ morphactin at 5 mg/l compared to untreated plants (Fig. 2). The accumulation of photosynthetic pigments as a result of these interaction treatments may be due to increase in photosynthetic efficiency as reflected by increase in both chl a, b and carotenoids content in sunflower plants.

Yield and its components

Data presented in Table 3 show that Velock variety significantly surpassed Eroflor variety in different growth parameters (e.g. plant height, stem diameter, number of seeds/head, seed index (g), seed yield/plant (g), seed yield (ton/fed), straw yield/plant, straw yield ton/fed, harvest index, oil percentage and oil yield of seed as compared to their corresponding controls. Similar results on sunflower cultivars were obtained by several other investigators (Hassanien *et al.*, 2001; Ibrahim *et al.*, 2003 and Galal & Hassanein, 2006). Difference in yield and its components between Velock and Eroflor sunflower cultivars may be due to difference in growth characters, photosynthetic pigments partitioning and migration of photosynthate among the plant organs, accumulation of dry matter which in turn reflected on yield and its components (Abd El-Gawad *et al.*, 1988).

Application of morphactin especially at 5 mg/l resulted in the highest increase in yield and its components (plant height, stem diameter, number of seeds/head, seed index, seed yield/plant, seed yield, straw yield/plant, straw yield and harvest index) as compared to their corresponding controls. In support, Hassanien *et al.*, (2001) in sunflower; Ali *et al.*, (2003) and Amin *et al.*, (2006) in maize plants found that low concentration of morphactin increased yield and its components and attributed this to the increasing ability of plants in building metabolites, retardation of senescence and promoting vegetative growth (Zayed *et al.*, 1985; El-Bassiouny, 1992 and Nepalia *et al.*, 1996). On the other hand, morphactin application at 100-200 ppm sharply suppressed vegetative growth and pod formation in *Vicia faba* plants (El-Desoki *et al.*, 1994). The present investigation showed that the most promising results of oil yield/fed obtained by morphactin application at 5 mg/l were due to increase in oil percentage and seed yield. In contrast, morphactin application at 10 mg/l had no effect on oil yield. due to increase in oil percentage and seed yield was decrease (Table 3).

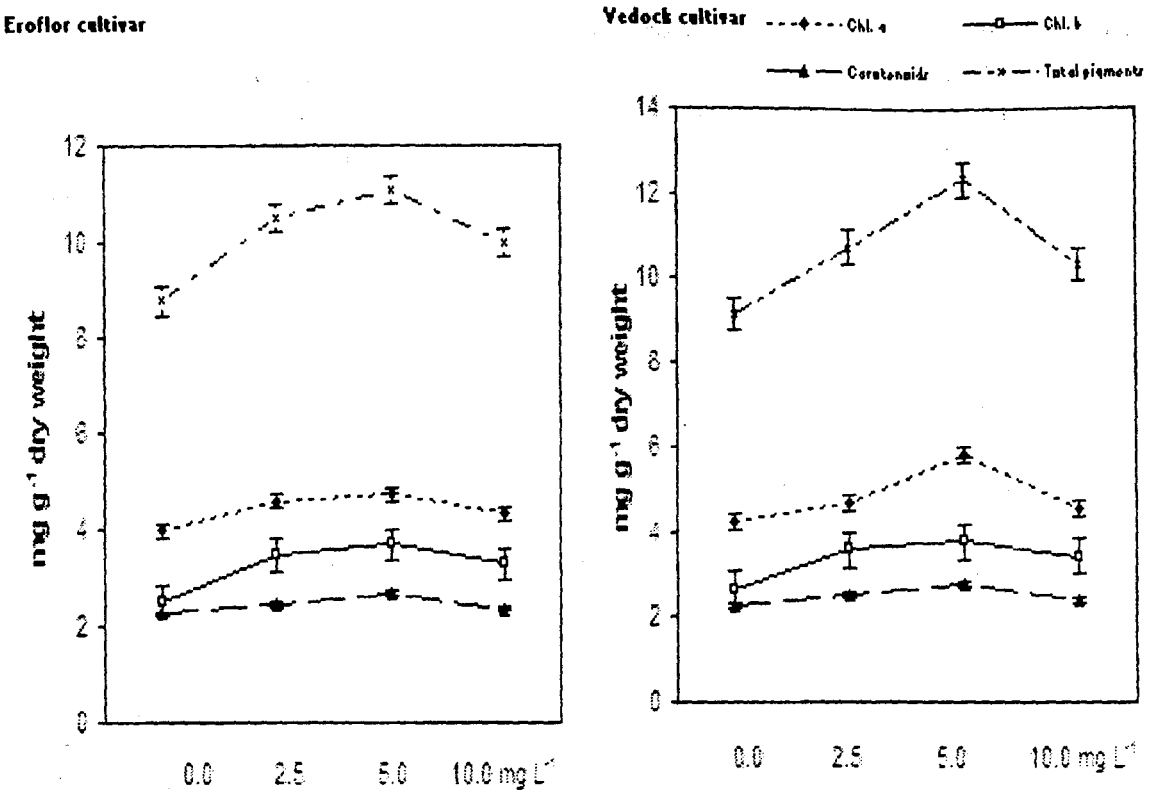

Fig. 1. Effect of interaction of morphactin and two sunflower cultivars on Photosynthetic pigments at 65 days after sowing (Combined analysis of two seasons). Vertical bars represent L.S.D. at 5%.

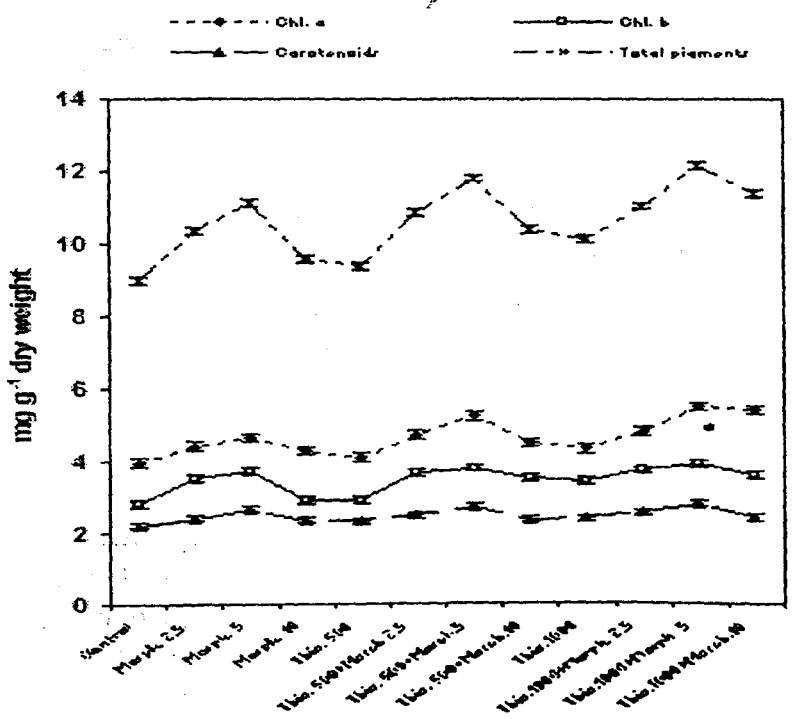

Fig. 2. Effect of interaction of morphactin and thiourea on Photosynthetic pigments of sunflower cultivars at 65 days after sowing (Combined analysis of two seasons). Vertical bars represent L.S.D. at 5% .

TABLE 3. Effect of morphactin and thiourea on yield and its components of two sunflower cultivars. (Combined analysis of two seasons).

Treatments (mg /l)		Plant height (cm)	Stem diameter (cm)	No. of seeds head^{-1}	Seed index weight (g)	Seed yield plant^{-1}	Seed yield (ton fed^{-1})	Straw yield plant^{-1}	Straw yield (ton fed^{-1})	Oil %	Oil yield (ton fed^{-1})	Harvest index
Eroflor cultivar		197.34	2.49	989.98	6.09	65.01	1.08	155.72	2.21	36.90	2.93	0.49
Vedock cultivar		205.01	2.76	1013.22	7.72	76.44	1.59	167.13	2.89	39.47	4.03	0.56
LSD at 5%		2.13	0.20	10.67	0.86	4.56	0.10	3.76	0.13	2.05	0.15	0.03
Morphactin	0.0	196.54	2.46	938.32	5.87	64.89	0.99	149.08	2.23	37.01	2.67	0.44
	2.5	202.72	2.57	1014.49	6.86	69.73	1.48	160.52	2.80	39.36	3.76	0.53
	5.0	207.36	2.78	1056.66	7.97	78.81	1.72	179.49	3.06	39.72	4.33	0.57
	10.0	199.18	2.66	994.92	6.48	67.43	1.09	157.93	2.11	40.65	2.68	0.52
LSD at 5%		2.01	0.05	23.58	0.18	3.22	0.04	2.64	0.15	1.16	0.16	0.06
Thiourea	0.0	195.96	2.49	945.27	5.92	65.05	1.02	143.75	2.29	37.41	2.73	0.46
	500	199.90	2.62	1001.81	6.89	69.43	1.50	156.09	2.57	39.62	3.79	0.59
	1000	205.76	2.76	1057.21	7.99	77.58	1.74	184.76	3.12	40.51	4.30	0.60
L.S.D. at 5%		2.59	0.07	34.51	0.27	3.91	0.15	6.01	0.11	1.66	0.16	0.08

The effect of thiourea on yield and its components (plant height, stem diameter, number of seeds/head, seed index, seed yield/plant, seed yield, straw yield/plant, straw yield, harvest index, oil percentage of seed and oil yield) was significantly increased with increasing thiourea up to 1000 mg/l as compared to their corresponding controls (Table 3). Thus, thiourea enhanced chlorophyll accumulation which leads to higher photosynthetic activity and accumulation of dry matter. It was reflected on the increased translocation and accumulation of certain microelements in plant organs which affected their yield and its components. (*e.g.* head extension, increased seed number and consequently dry weight). Similar results were obtained, using different concentrations and different modes of application (Sahu *et al.* 1993; Sahu & Singh, 1995; Mekki *et al.*, 1999 and Burman *et al.*, 2004).

Furthermore, sunflower yield is far more sensitive to the interaction treatments between two sunflower cultivars (Velock & Eroflor) and morphactin than with thiourea. The higher increase in plant height, stem diameter, number of leaves/plant, head diameter, dry weight/plant, number of seeds/head, seed yield/plant, straw yield/plant and straw yield were recorded in Velock & Eroflor cultivars at 5 mg/l morphactin as compared to their relative controls (Tables 4 and 5).

On the other hand, the interaction between morphactin and thiourea resulted in a general increase in crop growth and yield compared to their relative controls. Observation showed that maximum values were obtained by foliar application with 5 mg/l morphactin + 1000 mg/l thiourea, followed by 5 mg/l morphactin + 500 mg/l thiourea for previous parameters except for leaf area and leaf area index (Table 6).

From the preceding results and discussion, it can be concluded that foliar application of sunflower cultivars with morphactin (up to 5 mg/l) and thiourea (up to 1000 mg/l), individually or their interaction at elongation stage, stimulate the growth of sunflower plants via the enhancement of the biosynthesis of photosynthetic pigments and photosynthetic rate. In addition, it improved yield by increasing seed index, seed yield/plant, seed yield/fed, straw yield/plant, straw yield/fed and oil yield of seeds/fed and thus morphactin and/or thiourea treatments improved the yield of two sunflower cultivars.

TABLE 4. Effect of interaction of morphactin and two sunflower cultivars on growth characters at different stages of growth (Combined analysis of two seasons).

Treatments (mg /l)		Plant height (cm)			Stem diameter (cm)			Number of leaves plant^{-1}			Head diam-eter (cm)	Dry weight (g) plant^{-1}	No. of seeds head^{-1}	Seed yield (g) plant^{-1}	Straw yield (g) plant^{-1}	Straw yield (ton fed^{-1})
Eroflor cultivar		A	B	C	A	B	C	A	B	C	B	A				
Morphactin	0.0	80.96	100.01	187.67	1.49	1.79	2.19	17.79	21.09	23.59	16.47	53.15	969.5	66.53	149.59	0.96
	2.5	82.51	105.62	193.90	1.82	1.98	2.53	18.82	22.86	26.02	17.91	56.26	1018.3	71.24	167.81	1.59
	5.0	84.94	109.43	196.88	1.83	2.05	2.62	18.96	22.97	26.76	18.28	60.73	1039.2	76.50	175.09	1.65
	10.0	79.90	98.26	189..94	1.69	1.89	2.45	16.90	21.90	22.80	17.01	59.48	981.1	67.90	154.16	1.22
LSD at 5%		0.97	0.46	0.76	0.13	0.03	0.07	0.15	0.39	0.32	0.49	0.85	8.46	0.48	2.89	0.20
Vedock cultivar																
Morphactin	0.0	80.28	99.06	186.49	1.52	1.80	2.17	17.85	20.48	23.11	16.93	54.02	959.8	67.61	152.35	1.14
	2.5	83.47	110.29	194.06	1.72	1.96	2.54	18.63	22.69	25.63	17.75	57.46	1027.2	72.09	166.70	1.60
	5.0	85.06	106.01	197.23	1.83	2.10	2.64	19.55	23.78	27.08	18.09	60.34	1043.5	75.49	172.48	1.72
	10.0	79.68	100.22	189.38	1.83	1.92	2.46	18.11	21.86	23.64	17.42	60.01	976.1	68.25	156.09	1.34
LSD at 5%		0.89	0.32	1.82	0.16	0.09	0.08	0.17	0.76	0.36	0.24	1.32	11.06	0.50	2.72	0.16

TABLE 5. Effect of interaction of thiourea and two sunflower cultivars on growth characters at different stages of growth (Combined analysis of two seasons).

Treatments (mg /l)		Plant height (cm)			Stem diameter (cm)			Leaf area (LA) (cm^2)	Leaf area index (LAI)	Dry weight (g) $plant^{-1}$	Seed index (g)	Seed yield (g $plant^{-1}$)	Seed yield (ton fed^{-1})	Straw yield (g) $plant^{-1}$
Eroflor cultivar		A	B	C	A	B	C	B	C	A				
Thiourea	0.0	79.90	98.90	185.21	1.59	1.78	2.18	989.88	2.45	53.90	6.19	65.90	1.11	149.94
	500	82.86	103.96	194.43	1.74	1.97	2.56	1037.07	2.53	58.88	6.89	69.89	1.43	159.60
	1000	85.01	106.89	196.09	1.82	2.06	2.60	1079.78	2.67	60.87	7.39	74.96	1.59	174.38
L.S.D. at 5%		1.56	2.64	3.69	0.10	0.09	0.06	19.62	0.04	3.01	0.28	0.60	0.11	1.39
Vedock cultivar														
Thiourea	0.0	80.12	99.60	186.39	1.60	1.79	2.16	1009.96	2.44	54.24	6.32	66.12	1.19	150.04
	500	83.16	104.34	193.50	1.76	1.98	2.58	1098.48	2.57	57.36	7.13	70.34	1.52	162.35
	1000	86.00	107.69	198.01	1.82	2.09	2.62	1153.06	2.70	62.11	7.42	76.09	1.67	172.08
L.S.D. at 5%		2.76	3.01	4.23	0.11	0.12	0.09	21.37	0.05	2.59	0.44	0.85	0.15	4.89

A= Beginning of flowering stage, B= Seed filling stage and C=Ripining stage.

TABLE 6. Effect of interaction of morphactin and thiourea on growth characters of sunflower cultivars at different stages of growth (Combined analysis of two seasons).

Treatments (mg /l)		Plant height (cm)			Stem diameter (cm)			Number of leaves plant^{-1}		Head diameter (cm)		Leaf area (LA) (cm^2	Leaf area index (LAI)		Dry weight (g) plant^{-1}	Seed yield (g) plant^{-1}	Straw yield (g) plant^{-1}	Straw yield (ton fed^{-1})
Thiourea	Morphactin	A	B	C	A	B	C	B	C	A	C	B	B	C	A			
0.0	0.0	75.53	95.18	183.90	1.49	1.78	2.02	19.87	23.47	9.94	17.59	994.95	1.98	2.34	52.89	65.32	150.12	0.91
	2.5	77.44	103.39	190.90	1.66	1.86	2.29	21.72	24.64	11.25	17.91	1093.49	2.52	2.95	56.02	68.41	156.31	1.29
	5.0	79.89	106.27	195.82	1.80	1.98	2.54	22.89	26.60	11.64	18.64	1042.66	2.34	2.79	59.90	71.50	166.49	1.38
	10.0	72.69	98.49	186.94	1.74	1.90	2.49	20.49	23.72	10.29	18.37	979.59	2.11	2.49	49.55	66.90	153.58	0.96
500.0	0.0	79.96	99.84	186.79	1.56	1.80	2.15	20.85	23.90	10.78	18.52	1007.31	2.19	2.41	53.69	66.87	152.76	0.98
	2.5	82.68	106.46	193.47	1.72	1.89	2.43	22.59	25.51	11.76	19.63	1121.67	2.62	2.99	59.76	72.70	164.66	1.49
	5.0	84.90	110.57	197.60	1.82	2.05	2.64	23.87	26.76	12.80	19.76	1098.55	2.54	2.86	60.84	74.68	175.09	1.59
	10.0	77.93	100.25	189.89	1.80	1.99	2.54	21.90	24.49	11.09	18.69	996.11	2.33	2.57	52.89	68.59	159.58	1.24
1000.0	0.0	85.67	106.29	189.54	1.59	1.83	2.31	21.76	24.01	10.96	19.23	1101.61	2.28	2.44	54.79	67.40	154.49	1.22
	2.5	85.87	109.30	195.72	1.76	1.97	2.49	23.89	26.38	11.84	19.79	1201.03	2.67	3.08	60.90	74.31	167.30	1.59
	5.0	87.98	113.43	199.63	1.83	2.09	2.67	23.94	27.06	12.89	20.19	1136.93	2.59	2.89	62.80	76.26	177.21	1.72
	10.0	80.59	103.45	190.81	1.82	2.06	2.56	22.71	24.37	11.72	19.42	1086.15	2.43	2.60	53.34	69.71	162.39	1.29
LSD at 5%		0.12	1.64	2.01	0.05	0.02	0.14	0.36	0.17	0.22	0.19	0.24	0.08	0.05	1.00	0.83	2.10	0.03

A= Beginning of flowering stage, B= Seed filling stage and C=Ripining stage.

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استجابة صنفين من عباد الشمس للرش بالمورفاكتين و الثيوبوريا

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أجريت تجربتان حقليتان بمحطة البحوث الزراعية للمركز القومى للبحوث بشلقان محافظة القليوبية خلال موسمى ٢٠٠٥/٢٠٠٦ لدراسة تأثير الرش بالمورفاكتين بمعدل ٠,٠ ، ٢,٥ ، ٥ ، ١٠ ملليجرام / لتر و الثيوبوريا بمعدل ٠,٠ ، ٥٠٠ ، ١٠٠٠ ملليجرام / لتر وكذلك التفاعل بينهما على النمو ومحتوى الصبغات النباتية بالأوراق و المحصول ومكوناته وكذلك محتوى الزيت بالبذور لصنفي عباد الشمس ايروفلور و فيدوك و كانت أهم النتائج ما يلي :

- سجل صنف عباد الشمس فيدوك زيادة معنوية لصفات النمو الخضرى المتمثلة فى ارتفاع النبات ، قطر الساق، عدد الأوراق/ نبات ، مساحة الورقة ، دليل مساحة الأوراق ، قطر النورة ، الوزن الجاف/ نبات و محتوى الصبغات النباتية بالأوراق و المحصول ومكوناته (عدد البذور بالنورة ، دليل البذرة ، انتاج البذور للنبات وللفدان ، انتاج القش للنبات وللفدان وكذالك محتوى الزيت بالبذور و دليل الحصاد) مقارنة بصنف عباد الشمس ايروفلور خلال مراحل النمو المختلفة.
- أدى رش نباتات عباد الشمس بالمورفاكتين بتركيز ٢,٥ ، ٥ ملليجرام / لتر خلال مرحلة الاستطالة (٣٠ يوم من الزراعة) إلى زيادة معنوية فى صفات النمو الخضرى ومحتوى الصبغات النباتية بالأوراق والمحصول ومكوناته ثم نقصت بعد ذلك عند تركيز ١٠ ملليجرام / لتر من المورفاكتين خلال مراحل النمو المختلفة. سجل التركيز ٥ ملليجرام / لتر من المورفاكتين افضل النتائج وخاصة بالنسبة لانتاج الزيت بالبذور مقارنة بالكنترول.
- أدت معاملة نباتات عباد الشمس بالتركيزات ٥٠٠ ، ١٠٠٠ ملليجرام / لتر من الثيوبوريا خلال مراحل النمو المختلفة إلى حدوث زيادة معنوية فى صفات النمو الخضرى والصبغات النباتية بالأوراق خلال مراحل النمو المختلفة والمحصول ومكوناته وكذلك محتوى الزيت بالبذور وكانت أفضل النتائج نتيجة رش النباتات بالثيوبوريا بتركيز (١٠٠٠ ملليجرام / لتر) خلال مراحل النمو المختلفة وذلك مقارنة بالكنترول والتركيزات الأخرى.
- كان هناك تأثير معنوى موجب للتفاعل بين المورفاكتين بتركيز ٢,٥ ، ٥ ، ١٠ ملليجرام / لتر والثيوبوريا بتركيز ٥٠٠ ، ١٠٠٠ ملليجرام / لتر خلال مرحلة الاستطالة (٣٠ ، ٤٥ يوم من الزراعة) وكان للرش بالمورفاكتين بتركيز ٥ ملليجرام / لتر والثيوبوريا بمعدل ١٠٠٠ ملليجرام / لتر من أكثر المعاملات كفاءة فى زيادة النمو والمحصول . ومكوناته (قطر النورة ، انتاج البذور للنبات ، والنسبة المئوية للزيت ومحصول الزيت للفدان) والصبغات النباتية لصنفي عباد الشمس ايروفلور و فيدوك وذلك مقارنة بالكنترول والمعاملات الأخرى.