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Response of some Bread Wheat Cultivars to Naphthalene Acetic Acid under Calcareous Soils Conditions

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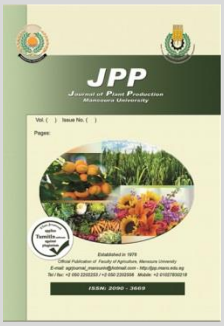

ABSTRACT

Two field experiments were conducted under calcareous soil at Mariout Research Station, Alexandria Governorate during 2018/2019 and 2019/2020. Each experiment was arranged in split plot design with four replicates. The present study investigated the effect of naphthalene acetic acid (NAA) as plant growth regulator, applied as soaking on the yield, its components of yielded grains and quality of bread wheat cultivars under calcareous conditions. Moreover, the study aims to determine suitable concentration of NAA as exogenous treatment to enhance wheat cultivars tolerance to calcareous soils. Grain soaking with five levels of NAA, at (0, 5, 10, 15 and 20 ppm) on three wheat cultivars (Misr -1, Gemmiza- 11 and Giza- 169) and irrigated from artesian well water (1780 ppm). Obtained results showed that increasing of NAA from 5 up to 15 ppm, significantly increased all yield, yield components and protein contents in each growing seasons. Misr- 1 cultivar was superior to Gemmiza-11 and Giza-169, in both seasons. NAA at 20 ppm was recorded as superior than 15 ppm for all yield criteria with Misr-1, in the two seasons. It was observed that 20 ppm concentration of NAA showed better results in enhancing the straw and grain yields of the wheat cultivar, Misr-1 coinciding with producing high yield, yield attributes and protein content under Mariout Region, Egypt. Therefore, the application of NAA, at 20 ppm and Misr-1 on wheat under calcareous soils was more effective of yield, yield components and quality.

Keywords: wheat (*Triticum aestivum* L.), cultivars, grain soaking naphthalene acetic acid (NAA), calcareous soil

INTRODUCTION

In Egypt, New reclaimed lands as a Mariout region which located in northern Egypt near the city of Alexandria Egypt, which was considered the calcareous soils constitute about 25-30% of the total area according to Ministry of Agriculture estimation. The highly calcareous soils in the North Western Coastal Zone (3 million fed.), calcareous soils are identified by the presence of calcium carbonate $CaCO_3$ in the parent material and an accumulation of lime, when these soils contain sodium carbonate, the pH may exceed 9. In some soils, $CaCO_3$ can concentrate into very hard layers, termed caliche, that are impermeable to water and plant roots. It properties related to plant growth, such as soil water relations and the availability of plant nutrients (El-Hady, and Abo-Sedera, 2006). Wheat (*Triticum aestivum* L.) is the most widely grown leading cereal crop in the world (FAO &WFP, 2015) and its demand is increasing as a result of a rise in global population. The International Food Policy Research Institute projected that the world demand for wheat will rise from 552 million tons in 1993 to 775 million tons by 2020, and by a total of 60% by 2050 (Singh *et al*., 2016). It is the most important growing cereal crop although wheat production per unit area of Egypt has significantly increased during the past years, wheat production supplies about 40% of its annual domestic demand (Anonymous, 2007). Therefore, it is very essential to increase wheat productivity. Extending wheat growing outside the Nile Valley is the first effort toward overcoming wheat problems. The world today faces very great challenges as a result of the demand and necessary need for the wheat crop due to the continuous population increase, as during the year 2050 the world population is expected to exceed 9 billion people, so the demand for this crop will increase by 50% (United Nations, 2015). Seed soaking technology with growth regulating substances is considered one of the best methods used to improve seedling emergence and make it regular and occur in short time, as it gives strong, homogeneous and stable seedlings with good and early field stability (AL-Obaidy, 2015), and in recent years, played an important role in controlling seed germination, vegetative growth, flowering and yield of several crop plants (Li *et al*., 2016). Naphthalene acetic acid (NAA) has become commercialized in some countries to increase the productivity of field crops and to fortify the value of horticultural crops, (Jahan *et al*., 2019). The use of growth regulator considered as one of the way of increasing yield. NAA, a synthetic growth regulator has proved its potentiality that in appropriate concentration NAA affects the growth and yield of a number of wheat plants. Reports revealed that application of optimum dose of NAA, had pronounced effect as growth promoter on growth, yield and biochemical processes of major cereal crops viz. rice (Jahan and Adam, 2014), wheat (Jahan and Adam, 2013, Islam and Jahan, 2016) and (Akter, 2016). The objective of the present study was to evaluate the response of bread wheat cultivars grown under calcareous soil conditions. Additional target of this work is to encourage the small farmers to produce this important crop in the deteriorated calcareous soil of North-Coastal Sector in Alexandria with low cost agriculture process.

MATERIALS AND METHODS

Two field experiments were carried out at Mariout, Agricultural Experimental Station of Desert Research Center, Alexandria Governorate, Egypt during 2018/2019

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and 2019/2020 winter seasons. Each experiment was arranged in split plot design with four replicates. Cultivars of wheat (*Triticum aestivum* L) cv., (Misr-1, Gemmiza- 11 and Giza- 169) were used which obtained from the Agricultural Research Center, Giza, Egypt. The grains (500g / L) were pretreated with naphthalene acetic acid soaking for 6 hr., at open air (0, 5, 10, 15 and 20 ppm) and redried to original weight nearly with forced air under shade (Sundstrom *et al*., 1987).Treatments arranged in a split-plot design, cultivars were allocated to main plots, while the grains soaking were allocated to sub-plot. The chemical used in the present work was naphthalene acetic acid (one of the plant growth regulators). The physical and chemical soil characteristics of the studied site were determined according to Klute, 1986, as recorded in Table 1. It was irrigated from artesian well water (1780 ppm), the chemical analysis of irrigation water was carried out using the standard method of Page *et al*., 1982.

Table 1. Some physical and chemical analyses of the experimental site as an average for both seasons

Physical analysis				
Sand (%)	Silt (%)	Clay (%)	Soil Texture	Ca CO_3 (%)
56	21	23	Sandy clay loam	26.1
Chemical analysis				
pH	EC dS/m	Available N (mg /kg)	Available P (mg /kg)	Available K (mg /kg)
8.6	1.2	344.4	3.3	702.4

The area of each plot was 3x4 m= 12 m^2, which contains 20 rows (3 m length, 0-5 m a part). Grains were sown in November 18th, 2018 in the first season and November 14th, 2019 in the second season at grain rates of 60 kg/fed., for both seasons. The recommended cultural practices of growing wheat plant were applied. At harvest, after 160 days, randomized ten plants selected from each plot to determine plant height (cm), No. of tillers /m^2, No. of spikes/m^2, No. of grains/spike, spike length (cm), 1000-grain weight (g), grain yield/fed., straw yield/fed., biological yield/fed., grain protein content and protein yield/fed. from 1 m^2 whereas, tillering index (%) and harvest index (%) were calculated as fallow: tillering index (%) = No. of spikes per m^2 ÷ No. of tillers per m^2 x 100 and harvest index = grain yield ÷ biological yield x 100. In addition, samples were chosen for some chemicals composition, the protein content was determined by multiplying percentage (N x 6.25) according to (Tripath *et al*., 1971) and protein yield (kg/fed.) was determined by multiplying protein percentage x grain yield (kg/fed.). Data were statistically analyzed by using analysis of variances according to Gomez and Gomez, 1984 and means were grouped by LSD test at the 5% probability level.

RESULTS AND DISCUSSION

1- Effect of wheat cultivars difference

Data in Table 2 showed that Misr-1, cultivar was significantly superior to Gemmiza-11, and Giza-169 cultivars in wheat yield and its components in the two growing seasons. These results may be due to the higher in for No. of grains/spike, grain yield (kg/fed.), straw yield (kg/fed.), biological yield (kg/fed.) and harvest index (%) in the two growing seasons, respectively. Also, No. of tillers /m^2, No. of spikes /m^2, tillering index (%), grain protein percentage (%) and protein yield (kg/fed.), No. of grains/ spike, 1000- grain weight (g) and No .of spikes /m^2. Coinciding with these obtained by these results are in agreement with the earlier findings Jahan *et al.* (2019) and Adam and Jahan (2011) who reported that grain yield and yield attributes of wheat were significantly influenced due to genotypes in both seasons. From the previous results, it could be concluded that wheat cultivars under study were variably in previous characteristics during two growing seasons with significant differences. Generally, these varied in the cultivars for previous studied characteristics may be attributed to the different genetically make up which effects on growth habit and response of each one to environmental conditions during the growing seasons.

2- Effect of the grain soaking in naphthalene acetic acid

Results in Table 3 showed that grain soaking in different naphthalene acetic acid concentrations, (0, 5, 10, 15 and 20 ppm) significantly increased all studied parameters; plant height (cm), number of tillers/m^2, number of spikes / m^2, 1000-grain weight (g), grain yield (kg/fed.), straw yield (kg/fed.), biological yield (kg/fed.), tillering index (%), harvest index (%), grain protein content and protein yield (kg/fed.), at 15 ppm NAA as compared with the control treatment in both seasons. Results also show that the maximum increases in the previous parameters were obtained by using 15 ppm naphthalene acetic acid; this may be due to presoaking of wheat (*Triticum aestivum* L.) grains in plant growth regulators before subjection to calcareous soil which increased nutrient uptake and yield. In second season non-significant difference within 15 and 20 ppm concentrations and the lowest values were observed in plots with control for both seasons. These results were accordance with those obtained by (Davies *et al.*, 1987, Aslam *et al*., 2010, Adam and Jahan, 2011, EL-Ghit, 2015 and Islam and Jahan, 2016) they reported that application of NAA at different concentrations effectively increased wheat yield and its components. The application of 100 and 200 mg/L. NAA to *Oryza sativa* (rice) increased grain yield/ plant by 27.67 and 6.85%, respectively, Alam *et al*. (2002) who noticed that NAA at 20 mg/L., enhanced the straw yield and grain yield of wheat cultivars. NAA has been used to enhance the growth and yield of cereals by promoting and improved root system, resulting in more, straighter and thicker roots (Bakhsh *et al*., 2011, Yan *et al*., 2014 and Basuchaudhuri, 2016). Also, Hussain *et al*. (2021) revealed that levels of NAA affected significantly all parameters of sorghum plants under study. Generally, plant growth regulators are one of the most important factors used to induce higher yield in field crops plant growth regulate physiological processes and synthetic. They may enhance the growth and development of field crops thereby increasing total dry mass of field crops.

Table 2. Cultivars differences in bread wheat yield, yield components and quality in two growing seasons under calcareous soils conditions

Cultivars	Plant height (cm)	No. of tillers/m²	No. of spike/m²	No. of grains/ spike	Spike length (cm)	1000-grain weight (g)	Yield			Harvest index (%)	Tillering index (%)	Protein	
							Grain (kg/fed)	Straw (kg/fed)	Biological (kg/fed)			content (%)	Yield (kg/fed)
						2018/2019 season							
Misr-1	88.86	322.37	311.85	46.76	10.12	44.18	2562.1	2908.7	5470.8	46.84	96.73	71.79	84.26
Gemmiza-11	91.14	294.86	286.14	43.40	10.36	49.02	2419.0	2748.4	5167.4	46.82	97.04	71.93	84.49
Giza-169	89.47	307.38	296.63	41.02	9.52	39.74	1927.1	2293.9	4221.0	45.65	96.50	71.08	83.79
L S D at 5%	1.31	11.33	8.94	3.19	0.53	2.55	22.17	27.13	45.33	0.71	0.22	0.113	0.129
						2019/2020 season							
Misr 1	91.34	326.08	320.06	48.33	10.18	46.65	2806.5	2966.4	5773.0	48.62	98.16	73.39	85.78
Gemmiza-11	92.87	307.49	291.49	44.57	10.39	47.13	2442.0	2651.6	5093.6	47.95	94.80	71.38	83.09
Giza-169	91.54	307.26	300.12	40.99	9.67	41.26	2027.5	2247.2	4274.8	47.40	97.68	72.55	85.12
LSD at 5%	1.12	12.02	7.33	2.92	0.61	0.39	19.12	17.55	48.13	0.82	0.13	0.091	0.105

Table 3. Effect of grain soaking in naphthalene acetic acid on bread wheat yield, yield components and quality in two growing seasons under calcareous soils conditions

Naphthalene acetic acid	Plant height (cm)	No. of tillers/m²	No. of spike/m²	No. of grains/ spike	Spike length (cm)	1000-grain weight (g)	Yield			Harvest index (%)	Tillering index (%)	Protein	
							Grain (kg/fed)	Straw (kg/fed)	Biological (kg/fed)			content (%)	Yield (kg/fed)
						2018/2019 season							
Control	89.21	305.58	295.55	43.67	9.98	43.74	2236.4	2512.9	4749.3	47.01	96.72	71.87	84.30
5 ppm	89.50	306.86	296.98	43.75	9.99	44.12	2276.7	2599.6	4876.3	46.63	96.77	71.70	84.24
10 ppm	90.06	308.36	298.17	43.73	10.02	44.13	2299.5	2656.7	4956.3	46.31	96.69	71.51	84.10
15 ppm	90.29	310.29	300.34	43.83	10.01	44.76	2354.0	2746.6	5100.6	46.09	96.81	71.45	84.13
20 ppm	90.07	309.92	299.99	43.65	10.01	44.81	2347.0	2735.8	5082.8	46.14	96.79	71.47	84.13
L S D at 5%	0.25	0.55	0.47	NS	NS	0.06	8.79	12.64	19.37	0.29	0.03	0.03	0.05
						2019/2020 season							
Control	91.78	311.59	302.19	44.63	10.05	44.74	2343.8	2526.5	4870.3	47.92	96.91	72.46	84.73
5 ppm	91.85	314.29	304.08	44.57	10.11	44.90	2433.5	2653.8	5087.3	47.85	96.73	72.29	84.51
10 ppm	91.97	314.45	305.10	44.65	10.09	45.05	2471.1	2666.2	5137.3	48.09	96.99	72.54	84.77
15 ppm	92.17	315.66	305.32	44.64	10.10	45.23	2419.7	2655.6	5015.3	48.02	96.72	72.38	84.55
20 ppm	91.81	312.07	302.77	44.66	10.08	45.16	2458.6	2606.7	5125.3	48.06	96.98	72.53	84.76
L S D at 5%	0.16	1.05	2.64	NS	NS	0.08	12.69	14.55	19.55	0.04	0.19	0.02	0.02

3- Effect of the interaction between bread wheat cultivars and grain soaking in naphthalene acetic acid

Table (4a and 4b), indicated that the interaction between wheat cultivars and grain soaking in naphthalene acetic acid was statistically significant for the yield, yield components and protein content in both seasons, with the presoaking grains of 20 ppm naphthalene acetic acid with Misr-1 wheat cultivar caused an increase in all studied parameters such as plant height (cm), number of tillers/m², number of spikes/m², 1000-grain weight (g), grain yield (kg/fed), straw yield (kg/fed), biological yield (kg/fed), tillering index (%), harvest index (%), grain protein content and protein yield (kg/fed.) as compared with the other treatments in both growing seasons. These effects may be attributed to the protective role of naphthalene acetic acid in plant cells from the oxidative stress induced by salinity. Thus, it can be concluded that though applied naphthalene acetic acid protected the photosynthetic machinery from the damaging effects of calcareous soil. On this respect Jahan *et al.* (2019), revealed that the application of NAA (25 mg L^{-1}) at 20, 35 and 50 DAS were effective for yield and yield attributes of 10 wheat genotypes. It was noted that yield, yield component and quality of wheat significantly affected by the interaction between the two studded factors with different behavior for both seasons of study.

Table 4 a. Effect of the interaction between wheat cultivars and grain soaking by naphthalene acetic acid on bread wheat yield, yield components and quality in the first season under calcareous soils conditions

Cultivars	Naphthalene acetic acid	Plant height (cm)	No. of Tillers /m²	No. of Spikes /m²	No. of grains/ spike	Spike length (cm)	1000-grain weight (g)	Yield			Harvest Index (%)	Tillering index (%)	Protein	
								Grain (kg/fed)	Straw (kg/fed)	Biological (kg/fed)			Content (%)	Yield (kg/fed)
							1st season							
Misr-1	Control	88.32	321.2	308.50	46.61	10.13	43.11	2494.5	2761.5	5256.0	47.46	96.04	12.06	300.89
	5 ppm	88.41	321.50	312.01	46.70	10.09	43.71	2534.1	2849.0	5383.0	47.07	97.05	12.00	304.08
	10 ppm	89.10	322.9	312.71	46.67	10.14	44.22	2557.7	2905.3	5463.0	46.82	96.85	12.25	313.30
	15 ppm	89.40	324.2	313.09	46.86	10.13	44.49	2608.3	2998.8	5607.1	46.52	96.56	12.25	319.48
	20 ppm	89.11	322.07	312.94	46.99	10.14	45.37	2616.0	3029.0	5645.0	46.34	97.16	12.13	317.19
Gemmiza-11	Control	90.52	293.1	282.31	43.45	10.33	48.67	2359.5	2606.5	4966.0	47.51	96.31	11.94	281.65
	5 ppm	90.93	294.8	284.80	43.49	10.35	48.89	2391.1	2701.9	5093.0	46.95	96.62	12.19	291.41
	10 ppm	91.41	295.1	287.09	43.38	10.37	49.09	2427.5	2745.5	5173.0	46.93	97.28	12.44	301.93
	15 ppm	91.65	294.5	288.55	43.53	10.41	49.42	2470.0	2847.2	5317.2	46.45	97.98	12.44	307.21
	20 ppm	91.20	296.8	287.96	43.17	10.37	49.04	2447.0	2841.0	5288.0	46.27	97.01	12.31	301.28
Giza-169	Control	88.80	302.45	295.86	40.96	9.50	39.45	1855.3	2170.7	4026.0	46.08	97.82	11.38	211.01
	5 ppm	89.17	304.3	294.13	41.07	9.55	39.76	1905.1	2248.0	4153.0	45.87	96.65	11.63	221.45
	10 ppm	89.69	307.1	294.71	41.16	9.57	39.08	1913.5	2319.5	4233.0	45.20	95.95	11.88	227.23
	15 ppm	89.83	312.19	299.38	41.12	9.50	40.39	1983.7	2393.9	4377.6	45.31	95.90	11.88	235.56
	20 ppm	89.90	310.9	299.09	40.79	9.52	40.04	1978.0	2337.5	4315.5	45.83	96.21	11.75	232.41
L S D at 5%		0.49	1.41	2.29	2.38	0.05	0.39	19.17	32.15	59.88	1.31	0.51	0.04	6.02

Table 4 b. Effect of the interaction between wheat cultivars and grain soaking by naphthalene acetic acid on bread wheat yield, yield components and quality in the second season under calcareous soils conditions

Cultivars	Naphthalene acetic acid	Plant height (cm)	No. of tillers $/m^2$	No. of spikes $/m^2$	No. of grains/ spike	Spike length (cm)	1000-grain weight (g)	Yield Grain (kg/fed)	Yield Straw (kg/fed)	Yield Biological (kg/fed)	Harvest index (%)	Tillering index (%)	Protein Content (%)	Protein Yield (kg/fed)
							2nd season							
Misr-1	Control	91.35	325.25	318.10	48.085	10.18	45.96	2762.0	2824.0	5586.1	49.45	97.81	11.88	327.99
	5 ppm	91.26	326.62	320.42	48.23	10.19	46.30	2789.4	3013.7	5803.5	48.07	98.11	11.91	332.06
	10 ppm	91.41	326.93	322.30	48.19	10.18	46.94	2832.5	3020.5	5853.4	48.39	98.59	11.94	338.13
	15 ppm	91.34	329.38	320.89	48.29	10.20	46.54	2840.3	2990.7	5831.0	48.71	97.45	12.00	340.86
	20 ppm	91.36	322.26	318.59	48.86	10.19	47.53	2808.7	2983.4	5792.7	48.49	98.86	12.03	337.90
Gemmiza-11	Control	92.65	306.08	288.51	45.14	10.35	47.01	2397.1	2523.0	4920.2	48.72	94.32	12.44	298.13
	5 ppm	92.88	308.86	293.31	44.58	10.42	47.06	2421.2	2715.9	5137.6	47.13	94.97	12.31	298.09
	10 ppm	92.91	308.23	292.18	44.54	10.38	47.41	2472.5	2714.5	5187.4	47.67	94.79	12.38	305.97
	15 ppm	93.55	308.44	293.25	44.54	10.45	47.45	2472.6	2692.5	5165.8	47.87	95.08	12.45	307.52
	20 ppm	92.37	305.88	290.23	44.05	10.39	46.76	2446.7	2612.3	5059.4	48.36	94.88	12.38	302.76
Giza-169	Control	91.34	303.45	299.97	40.67	9.64	41.25	1872.5	2232.6	4105.1	45.61	98.85	11.50	215.34
	5 ppm	91.43	307.39	298.51	40.90	9.72	41.36	2090.1	2231.9	4322.0	48.36	97.11	11.88	248.19
	10 ppm	91.6	308.21	300.82	41.24	9.71	40.81	2108.3	2263.7	4372.4	48.22	97.60	11.88	250.38
	15 ppm	91.63	309.18	301.84	41.09	9.66	41.70	2066.4	2283.7	4350.6	47.50	97.64	11.94	246.63
	20 ppm	91.71	308.08	299.50	41.08	9.66	41.19	2000.5	2224.5	4225.7	47.35	97.22	11.94	238.81
L S D at 5%		0.49	1.99	2.41	3.12	0.33	0.81	49.15	39.20	71.18	1.88	0.91	0.05	0.03

CONCLUSION

The findings of a two-years study revealed that the application of NAA (20 ppm) was effective for yield and yield attributes and protein content than the control plot, *i.e*., 0, NAA among the three tested cultivars. Maximum yield and yield attributes was obtained in Misr-1 cultivar when NAA was applied at 20 ppm under Mariout Region, Egypt. Therefore, the application of NAA at 20 ppm and Misr-1 on wheat under calcareous soils was more effective of yield, yield components and quality.

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إستجابة بعض أصناف قمح الخبز لنفثالين حمض الخليك تحت ظروف الأراضى الجيرية

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تم إجراء تجربتين حقليتين بمحطة بحوث مريوط التابعة لمركز بحوث الصحراء بمحافظة الإسكندرية خلال الموسمين الزراعيين ٢٠١٨/٢٠١٩ & ٢٠١٩/ ٢٠٢٠ لدراسة تأثير نقع حبوب القمح بنفثالين حمض الخليك لمدة ست ساعات بالماء العادى بمعدل (٥, ١٠, ١٥ و ٢٠ جزء فى المليون) مقارنة بدون نقع على ثلاث أصناف من القمح (صنف مصر-١ وجميزة-١١ و جيزة-١٦٩) والتي تم ريهم بماء بئر تصل درجة ملوحته 1780 جزء في المليون و تأثير ذلك على الإنتاجية والبروتين لحبوب القمح تحت ظروف الأراضى الجيرية. وقد صممت التجربة بنظام القطع المنشقة مرة واحدة حيث وضعت الأصناف فى القطع الرئيسية بينما وزعت مستويات نفثالين حمض الخليك على القطع الفرعية وأوضحت الدراسة النتائج الأتية: اعطت التركيزات العالية من نفثالين حمض الخليك بالنقع بتركيز ١٥ و٢٠ جزء فى المليون زيادة معنوية فى المحصول ومكوناته وكذلك البروتين فى حبوب القمح فى كلا الموسمين.أعطى صنف القمح مصر-١ أعلى إنتاجية للمحصول ومكوناته حيث تفوق فى عددالحبوب للسنبلة، ومحصول الجبوب (كجم للفدان)، ومحصول القش (كجم للفدان)، والمحصول البيولوجى (كجم للفدان) ودليل الحصاد (%) وأيضا البروتين فى الحبوب مقارنة بصنفى جميزة-١١ و جيزة-١٦٩ فى كلا الموسمين.أعطى صنف القمح مصر-١ والذى تم نقع حبوبه بنفثالين حمض الخليك بمعدل ٢٠ جزء فى المليون زيادة معنوية فى المحصول ومكوناته وكذلك البروتين فى حبوب القمح فى كلا الموسمين.اظهر البحث وجود إستجابة واضحة لإستخدام نفثالين حمض الخليك فى الأراضى الجيرية وذلك بالنقع لحبوب القمح بتركيز ٢٠ جزء فى المليون فى هذه المناطق وبالتالى زيادة الإنتاجية للمحصول.أوصت الدراسة بأنه عند زراعة محصول القمح صنف مصر-١ وخصوصا في بداية مراحل نموه يفضل معاملة حبوبه بنفثالين حمض الخليك بالنقع بمعدل ٢٠ جزء فى المليون تحت الظروف المماثلة لمنطقة مريوط (شمال الاسكندرية -مصر) لما له من أهمية فعالة في تحمل محصول القمح لظروف الأراضى الجيرية لنطاق معين في مراحل حياته الأولى.