IMPACT OF SEEDS SOAKING AND SEEDING DATES ON YIELD AND IT'S COMPONENTS OF SORGHUM

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ABSTRACT

A field experiment was carried out during spring and fall seasons of 2021 at the experimental field of Al-Hamidhyia research station -College of Agriculture - University of Anbar to investgate the effect of variety, soaking with atonik and seeding dates on yield and its components of sorghum. the experiment was carried out using RCBD, within split-split plots arrangement with 3 replications. The main plots included three seeding dates for spring season (15/3, 1/4 and 15/4) and three seeding dates for the fall season (1/7, 10/7 and 20/7), while sub plots included seeds soaking with three concentrations of Atonik(0, 2.5 and 5 mlL^{-1}), whereas the sub-sub plots included three varieties of Sorghum bicolor (Inqath, Lilo and Giza 113). The results showed that the Inqath variety was significantly superior in the studied traits and gave highest grain yield (4.70 and 5.70 ton ha^{-1}) for both seasons produsedSoaking seeds with Atonik had a significant effect on the studied traits; the highest concentration (5 ml L^{-1}) was significantly superior and achieved a highest grain yield (4.79 and 5.36 tons ha^{-1})for both seasons respectively. Seeding dates significantly affected the studied traits.

Keywords: Atonik, seed soaking, grain weight, growth regulator.
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مجلة العلوم الزراعية العراقية- 2024:55(5):1687-1697 مرير ونهاد

تأثير نقع البذور ومواعيد الزراعة في الحاصل ومكوناته للذرة البيضاء

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المستخلص

نفذت تجربة حقلية في حقل التجارب التابع لكلية الزراعة/جامعة الانبار(محطة ابحاث الحامضية) وذلك خلال الموسمين الربيعي والخريفي لعام 2021.صممت التجربة بهدف دراسة تأثير الصنف ونقع البذور ومواعيد الزراعة في حاصل الحبوب ومكوناته للذرة البيضاء.استعمل تصميم R.C.B.D بترتيب الالواح المنشقه– المنشقة وبثلاث مكررات اشتملت الالواح الرئيسيه على ثلاثة مواعيد للزراعة الربيعية(3/15و 4/1 و 4/15) وللعروة الخريفية (7/1 و 7/10 و7/20) والالواح الثانوية اشتملت على ثلاثة تراكيز نقع البذور قبل زراعتها (0 و 2.5 و 5 مل.لتر$^{-1}$).اما الالواح تحت الثانوية فشملت ثلاثة اصناف من الذرة البيضاء (انقاذ و ليلو و جيزة 113). اثرت عوامل الدراسة معنويا في الصفات المدروسة اذ نفوق الصنف انقاذ في الصفات المدروسة وسجل اعلى حاصل حبوب (4.70 و 5.70) طن بالهكتار لكلا العروتين بالتتابع, كان لنقع البذور بالاتونيك تأثير معنوي في الصفات المدروسة, وتفوق المستوى الاعلى 5 مل لتر–1 بأعلى حاصل حبوب بلغ 4.79 و 5.36 طن هـ$^{-1}$ لكلا العروتين بالتتابع.

الكلمات المفتاحية: اتونيك, نقع البذور, وزن الحبة, منظم نمو.
***البحث جزء من اطروحة دكتوراه للباحث الاول.**

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INTRODUCTION

Sorghum crop (*Sorghum bicolor* (L.) Moench) is an important cereal crop, as it constitutes a main food for the inhabitants of the dry and semi-arid regions of the world. It is ranked fifth among the most important cereal crops in the world, and ranks second in biofuel production, it could be used as a substitute for petroleum (11). More than 40% of the global production of sorghum is used for human nutrition, me to its flour, free of gluten, therefore it is an alternative for those who suffer from gluten sensitivity. Also, its glycemic index is low, thus it is suitable for diet and diabetics in addition to its importance as an antioxidant (17). Sorghum crop is characterized by its tolerance of environmental conditions that aren't suitable for the production of other summer crops (maize and soybeans), especially temperature, drought and soil salinization, as it is called "Crop Camel". More than 80% of the sorghum cultivation areas are described as low productivity and contribute a little more than half of the world production, while the cultivation areas located within the developed countries produce the rest of the world production. Despite the importance of sorghum, its cultivation areas witnessed a noticeable decline by an estimated 0.15 million hectares annually, starting from the mid-eighties, which was the peak of its production until recently (14), as the climate changes such as soil salinity, lack of irrigation water, high temperatures and drought negatively affect seed germination, plant performance, biochemical processes and then productivity. Therefore, it is necessary to study those obstacles and develop appropriate solutions by studying seeding dates to choose the appropriate date for seeding, as well as treating the weak of seed germination using technique of soaking the seeds with environmentally safe materials, cheapness and high efficiency.The aim of this study was to investigate which varieties have the best yield under the influence of seeding dates and soaking the seeds with the Atonik nutrient solution.

MATERIALS AND METHODS

A field experiment was carried out during spring and fall seasons of 2021at the experimental field of Al-Hamidhyia research station -College of Agriculture - University of Anbar to knowledge the effect of variety, soaking with atonik and seeding dates on yield and its components of sorghum. The experiment was carried out in RCBD with split-split plots arrangement using three replications. The main plots included three seeding dates for spring season (15/3, 1/4 and 15/4) and three seeding dates for the fall season (1/7, 10/7 and 20/7), while sub plots included seed soaking with three concentrations of Atonik (0, 2.5 and 5 mlL^{-1}), whereas the sub-sub plots included three varieties of sorghum (Inqath, Lilo and Giza 113). Soil management were carried out, and then the experiment land was divided into 81 experimental units, the experimental units area was 7.5 m^2 (2.5 m x 3 m), each experimental unit included 5 rows, 50 cm apart, and 25cm within the rows, reach a plant density of 80000 plants ha^{-1}.Phosphorous fertilizer was added with an average 100 Kg P ha^{-1} as a triple super phosphate (46% P_2O_5) at one dose before the seeding, while the nitrogen fertilizer was added with an average 200 kg N ha^{-1} as a urea (46% N) at three doses, the first at the seeding time, the second after 21 days of the first dose and third at the flowering stage. The seeds of sorghum varieties were soaked with Atonik nutrient solution according to the mentioned concentrations for a 8 hours and were sown according to the seeding dates under study. Crop management was carried out as needed, and the plants were harvested after the appearance of maturity signs.

Studied traits

1. Grain filling period (day): The grain filling period was calculated from 90% of flowering until physiological maturity.

2.Number of grains per head: The number of grains per ten heads randomly taken from each experimental unit at the harvest stage was calculated using Automatic grains counterand its mean was extracted.

3. Weight of 500 grains (g): five hundred grains were randomly taken from the grain yield of each experimental unit; weighed using a sensitive electronic scale and the mean of 500grains weight was extracted.

4. Grain yield (ton ha^{-1}): It was estimated by randomly harvesting the heads of ten plants from each experimental unit; discarded and

cleaned of impurities and then the grain yield was calculated by multiplying the mean of grains yield of the ten heads by the plant density and the results were converted to ton per hectare.

5. Biological yield (ton ha^{-1}): Ten plants were randomly harvested from each experimental unit, air-dried in the spring season and oven-dried in the fall season, weighed by a sensitive electronic scale, then the biological yield was calculated by multiplying the mean of plant dry weight of the ten plants by the plant density and the results were converted to ton per hectare. The data were statistically analyzed using Genstat program, and least significant difference (LSD) test at 0.05 probability level was used to compare the treatment means.

RESULTS AND DISCUSSION

Grain filling period (day): The results in Table (1) indicate that the sorghum varieties were significantly differed in grain filling period, Inqath variety gave the highest means (37.36 and 33.29 days) compared with Giza 113 variety which gave the lowest means (37.36 and 33.29 days) for both seasons respectively.The reason of differences may could be due to the different genetic variances of the varieties, which was reflected on their response to the environmental conditions that accompany the stages of plant growth and development, and then their differences in the duration of the grain filling. This result is in line with of (2). The results in Table (1) show that the time required to filling the grains was significantly increased by increasing the concentrations of Atonik, as the plants whose seeds were soaked at a 5 ml L^{-1} recorded the longest period for grain filling (40.66 and 35.81 days) compared with control treatment(seeds soaking with distilled water only) which recorded the shortest period (36.85 and 32.55 days) for both seasons respectively. The reason of increases could be due to the role of Atonik in increasing the ability to absorb and the transfer of important nutrients from the sources to the sinks, as well as the continued supply of sources, which increases the plant's ability to an increase the period of grains filling (16). The results in Table (1) reveal that the seeding dates were significantly differed in the grain filling period, the second date (1/4) for the spring season and the first date (1/7) for the fall season achieved the longest period for grain filling (43.33 and 35.00 days) respectively compared with the first date (15/3) for the spring season and the third date (20/7) for the fall season which recorded the shortest period (30.84 and 32.32 days) respectively. The reason for this could be due to the variation in the duration of illumination during seeding dates, which leads to a delay in physiological maturity. Also, high temperatures accelerate growth processes and then shorten plant life (1). The di-interaction between varieties and concentrations of Atonik had a significant effect on this trait (Table 1); the Inqath variety whose seeds were soaked at a 5 ml $L^{-1}$of Atonik recorded the highest values (41.89 and 36.44 days), while the Giza 113 variety whose seeds were soaked with distilled water only recorded the lowest values (35.44 and 31.11 days) for both seasons respectively. The di-interaction between varieties and seeding dates had a significant effect on this trait (Table 1) The Inqath variety whose seeds were planted in the second date (1/4) for the spring season and the first date (1/7) for the fall season achieved the highest values (44.55 and 36.20 days),whereas the Giza 113 variety whose seeds were planted in the first date (15/3) for the spring season and the third date (20/7) for the fall season achieved the lowest values (29.66 and 31.77 days) respectively.

Table 1. Effect of cultivars, seed soaking concentrations with Atonik and seeding dates on grain filling period (day)for sorghum, for the spring and fall seasons

Seeding Dates	Atonik Conc ml L^{-1}	Spring season Cultivars			Seeding date Atonik×	Fall season Cultivars			Seeding date Atonik×
		Inqath	Lilo	Giza		Inqath	Lilo	Giza	
1st date	0	29.67	29.67	27.33	28.89	34.33	33.00	32.33	33.22
	2.5	33.67	31.33	30.00	31.67	36.00	34.67	35.00	35.22
	5	33.00	31.33	31.67	32.00	38.33	36.67	34.67	36.56
2nd date	0	42.00	42.67	38.33	41.00	32.67	32.67	30.67	32.00
	2.5	45.00	42.67	41.33	43.00	37.00	36.00	35.00	36.00
	5	46.67	45.67	45.67	46.00	37.00	37.33	36.67	37.00
3rd date	0	40.67	40.67	40.67	40.67	32.67	34.33	30.33	32.44
	2.5	42.33	41.00	40.00	41.11	33.67	35.67	31.67	33.67
	5	46.00	44.67	41.33	44.00	34.00	34.33	33.33	33.88
L.S.D %5			N.S		5.07		N.S		1.64
					Conc. mean				Conc. Mean
×Conc cultivar	0	37.44	37.67	35.44	36.85	33.22	33.33	31.11	32.55
	2.5	40.33	38.33	37.11	38.59	35.55	35.44	33.89	34.96
	5	41.89	40.55	39.55	40.66	36.44	36.11	34.89	35.81
L.S.D %5			2.02		1.02		N.S		0.94
					Date mean				Date mean
Seeding ×Date Cultivar	1st date	32.11	30.77	29.66	30.84	36.22	34.78	34.00	35.00
	2nd date	44.55	43.67	41.77	43.33	35.55	35.33	34.11	34.99
	3rd date	43.00	42.11	40.66	41.92	33.44	34.77	31.77	33.32
L.S.D%5			5.17		5.05		1.94		1.29
Cultivar mean		39.88	38.85	37.36		35.07	34.96	33.29	
L.S.D%5			1.27				1.19		

Also, The di-interaction between concentrations of Atonik and seeding dates had a significant effect on this trait (Table 1); the soaked seeds at a 5 ml $L^{-1}$of Atonik and planted in the 1/4 and 1/7 for the spring and fall seasons respectively gave the highest values (46.00 and 37.00 days), while the soaked seeds with distilled water only and planted in the 15/3 and 10/7 for the spring and fall seasons respectively had the lowest values (28.89 and 32.00 days) respectively. The tri-interaction between the studied factors did not significant effect on the grain filling period.

Number of grains per head

The results in Table (2) reveal that the Inqath variety was significantly superior and achieved the highest means of number of grains per head (2569 and 2852 grain $head^{-1}$) compared with other varieties for both seasons respectively. The difference of varieties in this trait could be due to the differences in their genetic composition. In this context, Essa (12) indicated that the plant could be setting and ripen grains that it can equip with the products of photosynthesis. This result is in line with Abood and Abdulhameed (3). The results in Table (1) indicate that the plants whose seeds were soaked at a 5 ml $L^{-1}$of Atonik was significantly superior and gave the highest means of this trait (2565 and 2670 grains $head^{-1}$) compared with control treatment which gave the lowest means (2090 and 2293 grain $head^{-1}$) for both seasons respectively. The reason of superiority of the higher concentration of Atonik (5 mL L^{-1})could be attributed to an increase the products of photosynthesis and its transfer to the sinks (grains).The results in Table (2) show that the seeding dates were significantly differed in the grain number per head, the second date (1/4) for the spring season and the seconddate (10/7) for the fall season recorded the highest means (2732and 2659 grain $head^{-1}$) respectively compared with the first date (15/3) for the spring season and the third date (20/7) for the fall season which recorded the lowest means(1786and 2397 grains $head^{-1}$) respectively. The reason of the increase could be due to the appropriate

climatic conditions during the pollination and fertilization period, which helped to an increases the number of mature grains.These results are in agreed with Ahmad and Abood (5). The di-interaction between varieties and concentrations of Atonik had a significant effect on this trait (Table 2); the Inqath variety whose seeds were soaked at a 5 ml $L^{-1}$of Atonik gave the highest values (2767and 3033 grains $head^{-1}$),whereas the Giza 113 variety whose seeds were soaked with distilled water only had the lowest values (1933 and 2004 grain $head^{-1}$) for both seasons respectively. The di-interaction between varieties and seeding dates had a significant effect on this trait (Table 2); the Inqath variety whose seeds were planted in the second date (1/4 and 10/7) for the spring and fall seasons respectively recorded the highest values (2954 and 3007 grain $head^{-1}$) respectively, while the Lilo variety whose seeds were planted in the first date (15/3) for the spring season and Giza 113 variety whose seeds were planted in the third date (20/7) for the fall season recorded the lowest values (1781and 2103 grains $head^{-1}$) respectively. Also, The di-interaction between concentrations of Atonik and

Table 2. Effect of cultivars, seed soaking concentrations with Atonik and seeding dates on number of grains per head for sorghum, for the spring and fall seasons

Seeding Dates	Atonik Conc ml L^{-1}	Spring season				Fall season			
		Cultivars			Seeding ×date Atonik	Cultivars			Seeding date Atonik×
		Inqath	Lilo	Giza		Inqath	Lilo	Giza	
1st date	0	1610	1513	1540	1554	2544	2248	1910	2234
	2.5	1967	1838	1702	1835	2956	2563	2112	2543
	5	2071	1994	1851	1972	3040	2696	2162	2632
2nd date	0	2586	2436	2123	2381	2800	2379	2102	2427
	2.5	3108	2865	2675	2882	3008	2617	2475	2700
	5	3168	2897	2737	2934	3213	2804	2535	2850
3rd date	0	2506	2363	2137	2335	2529	2129	2001	2219
	2.5	3047	2541	2645	2744	2740	2477	2119	2445
	5	3064	2663	2646	2791	2848	2546	2191	2528
L.S.D %5			577.1		562.8		N.S		695.7
					Mean conc				Mean conc
×Conc cultivar	0	2234	2104	1933	2090	2624	2252	2004	2293
	2.5	2707	2414	2340	2487	2901	2552	2235	2562
	5	2767	2518	2411	2565	3033	2682	2296	2670
L.S.D %5			216.1		203.2		680.9		275.2
					Mean date				Mean date
Seeding ×Date Cultivar	1st date	1882	1781	1697	1786	2846	2502	2061	2469
	2nd date	2954	2732	2511	2732	3007	2600	2370	2659
	3rd date	2872	2522	2476	2623	2705	2384	2103	2397
L.S.D%5			324.9		233.5		559.8		283.5
Mean cultivar		2569	2345	2228		2852	2495	2178	
L.S.D%5			187.6				119.6		

seeding dates had a significant effect on this trait (Table 2); the soaked seeds at a 5 ml L^{-1} of Atonik and planted in the second date(1/4 and 1/7) for the spring and fall seasons respectively achieved the highest values (2934 and 2850 grains $head^{-1}$), whereas the soaked seeds with distilled water only and planted in the first date (15/3) for the spring season and the third date (20/7) for the fall season achieved the lowest values (1554 and 2219 grain $head^{-1}$) respectively. The tri-interaction between the studied factors had a significant effect on the this trait in the spring season only (Table 2); the Inqath variety whose seeds were soaked at a 5 ml $L^{-1}$of Atonik and planted in the1/4 gave a highest value (3168 grain head-

^{1}), while the Lilo variety whose seeds were soaked with distilled water only and planted in the 15/3 gave a lowest value (1513grains head^{-1}).

Weight of 500 grains (g)

The results in Table (3) show that the Giza 113 variety was significantly superior and achieved the highest means of 500 grains weight (14.97 and 16.70 g) compared with Inqath variety which achieved the lowest means (14.24 and 14.32 g) for both seasons respectively. The reason of variation could be due to the different genetic variation of the varieties and their suitability to environmental conditions, as the weight of the grain is a function of the photosynthesis rate. This result is in line with Bughdady (9) and Gebrekorkos et al., (13). The results in Table (3) reveal that the plants whose seeds were soaked at a 5 ml L^{-1} of Atonik was significantly superior and gave the highest means of this trait (15.19and 15.58 g) compared with control treatment which gave the lowest means (14.06and 14.85 g) for both seasons respectively. The reason of the increases could be attributed to the role of Atonik solution in increasing the absorbing of sufficient amount of nutrients and improving the metabolic processes, which led to an increase the vegetative and root growth, accumulation of dry matter in the leaves and their transfer to the grains, which led to an increase the weight of the grains. This result is in line with Mizban (16).

Table 3. Effect of cultivars, seed soaking concentrations with Atonik and seeding dates on weight of 500 grains for sorghum, for the spring and fall seasons

Seeding Dates	Atonik Conc ml L^{-1}	Spring season Cultivars			Seeding ×date Atonik	Fall season Cultivars			Seeding ×date Atonik
		Inqath	Lilo	Giza		Inqath	Lilo	Giza	
1st date	0	13.33	13.67	13.33	13.44	14.56	15.17	16.67	15.46
	2.5	14.35	14.33	14.82	14.50	14.67	15.47	17.53	15.89
	5	15.29	14.67	15.00	14.98	14.92	15.68	17.83	16.14
2nd date	0	14.36	14.82	14.73	14.63	13.60	14.97	16.73	15.10
	2.5	14.54	14.85	15.67	15.02	14.27	15.27	17.07	15.53
	5	14.86	15.08	15.84	15.26	14.43	15.44	17.67	15.84
3rd date	0	13.00	14.71	14.67	14.12	13.27	13.82	14.90	13.99
	2.5	13.84	15.33	15.08	14.75	14.93	14.00	16.17	15.03
	5	14.67	15.67	15.67	15.33	14.33	14.16	15.78	14.75
L.S.D %5			N. S		1.61		N. S		0.92
					Mean conc				Mean conc
×Conc cultivar	0	13.56	14.40	14.24	14.06	13.81	14.65	16.10	14.85
	2.5	14.24	14.83	15.19	14.75	14.62	14.91	16.92	15.48
	5	14.94	15.14	15.50	15.19	14.56	15.09	17.09	15.58
L.S.D %5			N. S		0.90		N. S		0.56
					Mean date				Mean date
Seeding ×Date Cultivar	1st date	14.32	14.22	14.38	14.30	14.71	15.44	17.34	15.83
	2nd date	14.58	14.91	15.41	14.96	14.10	15.22	17.15	15.49
	3rd date	13.83	15.23	15.14	14.73	14.17	13.99	15.61	14.59
L.S.D%5			2.02		0.63		1.08		0.64
Mean cultivar		14.24	14.78	14.97		14.32	14.88	16.70	
L.S.D%5			0.64				0.69		

The results in Table (3) indicate that the seeding dates were significantly differed in this trait, the second date (1/4) for the spring season and the first date (1/7) for the fall season recorded the highest means (14.96and 15.83 g) respectively compared with the first date (15/3) for the spring season and the third date (20/7) for the fall season which recorded the lowest means (14.30and 14.59 g) respectively. The reason of superiority of the mentioned dates could be due to the appropriate environmental conditions during

the stage of grains formation and its filling, which contributed to an increase in the rate of photosynthesis and the accumulation of dry matter in the grains during the stage of formation and filling, and then increasing their weight. These results are in agreed with Bughdady (9) and Khudhair and Hamza (15). The di-interaction between varieties and seeding dates had a significant effect on this trait (Table 3); the Giza 113 variety whose seeds were planted in the second date (1/4) for the spring season at first date (1/7) for the fall season recorded the highest values (15.41and 17.34 g) respectively, while the Inqath variety whose seeds were planted in the third date (15/4) for the spring season and Lilo variety whose seeds were planted in the third date (20/7) for the fall season recorded the lowest values (13.83 and 13.99g) respectively. Also, The di-interaction between concentrations of Atonik and seeding dates had a significant effect on this trait (Table 3); the soaked seeds at a 5 ml L^{-1} of Atonik and planted in the second date (1/4) for the spring season and the first date (1/7) for the fall season achieved the highest values (15.26and 16.14g), whereas the soaked seeds with distilled water only and planted in the first date (15/3)for the spring season and the third date (20/7) for the fall season achieved the lowest values (13.44 and 14.75g) respectively. The di-interaction between varieties and concentrations of Atonik and the tri-interaction between the studied factors wasn't significant effect on this trait.

Grain yield (ton ha^{-1})

According to the research data, the results in Table (4) indicate that the sorghum varieties were significantly differed in grain yield, Inqath variety gave the highest means (4.70 and 5.70ton ha^{-1}) compared with Giza 113 variety which gave the lowest means (4.22 and 4.55 ton ha^{-1}) for both seasons respectively. The superiority of Inqath variety could be due to its superiority in the number of grains per head (Table 2).This result is in line with of Abood et al., (4), they indicated that the sorghum varieties were significant differences in the grain yield.The results in Table (4) show that the grains yield was significantly increased by increasing the concentrations of Atonik, as the plants whose seeds were soaked at a 5 ml L^{-1} recorded the highest means (4.79 and 5.36 ton ha^{-1}) compared with control treatment which recorded the lowest means (4.02 and 4.70 ton ha^{-1}) for both seasons respectively. The reason of superiority of the high concentration of Atonik could be due to its superiority in the number of grains per head and weight of 500 grains (Tables 2 and 3). This result is in line with Mizban (16) and Al-Rawi (8). The results in Table (4) reveal that the seeding dates were significantly differed in the grain yield, the second date (1/4) for the spring season and the first date (1/7) for the fall season recorded the highest means (5.27 and 5.48 ton ha^{-1}) respectively, compared with the first date (15/3) for the spring season and the third date (20/7) for the fall season which recorded the lowest means(3.98 and 4.77 ton ha^{-1}) respectively. The reason of increase could be due to the superiority of the two dates in the number of grains per head and weight of 500 grains (Tables 2 and 3). These results are in agreement with the Ajaj et al., (6) and Carcedo et al., (10). The di-interaction between varieties and concentrations of Atonik had a significant effect on this trait in the spring season only (Table 4); the Inqath variety whose seeds were soaked at a 5 ml $L^{-1}$of Atonik recorded a highest value (5.06 ton ha^{-1}), while the Giza 113 variety whose seeds were soaked with distilled water only recorded lowest value (3.72 ton ha^{-1}).

Table 4. Effect of cultivars, seed soaking concentrations with Atonik and seeding dates on grain yield (ton ha^{-1})for sorghum, for the spring and fall seasons

Seeding Dates	Atonik Conc ml L^{-1}	Spring season				Fall season			
		Cultivars			Seeding ×date Atonik	Cultivars			Seeding ×date Atonik
		Inqath	Lilo	Giza		Inqath	Lilo	Giza	
1st date	0	3.81	3.37	3.25	3.47	5.53	4.65	4.32	4.86
	2.5	4.30	3.55	4.61	4.15	6.80	5.53	4.91	5.74
	5	4.42	4.22	4.34	4.32	6.90	5.70	5.01	5.87
2nd date	0	4.71	4.68	4.30	4.56	5.76	4.62	4.39	4.92
	2.5	5.79	5.47	5.56	5.60	5.87	5.02	4.57	5.15
	5	5.88	5.64	5.45	5.65	5.92	5.12	4.85	5.29
3rd date	0	3.88	4.60	3.63	4.03	4.32	4.64	4.17	4.37
	2.5	4.67	4.83	3.26	4.25	4.78	5.89	4.37	5.01
	5	4.88	4.74	3.64	4.42	5.43	4.96	4.42	4.93
L.S.D %5			1.42		1.13		N. S		N. S
					Mean conc				Mean conc
×Conc cultivar	0	4.13	4.21	3.72	4.02	5.20	4.63	4.29	4.70
	2.5	4.92	4.61	4.47	4.66	5.81	5.48	4.61	5.30
	5	5.06	4.86	4.47	4.79	6.08	5.26	4.76	5.36
L.S.D %5			0.80		0.64		N. S		0.61
					Mean date				Mean date
Seeding ×Date Cultivar	1st date	4.17	3.71	4.06	3.98	6.41	5.29	4.74	5.48
	2nd date	5.46	5.26	5.10	5.27	5.85	4.92	4.60	5.12
	3rd date	4.47	4.72	3.51	4.23	4.84	5.16	4.32	4.77
L.S.D%5			0.93		0.90		0.72		0.34
Mean cultivar		4.70	4.56	4.22		5.70	5.12	4.55	
L.S.D%5			0.38				0.48		

The di-interaction between varieties and seeding dates had a significant effect on this trait (Table 4); the Inqath variety whose seeds were planted in the second date (1/4) for the spring season and the first date (1/7) for the fall season achieved the highest values (5.46 and 6.41 ton ha^{-1}),whereas the Giza 113 variety whose seeds were planted in thefirst date (15/3) for the spring season and the third date (20/7) for the fall season achieved the lowest values (3.51 and 4.32 ton ha^{-1}) respectively. The di-interaction between concentrations of Atonik and seeding dates had a significant effect on this trait in the spring season only (Table 4); the soaked seeds at a 5 ml L^{-1}of Atonik and planted in the 1/4 gave a highest value (5.65 ton ha^{-1}), while the soaked seeds with distilled water only and planted inthe15/3 gave a lowest value (3.47ton ha^{-1}). The tri-interaction between the studied factors had a significant effect on the grain yield in the spring season only (Table 4); the Inqath variety whose seeds were soaked at a 5 ml L^{-1}of Atonik and planted in the1/4 gave a highest value (5.88ton ha^{-1}).

Biological yield (ton ha^{-1})

The results in Table (5) show that the Inqath and Lilo varieties were significantly superior and achieved the highest means of biological yield (25.42 and 23.76ton ha^{-1}) compared with Giza 113 variety which achieved the lowest means (21.04 and 22.51 ton ha^{-1}) for the spring and fall seasons respectively. The reason of difference between sorghum varieties in the biological yield could be due to their difference in the genetic structure. These results are in line with Abood et al., (4).The results in Table (5) reveal that the biological yield was significantly increased by increasing the concentrations of Atonik in the fall season only, as the plants whose seeds were soaked at a 5 ml L^{-1} gave highest mean (23.95ton ha^{-1})

compared with control treatment which gave a lowest mean(22.40ton ha^{-1}).

Table 5. Effect of cultivars, seed soaking concentrations with Atonik and seeding dates on biological yield (ton ha^{-1})for sorghum, for the spring and fall seasons

Seeding Dates	Atonik Conc ml L^{-1}	Spring season				Fall season			
		Cultivars			Seeding ×date Atonik	Cultivars			Seeding ×date Atonik
		Inqath	Lilo	Giza		Inqath	Lilo	Giza	
1st date	0	20.78	19.40	19.11	19.76	19.20	18.48	25.06	20.91
	2.5	24.50	20.54	19.90	21.64	20.16	21.90	21.06	21.04
	5	22.12	20.04	20.44	20.86	19.11	21.97	20.75	20.61
2nd date	0	22.02	21.27	19.54	20.94	24.59	26.16	23.51	24.75
	2.5	28.36	24.65	20.76	24.59	24.70	23.54	24.79	24.34
	5	30.36	26.39	20.30	25.68	24.42	27.52	24.89	25.61
3rd date	0	23.32	23.09	20.93	22.44	21.06	24.69	23.86	23.20
	2.5	27.22	27.59	24.93	26.58	23.38	23.46	22.66	23.16
	5	30.15	30.07	24.04	28.08	26.05	26.19	24.70	25.64
L.S.D %5			N. S		3.58		4.15		2.04
					Mean conc				Mean conc
×Conc cultivar	0	22.04	21.25	19.86	21.05	21.61	23.11	24.14	22.95
	2.5	26.69	24.26	21.86	24.27	22.74	22.96	22.83	22.84
	5	27.54	25.50	21.59	24.78	23.19	25.22	23.44	23.95
L.S.D %5			N. S		N. S		2.10		1.17
					Mean date				Mean date
Seeding ×Date Cultivar	1st date	22.46	19.99	19.81	20.75	19.49	20.78	22.29	20.85
	2nd date	26.91	24.10	20.20	23.73	24.57	25.74	24.39	24.90
	3rd date	26.89	26.91	23.30	25.70	23.49	24.78	23.74	24.00
L.S.D%5			N. S		2.97		N. S		1.02
Mean cultivar		25.42	23.66	21.04		22.51	23.76	23.47	
L.S.D%5			2.03				1.28		

The superiority of the higher concentration of Atonik (5 mL L^{-1}) could be attributed to its superiority in the vegetative growth and grain yield and its components (Tables 2, 3 and 4).The results in line with Mizban (16).The results in Table (5) indicate that the seeding dates were significantly differed in the grain yield, the third date (15/4) for the spring season and the second date (10/7) for the fall season achieved the highest means (25.70 and 24.90 ton ha^{-1}) respectively compared with the first date (15/3 and 1/7) for the spring and fall seasons which achieved the lowest means (20.75 and 20.30 ton ha^{-1}) respectively. The reason of superiority of the 15 April 15 and 10 July in this trait may be due to their superiority in the grain yield and its components as well as the dry matter. These results are in agreement with Ahmed and Abood (5) and Bughdady (9) and Mahmood and AL-Hassan (18) The di-interaction between varieties and concentrations of Atonik had a significant effect on this trait in the fall season only (Table 5); the Lilo variety whose seeds were soaked at a 5 ml L^{-1} of Atonik gave a highest value (25.22 ton ha^{-1}), whereas the Inqath variety whose seeds were soaked with distilled water only gavealowest value (21.61ton ha^{-1}). The di-interaction between varieties and seeding dates had a significant effect on this trait (Table 5); the Inqath and Lilo varieties whose seeds were planted in the second date (1/4) for the spring season and the second date (10/7) for the fall season achieved the highest values (26.91 and 25.74 ton ha^{-1}), while the Giza 113 and Inqath varieties whose seeds were planted in the first date (15/3 and 1/7) for the spring and fall seasons achieved the lowest values (19.81 and 19.49 ton ha^{-1}) respectively. The di-interaction between concentrations of Atonik and seeding dates had a significant effect on this trait (Table 5); the soaked seeds at a 5 ml L^{-1}of Atonik and planted in the third date (15/4 and 20/7) for the spring and fall seasons gave the highest values (28.08 and 25.64 ton ha^{-1}), whereas the soaked seeds with

distilled water only and planted in the first date (15/3 and 1/7) for the spring and fall seasons gave the lowest values (19.76 and 20.91ton ha^{-1}) respectively. The tri-interaction between the studied factors had a significant effect on the grain yield in the fall season only (Table 5); the Lilo variety whose seeds were soaked at a 5 ml L^{-1}of Atonik and planted in the 10/7 recorded a highest value (27.52ton ha^{-1}), whereas the Lilo variety whose seeds were soaked with distilled water only and planted in the 1/7recorded a lowest value (18.48 ton ha^{-1}). It could be concluded that the use of seed soaking technology with Atonik solution at a 5 ml L^{-1}improved the growth traits, which was reflected on the yield components and grain yield of sorghum. Also, the seeding dates had a significant effect on the yield and its components, as the second date of the spring season (1/4) and the first date of the fall season (1/7) were distinguished by the best grain yield.The results also showed that the Inqath variety was more responsive to the studying conditions and this was reflected on the yield components and grain yield.

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