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EFFECT OF NITROGEN FERTILIZATION LEVELS ON YIELD AND YIELD COMPONENTS OF DURUM WHEAT (TRITICUM DURUM DESF.)

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ABSTRACT

The experiment was carried out during the winter agricultural seasons 2021/2022 at two locations in Mosul (Bashiqa and Balawat) to study the response of five durum wheat varieties (Duma, Gigamor, Maggi, Sardar, Zeina2) to three levels of nitrogen fertilizer (88, 174 and 264 kg/ha) applied as of urea 46% N for traits, flowering date, 1000 grain weight, number of spikes/1 m2, number of grains/10 spikes, harvest index and grain yield using randomized complete block design with a split plots system with three replications. The combined analysis of variance result showed significant differences between locations for flowering date, number of spikes per plant and harvest index, between varieties for all studied traits and between nitrogen fertilizer levels for for all traits except for the flowering date. The variety Zeina2 surpassed others for most traits including grain yield except flowering date followed in importance by Sardar variety. The level of nitrogen fertilizer 264 kg/ha surpassed for all traits according to Duncan's Multiple Range Test, but it was found through the results of trend analysis that the best levels of nitrogen fertilizer was 88, 183.75, 171.75, 134.99, 264.0 and 211.63 kh/ha for flowering date, 1000 grains weight, number of spikes per plant, number of grains per spike, harvest index and grain yield respectively, whereas, the appropriate regressive relationship for fertilizer levels was of first degree (linear) with flowering date and harvest index, and of second degree (squared) with other traits. From combination between locations, varieties and nitrogen fertilizer levels it turns out that variety Zeina2 at the level of 264 kg/ha of nitrogen fertilizer in Balawat location had a good performance for most of studied traits, including grain yield.

Keywords: durum wheat, varieties, locations, nitrogen fertilizer

INTRODUCTION

Durum wheat (Triticum durum Desf.) represent about 8% of the worldwide cultivated areas, and the cultivated area of durum wheat in Iraq is estimated at 12 thousand hectares (Mushimesh et al., 2016). It is one of the most important grain crops in the rainfed region of northern Iraq due to its importance in the manufacture of groats, grains and bulgur, which are basic materials for well-known popular foods such as kibbeh, bulgur, harissa, macaroon, noodles and spaghetti, which no house in Iraq, the Middle East and North Africa does not dispense with this important material (Al-Adari 2014). In Iraq, the population is increasing by more than 3% and its population is more

than thirty million, and wheat is produced in northern Iraq on rainy conditions and in a fluctuating manner due to its dependence on annual rainfall. Al-Rawi et al., (1999) pointed out that production of wheat does not meet the need, and in order to obtain stability and rise up the productivity of the unit area, it is essential to resort to the use of highly productive varieties and to give supplementary irrigation during the growth of the crop, as all the old varieties suffer from a decrease in yield, sensitivity to rust diseases and logging in the high rainy seasons, and the goals of finding new varieties determine the high productivity and stability with different climatic conditions, their tolerance to drought and high temperatures, early maturity and resistance to diseases and insects, as well as the quality of good grain.

The high productivity and quality of the durum wheat crop depends on the crop service processes and on the characteristics of the grains, and among the factors affecting them are fertilization, genotypes and possible interactions between these factors (Bouacha et al. 2014), and for the purpose of promoting this important crop, its production must be confronted through two strategies, the first is the vertical expansion of the lands in which it is well cultivated through the application of modern technologies (modern irrigation systems, fertilization and high-productivity varieties), and the second strategy is horizontal expansion through the cultivation of wheat crops in reclaimed lands (Afaf et al. 2014), which suffers from poor fertility and low water storage capacity, and here nutrients in addition to varieties are the main factors affecting productivity and quality (Hammouda, et al. 2015). Several studies have clearly shown that nitrogen absorption and its refilling is strongly influenced by its supply (Ercoli et al., 2013; Alhabbar et al. 2018b). On the other hand, the response to nitrogen fertilizer is variable due to different genetic factors and environmental conditions. Moreover, several studies have shown that the increase in the usage of nitrogen fertilizer has led to a decrease in the specification of coarse wheat (Naser et al., 2020). Some researchers mentioned that in semi-arid areas characterized by lack of rain-fall, the response of wheat crop to nitrogen application was little or non-existent, particularly due to the variability of rainfall. Actually, in the case of good rainfall, high nitrogen application can lead to early growth and resulting increase in tillering number which leads to rapid reduction of water in the soil, while in the event of a deficit in rainfall during the grain filling phase, a decrease in the grain yield is expected (Cammarano, 2019; López-Bellido et al. 2006; Alhabbar et al. 2018a) indicated that the efficiency of nitrogen fertilizer in most of Mediterranean regions was much lower compared with temperate areas, and stresses the importance of selecting genotypes capable of using nitrogen better, therefore improving the nitrogen efficiency of wheat crop and reducing the negative impacts on the environment due to volatilization and nitrate leaching, while preserving the environment at the same time. Among other studies in this field, (Henfey, 2021) stated that the appropriate amount of fertilizer is a major factor that has a significant effects on grain yield and yield components of durum wheat, and the results of his study in which levels of potassium fertilizer were used showed significant differences in all the traits included in the study, excluding plant height in two growing seasons and harvest index in the first season only, and also the genotypes had a significant impact on most of yield traits and its components in two growing seasons. (Benchelali et al. 2022) indicated by their testing of four genotypes under four rates of nitrogen 0, 40, 80 and 120 kg per

hectare during three growing seasons, that the traits under study were significantly influenced by genotype, seasons, and nitrogen rates, and that high levels of fertilizer improved some traits, and one of the modern varieties showed better ability to survive under different nitrogen rates and water stress, producing higher yield.

The aim of the present study was to evaluate five durum wheat varieties and study their response to nitrogen fertilizer levels for grain yield and some of its components in two locations in Nineveh Governorate.

MATERIALS AND METHODS

The experiment was carried out during the winter agricultural seasons 2021/2022 in two locations classified as the Mediterranean region with semi-guaranteed rain, the first in Bashiqa (20 km east of Mosul city center) and the second in Balawat belonging to Nimrud sub-district (30 km southeast of the city center of Mosul) to study the response of five durum wheat varieties (Duma, Gigamor, Maggi, Sardar, Zeina2) to three levels of nitrogen fertilizer (88, 174 and 264 kg per hectare) applied as urea 46% N, corresponding to levels 40, 80 and 120 kg/ha of pure nitrogen. A randomized complete block design with a split plots system was used with three replications, where the levels of nitrogen fertilizer were distributed in the main plots and the varieties in the sub-plots. The sowing in both location was on December 1, 2021, which is the recommended date for durum wheat in these agricultural areas, in lines (five lines per each sub experimental unit), 1 m long and a distance between them 0.18 m with seeding rate of 140 kg per hectare under rainy conditions with supplemental irrigation as needed to simulate rain, where the average rainfall during the season was 158 mm distributed in quantities of 51, 43, 13, 10, 20 and 21 mm per month and 76, 117, 17, 24, 13 and 32 for the months of December, January, February, March, April and May, in Bashiqa and Balawat respectively, (Nineveh Directorate of Agriculture 2022). The compound fertilizer DAB 18-46-0 NPK was added during the preparation of the land at a rate of 160 kg per hectare for the whole experiment with homogeneity in each location, while nitrogen fertilizer levels were added in the tillering stage. Agricultural operations were carried out to serve the crop as needed. At maturity, data were recorded for traits: flowering date (NDF), 1000 grains weight in gram (1000 GW), number of spikes per 1 m2 (NS), number of grains per 10 spikes (NG10S), harvest index (HI) and grain yield (GY).

A combined analysis was conducted across the two locations for the data of the studied traits according to the experimental design method used, and the differences between the mean of locations, nitrogen fertilization levels, varieties and all their combinations were compared by Duncan's Multiple Range Test, and also, a trend analysis of nitrogen fertilization levels was conducted to identify the nature of the response of the studied traits to it (Al-Zubaidy and Al-Falahy (2016). According to this method, the best level of nitrogen fertilizer for any trait was estimated (when the quadratic relationship is appropriate) from the equation: Xbest level = -b1 / 2b2 = kg urea/ha, where in quadratic regression equation, b1 refers to partial regression coefficient which relates to the first degree relationship and b2 refers to partial regression coefficient which

relates to the linear second degree relationship. When substituting the value of the best fertilizer level into the second-order regression equation, the best mean for the trait is obtained
note that the two available programs, SAS (Statistical Analysis System) and MINITAB were used to implement the statistical procedures.

RESULTS AND DISCUSSION

The results of the combined analysis of variance for the studied traits appear in Table (1), in which it is noted that the mean squares of each of the genotypes, locations, and fertilizer levels were

Table (1): The results of combined analysis of variance for the studied traits

Source	df	Mean Square					
		NDF	1000 GW	NS	NG10S	HI	GY
Locations	1	2570.68**	10.243	1137.778	1078227.8**	354.613**	14239.755
Reps/location	4	4.544	19.931	9638.056	810.089	203.441	44387.509
Fertilizer	2	3.744	16.875**	4010.833*	5294.80**	237.121**	35150.175*
Linear	(1)	7.35*	3.205	220.417	7661.40**	465.329**	22813.752
Quadratic	(1)	0.138	30.545*	7801.250**	2928.20*	8.912	373713.1**
Fer x Loc	2	19.877**	96.804**	726.944	3377.91	5.631	13090.0031
Error a/Loc	8	1.994	10.949	1023.056	1024.21	52.408	15239.62
Varieties	4	5.127**	115.756**	20302.361**	3613.04*	34.683*	29855.33*
Var x Fer	8	3.203	30.495	5729.236*	4344.73*	26.610*	19276.329
Var x Loc	4	1.317	173.006**	1738.472	3414.42*	36.196*	18604.003
Var xFerxLoc	8	6.475**	28.204	4220.347	721.675	63.965**	18945.592
Error b/Loc	48	1.692	20.622	2236.042	1726.903	13.829	14296.338

significant for all traits except for 1000 GW, NS and GY in case of seasons and NDF in case of levels of fertilizer (not significant), these results are in agreement with what was mentioned by Benchelali et al. (2022) whom indicated by their testing of four genotypes at four nitrogen levels from 0 to 120 kg per hectare during three seasons, that the traits under study were significantly affected by environments, genotype, and nitrogen level, and it appeared from the results of trend analysis that the mean squares of the quadratic relationship reached the significant limit 1000 GW, NS, NG10S and GY with fertilizer levels, while that related to the linear relationship was only

significant for NGF and HI. The mean quare of all kinds of interactions were significant for some traits and not for others, while the Duncan Multiple Range Test showed that they were all significant for all traits except for the interaction of locations with fertilizer levels for NS and GY, which did not reach the significant limit in both tests. On the basis of what was shown by F-test for the three factors (locations, fertilizer levels and varieties) and what was shown by Duncan Multiple Range Test, the following is a review of the nature of the differences between the means of the three factors and the combinations between them for the studied traits. It is noted for NDF trait, which is shown in Table (2), that there is a significant difference between the two locations, as the plants of Bashiqa were earlier and NDF reached 118.133 days.

Table (2): Effect of nitrogen and varieties on flowering date

Locations	Varieties	Levels of Urea Fertilizer (kg/ha)			Var x Loc	Varieties Effects	Location Effects
		88	176	264			
Basheqa	Duma	118.00d-f	118.33d-f	116.667f	117.667c		
	Gigamor	127.333c	127.67bc	131.667 a	128.889a		
	Maggy	118.67d-f	117.67d-f	116.333f	117.556c		
	Sardar	127.333c	129.00bc	129.67a-c	128.667a		
	Zeina2	117.33d-f	117.33d-f	119.667d	118.111c		
	Duma	128.00bc	129.67a-c	129.000bc	128.889a		
	Gigamor	119.667d	117.000ef	117.000ef	117.889c		
	Maggy	127.333c	127.67bc	130.000ab	128.333a		
	Sardar	119.667d	119.33de	119.333df	119.444a		
	Zeina2	127.67bc	131.667a	128.667bc	129.333a		
	122.67bc	123.00bc	124.167ab		123.278b		
	123.00bc	123.33bc	123.000bc		123.111b		
	122.67bc	123.50bc	124.333ab		123.500b		

123.50bc	122.333c	123.50bc		123.111b	
123.67bc	125.50a	124.00a-b		124.389a	
118.667c	117.933c	117.8000c			
127.533b	129.133a	129.800a			
123.100a	123.533a	123.800a			

-Means of factors and their interactions followed by the same letter are not significantly different from each other.

From the comparison between the means of varieties, it is noted that the two varieties Gigamor and Sardar were distinguished by being more early with a non-significant difference than Duma and Maggy varieties, while the variety Zeina2 was more delayed in flowering significantly than the other four varieties. The comparison between the levels of nitrogen fertilizer means showed that the differences were not significant for this trait, and that the least NDF was 123.1 days at the level of 88 kg/ha, consistent with the result shown by the trend analysis (Table 3), which shows that the appropriate relationship between the levels of fertilization and NDF was of the first degree (linear), where the number of days was less at the first level and increases with increasing nitrogen fertilizer level, and the linear regression equation is suitable for predicting the number of days at any level of fertilizer. It was

Table (3). The appropriate regression equation to predict the value of any trait, the best rate of fertilizer and the mean of the trait.

Sq	The appropriate regression equation	Best urea level	Better mean
1	NDF = 122.8 + 0.00398 Urea Fertilizer	88	123.1
2	1000 GW = 49.98 - 0.05880 Urea Fertilizer + 0.000160 (Urea Fertilizer)2	183.75	44.58
3	NS = 308.3 - 0.8759 Urea Fertilizer + 0.002550 (Urea Fertilizer)2	171.75	233.08

4	NG10S = 346.1 - 0.422 Urea Fertilizer + 0.001563 (Urea Fertilizer)2	134.99	317.62
5	HI = 33.05 + 0.03165 urea fertilizer	264.0	41.629
6	GY = 325.0 + 1.881 Urea Fertilizer - 0.004444 (Urea Fertilizer)2	211.63	524.04

found from varieties and locations combination that the varieties Duma, Maggy and Zeina2 in Bashiqa and Gigamor in Balawat showed the lowest NDF with a significant difference from some other combinations, while the locations x fertilize levels showed the three levels of fertilizer surpassed in Bashiqa with the least NDF with a significant difference from other combinations. Sardar variety at 176 kg/ha of fertilizer gave the lowest NDF, which was 122.333 days, with a significant difference from some other combinations. As for the comparison of the means of combinations between the three factors, it was shown that the two varieties Duma and Maggy at the fertilizer level of 264 kg/ha in Bashiqa showed the lowest NDF amounting to 116,666 and 116,333 days, respectively, with a significant difference from most of the other combination cases. 1000 GW trait is important and has been studied as it is one of the technological indicators and an important element of productivity (Budak, 2000), its data presented in Table (4), and it was shown that there is a significant difference between the two locations, although the Bashiqa location gave the highest mean for the trait (45.736 g). Among the varieties, it is noted that the two varieties Duma and Sardar were surpassed by highest means for the trait (48.394 and 47.072 gm respectively) 47.072 with non-significant difference with Gigamor only. The comparison between the levels of nitrogen fertilizer means showed that 88 kg/ha gave highest 1000 GW (46.042 g) with non-significant difference with the higher level of 264 kg/ha, this is consistent with Kakar et al. (2002) that the application of nitrogen fertilization led to an increase in the weight of 1000 grains. Trend analysis results (table 3) shows that the appropriate relationship between the levels of fertilization and 1000 GW was of the second degree (quadratic), and the quadratic regression equation is suitable for predicting the 1000 GW at any level of fertilizer. At this degree of relationship, it appeared that the best amount of nitrogen fertilizer = 183.75 kg/ha to give the best mean for the trait 44.58 gm. It was found from varieties x locations combination that the variety Gigamor in Balawat and Duma in Bashiqa showed the highest 1000 GW with a significant difference from some combinations, while the locations x fertilizes levels showed the 176 kg/ha of fertilizer surpassed in Bashiqa with higher 1000 GW with a significant difference from only 176 kg/ha in Balawat. Duma variety with 176 kg/ha of fertilizer gave the highest 1000 GW, which was 50.972 gm, with a significant difference from some other combinations. From the comparison of the means of combinations between the three factors, it was shown that the variety Gigamor at the fertilizer level of 88 kg/ha in Balawat showed the highest 1000 GW amounting to 53.277 gm with a significant difference from most of the other combination cases.

Table (4): Effect of nitrogen and varieties on 1000-grain weight

Locations	Cultivars	Levels of Urea Fertilizer (kg/ha)			Var x Loc	Varieties Effects	Location Effects
		88	176	264			
Basheqa	Duma	45.338a-i	51.346a-d	51.725 a-c	49.470 ab		
	Gigamor	46.825a-i	44.915 a-i	50.219 a-e	47.319 bc		
	Maggy	47.075a-g	50.124 a-f	37.930 i	45.043b-d		
	Sardar	50.878a-e	40.425 g-i	49.003 a-f	46.769 bc		
	Zeina2	43.231 b-i	39.154 h-i	40.303 g-i	40.896 d		
balawat	Duma	47.538a-g	41.544 f-i	47.433 a-h	45.505b-d		
	Gigamor	53.277 a	52.031 ab	52.113 ab	52.473 a		
	Maggy	42.410 d-i	39.161 hi	43.442 b-i	41.671 d		
	Sardar	39.418 hi	42.123 e-i	40.860 g-i	40.800 d		
	Zeina2	44.433 a-i	44.929 a-i	42.772 c-i	44.045 cd		
Duma		46.081 a-e	48.130 a-c	50.972 a		48.394 a	
Gigamor		48.976 ab	45.275 a-c	43.466 b-e		45.906 ab	
Maggy		45.384 a-e	40.349 e	43.868 b-e		43.200 bc	
Sardar		47.843 a-c	45.596 a-e	47.777 a-d		47.072 a	
Zeina2		41.925 c-e	43.526 b-e	41.816 de		42.422 c	
Basheqa		45.667 a	46.956 a	44.586 ab			45.736 a
balawat		46.417 a	42.195 b	46.574 a			45.062 a
Effect of Urea		46.042 a	44.575 b	45.580 ab			

- Means of factors and their interactions followed by the same letter are not significantly different from each other.

The means of the three factors and their interactions for NS ((which is related to productivity and is considered one of its important components, (Lakmis and Bakkour, 2009)) are shown in Table (5), in which it is noted that Bashiqa location gave the highest mean of 249.89 spikes, but it is not significant than that of Balawat location. As for the cultivars, the highest NS mean appeared in the variety Zeina2,

followed in importance by the two varieties Sardar and Maggy, with means reaching 256.67 and 245.0 spikes respectively.

Table (5): Effect of nitrogen and varieties on number of spikes/m2

Locations	Varieties	Levels of Urea Fertilizer (kg/ha)			Var x Loc	varieties Effects	Location Effects
		88	176	264			
Basheqa	Duma	191.67g-h	201.67f-g	215.00 d-h	202.78 c		
	Gigamor	225.00d-h	253.33a-g	145.00 h	207.78 bc		
	Maggy	276.67a-g	246.67a-g	225.00 d-h	249.44a-c		
	Sardar	198.33 f-g	236.67a-h	191.67 gh	208.89 bc		
	Zeina2	268.33a-g	208.33e-h	271.67a-g	249.44a-c		
balawat	Duma	206.67e-h	200.00 f-h	315.00 a-c	240.56 bc		
	Gigamor	263.33a-g	235.00b-h	268.33 a-g	255.56 ab		
	Maggy	253.33a-g	215.00e-h	305.00 a-d	257.78 ab		
	Sardar	296.67a-e	293.33 a-f	286.67 a-g	292.22 a		
	Zeina2	330.00 a	241.67a-g	325.00 ab	298.89 a		
Duma		208.33 de	227.50c-e	180.00 e		205.28 c	
Gigamor		237.50b-e	241.67b-c	208.33 de		229.17 bc	
Maggy		237.50b-e	204.17d-e	293.33 ab		245.00 b	
Sardar		258.33a-c	225.00c-e	286.67 a-c		256.67 b	
Zeina2		313.33 a	267.50a-c	305.83 a		295.56 a	
Basheqa		259.33 a	237.00 a	253.33 a			249.89 a
balawat		242.67 a	229.33 a	256.33 a			242.78 a
Effect of Urea		251.00 a	233.17 b	254.83 a			

The comparison between the means of nitrogen fertilizer levels indicates that the high level of 264 kg/ha surpassed by highest number of spikes of 254.83 with a significant difference from the second level of 176 kg/ha only, these results are in agreement with Sobh et al. (2000). Trend analysis results (table 3) shows that the appropriate relationship between the levels of fertilization and NS was of the second degree (quadratic), and the quadratic regression equation is suitable for

predicting the NS at any level of fertilizer. At this degree of relationship, it appeared that the best amount of nitrogen fertilizer =
171.75 kg/ha to give the best mean for the trait = 233.08 spike. The combination of locations and varieties showed the superiority of Sardar and Zeina2 varieties in Balawat with highest means, which

amounted to 292.22 and 298.89 spikes respectively, with a non-significant difference from Gigamor and Maggy in the same location and Zeina2 in Bashiqa. The combination of varieties with fertilizer levels showed the superiority of variety Zeina2 at the fertilizer levels 88 and 264 kg/ga with the highest number of spikes (313.33 and 305.83 respectively), with an insignificant difference from Zeina2 at level 176 and Maggy and Sardar at level 264 kg/ha. As for the interaction between the three factors, it was shown that the variety Zeina2 in Balawat at a fertilizer rate of 88 kg/ha gave the highest mean for the trait, which reached 330 spikes, with a non-significant difference from some other combinations in the two locations. It is clear for the trait of the NG10S (which is one of the main productivity components as it affects significantly and directly in the production of grain), whose means are shown in Table (6), that the mean of the trait in Balawat location was significantly higher and amounted to 437,844 grains. Among the varieties, the

Table (6): Effect of nitrogen and varieties on number of grains per 10 spikes

Locations	varieties	Levels of Urea Fertilizer (kg/ha)			Var x Loc	Varieties Effects	Location Effects
		88	176	264			
Basheqa	Duma	221.67 de	214.33 de	186.00 e	207.33 b		
	Gigamor	429.67 ab	467.00 ab	443.67 ab	446.78 a		
	Maggy	230.33 de	224.67 de	311.67 cd	255.56 b		
	Sardar	416.67a-c	370.67 bc	490.67 ab	426.00 a		
	Zeina2	212.00 de	206.00 de	182.33 e	200.11 b		
balawat	Duma	437.67 ab	401.33a-c	452.00 ab	430.33 a		
	Gigamor	191.67 e	227.33 de	183.00 e	200.67 b		
	Maggy	417.67a-c	417.67a-c	447.33 ab	427.56 a		
	Sardar	219.67 de	224.67 de	249.00 de	231.11 b		
	Zeina2	434.33 ab	449.67 ab	491.67 a	458.56 a		
Duma		325.67 ab	340.67 ab	314.83 b		327.06 b	
Gigamor		323.50 ab	297.67 b	401.17 a		340.78 a	
Maggy		324.83 ab	303.67 b	317.17 b		315.22 c	
Sardar		304.67 b	322.50 ab	315.17 b		314.11 c	

Zeina2	327.00 ab	337.17 ab	370.33 ab		344.83 a	
Basheqa	215.07 b	219.40 b	222.40 b			218.956 b
balawat	427.20 a	421.27 a	465.07 a			437.844 a
Effect of Urea	321.13 b	320.33 b	343.73 a			

- Means of factors and their interactions followed by the same letter are not significantly different from each other.

two varieties Zeina2 and Gigamor had the highest number of grains, 344.83 and 340.78 grains respectively, with a significant difference from the other varieties, followed in importance by Duma. As for nitrogen fertilizer levels, it seems that the quantity 264 kg/ha gave the highest mean of the trait amounting to 343.73 grains with a significant difference from other two levels, These results are in line with what was found by Lakmis and Bakkour (2009), but trend analysis results (Table 3) shows that the appropriate relationship between the levels of fertilization and NG10S was of the second degree (quadratic), and the quadratic regression equation is suitable for predicting the NG10S at any level of fertilizer, and at this degree of relationship, it appeared that the best amount of nitrogen fertilizer =
134.99 kg/ha to give the best mean for the trait = 317.62 grains. The interaction of locations x varieties showed that the two varieties Gigamor and Sardar in Bashiqa and the cultivars Duma, Maggy and Zeina2 in Balawat did not differ from each other significantly in NG10S, but they were significantly better than the other combination cases. It appeared from the combination between locations and fertilizer levels that the three levels in Balawat location were similar in their effects on NG10S and at the same time they were significantly surpassed their counterparts in Bashiqa, and the highest mean was 465.07 grains at the fertilizer level of 264 in Balawat. From the combination between varieties and fertilizer levels, it was found that the highest mean of NG10S was 401.17 grain for Gigamor at level 264 kg/ha of the nitrogen fertilizer, with a significant difference from some other combinations. As for comparing the means of combinations between the three factors, it showed the superiority of the Zeina2 variety at the fertilizer level of 264 kg/ha in Balawat, with a significant difference from most of the other combinations. For HI trait, which is shown in Table (7), it was found that there is a significant difference between the two locations, as Balawat location surpassed significantly Bashiqa one in HI (40.607%). From the comparison between the means of varieties, it is noted that the Zeina2 variety was gave higher mean of 40.244% with a non-significant difference from Gigamor, Maggy and Sardar. The comparison between the levels of nitrogen fertilizer means showed the superiority of the level of 268 kg/ha by higher mean of 41.629% with a significant difference from the level of fertilizer 88 kg/ha only, and that the least HI was 36.059% at the level of 88 kg/ha, consistent with the result shown by the trend analysis (Table 3), which shows that the appropriate relationship between the fertilizer levels **and**

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Table (7): Effect of nitrogen and varieties on harvest index.

Locations	Varieties	Levels of Urea Fertilizer (kg/ha)			Var x Loc	Varieties Effects	Location Effects
		88	176	264			
Basheqa	Duma	30.569 f	32.710 d-f	37.664 b-f	33.648 c		
	Gigamor	41.695a-d	41.402a-e	35.134 c-f	39.410 ab		
	Maggy	37.300 b-f	35.858 c-f	44.036 a-c	39.065 ab		
	Sardar	31.793 e-f	45.759 ab	39.835 a-f	39.129 ab		
	Zeina2	35.356 c-f	35.464 c-f	37.427 b-f	36.083 bc		
	Duma	34.843 c-f	39.981 a-f	45.737 ab	40.187 ab		
	Gigamor	32.268 d-f	34.941 c-f	39.031 a-f	35.413 bc		
	Maggy	42.566a-c	38.026 b-f	47.791 a	42.794 a		
	Sardar	35.489 c-f	39.579 a-f	41.857 a-d	38.975 ab		
	Zeina2	38.713 a-f	38.046 b-f	47.779 a	41.513 a		
	36.132c-e	37.056b-e	36.399 c-e		36.529 b		
	34.547 e	40.809a-e	41.935 a-c		39.097 ab		
	35.099 de	37.722b-e	41.582 a-d		38.135 ab		
	37.417b-e	36.483c-e	43.411 ab		39.104 ab		
	37.101b-e	38.813a-e	44.818 a		40.244 a		
	34.196 b	35.710 b	40.003 ab				
	37.922 ab	40.643 ab	43.255 a				
	36.059 b	38.177 ab	41.629 a				

- Means of factors and their interactions followed by the same letter are not significantly different from each other.

HI was of the first degree (linear), where the HI was less at the first level and increases with increasing nitrogen fertilizer level, and the linear regression equation is suitable for predicting the HI at any level of fertilizer. It was found from varieties and locations combination that all varieties in the two locations had similar effects on the HI except Duma in Bashiqa and Gigamor in Balawat which gave a significant decrease in HI, while the combination of locations x fertilize levels showed that the level 264 kg/ha in Balawat location gave the highest mean of HI amounting to 43.255% with a significant difference from 88 and 176 kg/ha in Bashiqa. From the combinations of varieties and fertilizer levels, it is clear that the Zeina2 variety at the level of 264 kg/ha gave the highest mean of HI amounting to 44.818%, with a significant difference from most other combinations. As for the comparison of the means of combinations between the three factors, it was shown that the cultivar Zeina2 at the fertilizer level 264 kg/ha in Balawat gave the highest

mean of HI of 47.779% with a significant difference from most of the other combinations, followed in importance by the variety Maggy at the same level of fertilizer and location. Finally, GY trait is one of the most important traits under study, and it is the outcome of the interaction between its components and environmental factors, and it was studied to determine the effect of locations and nitrogen fertilizer levels on the yield of the varieties approved in the study. Table (8) presents the means the three factors and their interactions for GY, in which it is noted that Balawat location gave the highest mean of 508.04 gm, but it is not significant than that of Bashiqa location. As for the cultivars, the highest GY mean appeared in the variety Zeina2 (508.04 gm), with significant difference from all other varieties, followed in importance by Sardar, with mean reaching 506.41 gm. The comparison between the means of nitrogen fertilizer levels indicates that the level of 174 kg/ha surpassed by highest GY of 518.4 gm with a significant difference from the lower level of 88 kg/ha only, this agrees with Ihsan et al. (2007) in terms of the response of grain yield to nitrogen fertilization, while trend analysis results (table 3) shows that the appropriate relationship between the levels of fertilization and GY was of the second degree (quadratic), and the quadratic regression equation is suitable for predicting the GY at any level of fertilizer. At this degree of relationship, it appeared that the best amount of nitrogen fertilizer = 211.63 kg/ha to give the best mean for the trait = 524.04 gm. The combination of locations and varieties showed the variety Zeina2 in Balawat gave

Table (8): Effect of nitrogen and varieties on grain yield

Locations	varieties	Levels of Urea Fertilizer (kg/ha)			Var x Loc	Varieties Effects	Location Effects
		88	176	264			
Basheqa	Duma	390.33 b	535.96 ab	429.01 ab	451.77 a		
	Gigamor	539.74 ab	644.61 a	380.39 b	521.58 a		
	Maggy	452.38 ab	558.49 ab	592.87 ab	534.58 a		
	Sardar	374.45 b	494.08 ab	474.23 ab	447.59 a		
	Zeina2	458.06 ab	510.79 ab	386.71 b	451.86 a		
balawat	Duma	432.74 ab	431.81 ab	593.49 ab	486.01 a		
	Gigamor	419.71 ab	456.09 ab	547.87 ab	474.56 a		
	Maggy	496.01 ab	511.97 ab	606.82 ab	538.27 a		
	Sardar	417.05 ab	585.90 ab	501.98 ab	501.64 a		
	Zeina2	580.68 ab	454.30 ab	605.25 ab	546.75 a		
Duma		465.03a-c	590.28 a	404.70 c		486.67c	
Gigamor		413.42 bc	526.28a-c	533.55a-c		491.08 c	
Maggy		445.40a-c	471.30a-c	490.10 a-c		468.93d	
Sardar		457.86a-c	484.03a-c	577.34 ab		506.41 bc	

Zeina2	498.86a-c	520.10a-c	553.62 a-c		524.19 a	
Basheqa	427.51 a	529.45 a	491.69 a			482.88 a
balawat	484.72 a	507.36 a	532.04 a			508.04 a
Effect of Urea	456.11 b	518.40 a	511.86 a			

- Means of factors and their interactions followed by the same letter are not significantly different from each other.

highest mean of GY (546.75 gm), with a non-significant difference from all other cases of combination, followed by the variety Sardar with mean of 506.41 gm. The combination of varieties with fertilizer levels showed the variety Duma at the fertilizer levels 174 kg/ga surpassed by higher GY, with an insignificant difference from most of the other combinations, followed by variety Sardar at fertilizer level of 268 kg/ha. As for the combination between the three factors, it was shown that the variety Gigamor in Basheqa at a fertilizer rate of 174=6 kg/ha gave the highest mean for the trait, which reached
644.61 gm, with a non-significant difference from most other combinations in the two locations.
It was concluded from the foregoing that Bashiqa location was surpassed in that its plants had more early flowering, and Balawat location was significantly surpassed for the two traits, number of spikes per plant and harvest index, while the differences between the two locations did not reach the significant limit for other traits. The comparison between the varieties indicated that the Zeina2 variety was significantly surpassed others in grain yield and its components from some other traits, namely, number of spikes per plant, number of grains per spike and harvest index, but it gave significantly more flowering date, followed in importance by Sardar variety with good performance for the traits, 1000 grains weight, number of spikes per plant, harvest index and grain yield, in addition to the fact that its plants were significantly more early in flowering. The results also showed that there were significant differences between the levels of nitrogen fertilization for all traits except for the flowering date (the differences did not reach the significant limit), and the results confirmed the superiority of the highest level of fertilizer (264 kg per hectare) in all traits according to Duncan's Multiple Range Test, but it was found through the results of trend analysis that the best levels of nitrogen fertilizer was 88, 183.75, 171.75, 134.99, 264.0 and 211.63 for the traits, flowering date, 1000 grains weight, number of spikes per plant, number of grains per spike, harvest index and grain yield respectively. It was revealed by comparing the means of combinations between the three factors that the variety Zeina2 at the level of 264 kg/ha of nitrogen fertilizer in Balawat location had a good performance for most of studied traits, including grain yield

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