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SELECTION RESPONSE FOR GRAIN YIELD AND ITS COMPONENTS IN BREAD WHEAT UNDER LOW INPUT CONDITIONS FROM F_3 TO F_5 GENERATIONS

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ABSTRACT

An experiment was conducted during the three successive growing seasons, 2017/2018, 2018/2019 and 2019/2020 at El-Gemmeiza, Agricultural Research Station, Agricultural Research Center, Egypt, to study the relative merits of pedigree selection under favorable and low input conditions (low nitrogen and water). Three cycles of pedigree selection for high grain yield were achieved under both conditions. The base population was the F_2-population of the cross Sakha 94× Sids13. In the F_5 generation, the selected families under favorable and low input conditions were evaluated at both environments. The phenotypic of variability for grain yield/plant in the F_2 generation was very high and accounted to 39.48% with a range of 10.18 to 58.13 % under favorable conditions, while under low input conditions reached to 30.53% with a range from 10.01 to 44.76%. The genotypic variance was slightly less than the phenotypic variance under both conditions and generally decreased from the base population (F_2) to F_5-generation. Broad- sense heritability estimates for grain yield plant under favorable and low inputs conditions were ٨٦,١٣ and ٦٧,٥٠% after three cycles of selection, respectively. Realized heritability under favorable conditions was (43.٨١, 54.69 and 72.32%) compared to (41.58, 48.73 and 60.45%) under low input conditions for cycles 1, 2 and 3, respectively. The average observed gain from selection under favorable conditions, that was evaluated under both conditions, showed significant increase in grain yield from the bulk sample by 21.89 and 43.37%, and from the better parent by 32.20 and 46.82 %, respectively. Selected families for grain yield under low input conditions that was evaluated under both conditions showed a significant increase in grain yield from the bulk sample by 16.12 and 32.21 % and from the better parent by 19.27 and 33.66 %, under favorable and low input conditions, respectively. Results revealed that the antagonistic selection reduced sensitivity to low input stress, and synergistic selection increased it. Moreover, selection for grain yield/plant under low input stress was better than under favorable conditions.

Key words: ***Wheat (Triticum aestivum L.), Pedigree selection, Low input stress, Grain yield, Stress susceptibility index (SSI), Stress tolerance index (SSI).***

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the essential cereal crop contributing basic calories for 85 % of the world population (Chaves *et al* 2013). Wheat is the staple food in more than 40 countries of the world (Sharma *et al* 2019). In Egypt, the cultivated wheat area was about 1.4 million ha. In 2020, the average of annual local production was about 6.42 tons/ha (MALR 2021). However, there is still a gap between consumption and production. Determining situations for closing yield gaps is important for setting right the efforts dedicated to enhance genetic material and agronomic practices (Marianne and Mark 2001). Stated differently, wheat improving advantage not only large and high-input farmers but also smallholder farmers who do not use limited amounts of fertilizer and other inputs (Muurinen *et al* 2006). Therefore, breeding for the development of high yielding varieties under low input conditions (irrigation and fertilization), is needed in order to reach suitable genotypes grown under regions expanding in the new lands. Nitrogen (N) is a key element for plant nutrition (Zhou *et al* 2018). Applying N fertilizers increased the yield of wheat but in some cases accompanied by adverse effects due to severely limiting irrigation. Therefore, an attempt has been made to evaluate the effect of irrigation regimes and N levels and the best combination on the wheat yield and yield components. The combination of N and water stress has been recently reported (Islam *et al* 2021) and may be useful to identify genotypes that are more able to maintain nitrogen use efficiency (NUE) performance under water shortage . Pedigree selection method has become the most popular procedures of selection in the segregating generations. Most of the Egyptian wheat cultivars were produced through this method. It is preferred by plant breeders because it is versatile, relatively rapid and makes possible conducting of genetic studies along with the plant breeding work (Kheiralla *et al* 2004, Ahmed a, 2006), Mohiy 2015 and (Salous 2017) who noted a highly significant differences among families, satisfactory genotypic coefficient of variability and large magnitude of broad sense heritability for all studied traits. The aims of the present work were to study; (1) Response to selection from F_3 to F_5 for grain yield under favorable and low input conditions. (2) Estimate phenotypic (PVC%) and genotypic (GVC%) coefficients of variability , heritability under both conditions .(3) Stress susceptibility index (SSI) to environmental conditions and Stress tolerance index (STI).

MATERIALS AND METHODS

Site description

The experiments were carried out during the three successive seasons, viz., 2017/2018, 2018/2019 and 2019/2020 at El-Gemmeiza Agric. Res. Stat., (ARC), Ministry of Agric, Egypt.

Plant Materials and Field experimental design

Three cycles of pedigree selection were practiced in F_2 and F_3 and F_4 families under normal and low input conditions and evaluated under both environments in F_5 generation. The breeding materials used in this study were 100 F_3 families traced back to random 500 F_2 plants. The base population was the F_2 generation of the cross Sids13 x Sakha94.

Table 1. Pedigree, history and origin of the parents involved in bread wheat population.

Parental name	Pedigree & History	Origin
Sakha94 (P1)	**OPATA/RAYON//KAUZ. CMBW90Y3180-0TOPM-3Y-010M-010M-010Y-10M-015Y-0Y-0AP-0S.**	**EGYPT**
Sids13 (P2)	**KAUZ"S"//TSI/SNB"S". ICW94-0375-4AP-2AP-030AP-0APS-3AP-0APS-050AP-0AP-0SD.**	**EGYPT**

Two field experiments were conducted to evaluate the 100 F_3 families selected from the F_2 population, in a randomized complete block design with three replicates in 2017/2018 growing season. The first experiment was conducted under normal conditions and irrigated five times through the whole season. Nitrogen was added as the recommended dose of (70 kg/fed.) Meanwhile, the other experiment expressed the low input conditions, where one surface irrigation was given after the establishment i.e. two irrigations were given through the whole growing season) and was given one surface dose of N fertilizer (35 kg/fed) was given with the first irrigation. Each experiment comprised 100 F_3 families, the parents, F_3 bulked random sample comprised of a mixture of equal number of seeds from each plant to the whole F_3 families. Each family was represented by a single row 3 m long and 20 cm apart with 10 cm between grains within row. Data were recorded on ten guarded plants from each family for, days to heading, plant height, number of spikes/plant, number of kernels/spike, 100-kernels weight, and grain yield/plant.

In the second season 2018/2019 The highest 20 - F_3 families selected for grain yield were planted along with the two parents and the bulk sample in a randomized complete block design experiment with three replications. Each family was represented by a single row of 3 m long, 20 cm apart and 10 cm between grains within row as previously practiced in the first season. At the end of the season, the highest 10- yielding plants from each family were saved to give the F_5 lines.

In 2019/2020 growing season the ten highest yielding families (F4 families) selected were evaluated along with parents and the bulk sample under both conditions in two separate experiments. Data were recorded for the studied characters on ten guarded plants from each family, each parent, and the bulk sample.

Statistical analysis

Data were subjected to proper statistical analysis according to Steel *et al* (1997). Genotypes means were compared using Revised Least Significant Differences test (RLSD) according to El-Rawi and Khalafala (1980). The phenotypic (σ^2p), genotypic (σ^2g) variances, and heritability in broad sense (H) were calculated according to Walker (1960). Realized heritability (h^2) was calculated as; h^2 = R/S Falconer (1989); Where R = response to selection and S = selection differential. The phenotypic (PVC%) and genotypic (GVC %) coefficients of variability were calculated as outlined by Burton (1952).

Stress susceptibility index (SSI) was calculated according to the method of Fischer and Maurer (1978) = $[1-(Ys/Yp)] / [1-(\bar{Y}s/\bar{Y}p)]$. Stress tolerant index (STI) according Kristin et al. (1997) who proposed STI index for identifying genotypes with high yield and stress tolerance. (STI) = $(Yp * Ys)/(\bar{Y}p)2$.

RESULTS AND DISCUSSION

Base population description (F_2 generation)

The characteristics of the two parents and their F_2 generation under normal and low input conditions are presented in Table (2). Results revealed that Sakha 94 (P_1) recorded the highest values of plant height, number of spikes plant^{-1}, number of kernels spike^{-1}, 100-kernel weight and grain yield compared to Sids13 (P_2) under normal and low input conditions.

Table 2. Means, coefficient of variability (CV%), heritability in broad sense (Hb) and expected genetic advance (ΔG) of the base population (F_2) estimated under favorable and low input conditions for the studied characters.

Item		DH	PH	S/P	K/S	100- KW	GY/P
		Favorable conditions					
F2 Population	Mean ±SE	102.84 ±0.19	110.14 ±0.32	11.88 ±0.22	67.77 ±0.59	4.52 ±0.03	33.49 ±0.59
	Max.	112	135	28	114	6.55	٥8.13
	Min.	92	85	2	34	2.64	10.18
	CV%	4.06	6.49	41.90	19.53	13.64	39.48
	Hb%	76.35	85.03	82.61	55.13	67.48	85.51
	ΔG/mean%	6.39	11.37	71.30	22.18	18.97	69.53
Sakha94 (P1)	Mean ±SE	105.4 ±0.51	115.00 ±0.45	9.80 ±0.37	70.80 ±3.09	4.87 ±0.08	25.38 ±1.01
	CV%	1.08	0.92	8.54	9.75	3.64	8.9
Sids13 (P2)	Mean ±SE	105.20 ±0.37	107.60 ±0.51	9.40 ±0.40	62.20 ±2.22	4.45 ±0.10	22.26 ±0.70
	CV%	0.8	1.06	9.52	7.99	5.04	7.07
		Low input conditions					
Item		DH	PH	S/P	K/S	100-KW	GY/P
F2 Population	Mean ±SE	85.95 ±0.28	92.38 ±0.36	6.81 ±0.11	46.92 ±0.47	4.19 ±0.04	23.75 ±0.32
	Max.	105	109	13	68	6.55	44.76
	Min.	70	66	2.0	20	1.22	10.1
	Reduction%	16.42	16.12	42.68	30.77	7.30	29.08
	CV%	7.19	8.70	37.39	22.46	23.96	30.53
	Hb%	76.67	82.66	67.12	77.37	77.54	78.72
	ΔG/mean%	11.36	14.81	51.70	35.8	38.27	49.51
Sakha94 (P1)	Mean ±SE	90.00 ±0.71	99.20 ±0.58	8.20 ±0.37	52.20 ±1.11	4.58 ±0.14	21.52 ±0.85
	Reduction %	14.61	8.99	16.33	26.27	5.95	15.21
	CV%	1.76	1.31	10.2	4.77	6.7	8.79
Sids13 (P2)	Mean ±SE	99.20 ±0.58	94.80 ±0.66	7.20 ±0.37	50.20 ±1.02	4.04 ±0.06	19.67 ±0.53
	Reduction%	5.7	11.9	23.4	19.29	9.21	11.64
	CV%	1.31	1.56	11.62	4.54	3.57	6.07

ΔG = expected genetic advance from selecting the best 100/500 plants under favorable and Low input conditions. Hb = heritability in broad sense, DH= days to heading, PH = plant height, S/P = spikes/plant, K/S = kernels/spike, 100- KW= 100- kernel weight and GY/P = grain yield/plant.

The data of F_2 generation, conclude that sowing under low input conditions decreased days to heading, plant height, number of spikes plant, number of kernels spike, 100-kernel weight and grain yield plant by 16.42, 16.12, 42.68, 3077, 7.30 and 29.08%, respectively, These results are in agreement with those of (El-Morshidy *et al* 2010), (Soliman *et al* 2014) and (Salous 2017). Mahdy (2007) who reported an average reduction caused by drought stress of 14.21 and 6.30% for plant height and spike length respectively, across two seasons of evaluation of twenty varieties.

The coefficient of variability was appropriate for selection and ranged from 4.06 to 41.90% and from 7.19 to 37.39% for days to heading and number of spikes plant^{-1} under normal and low input conditions, respectively. Similar results were found by (Amin 2003), (Zakaria *et al* 2008), (Mahdy 2012) and (Salous *et al* 2014).

Estimates of broad sense heritability in the F_2 generation under normal conditions were 76.35, 85.03, 82.61, 55.13, 67.48 and 85.51% for days to heading, plant height, number of spikes plant^{-1}, number of kernels spike^{-1}, 100-kernel weight and grain yield plant^{-1}, while, under low input conditions they were 76.67, 82.66, 67.12, 77.37, 77.54 and 78.72 for the same characters, respectively Table (2). In the context Shabana et al. (1980) reported higher h^2 in perfect environments rather than in stressed one which partially coincides with our results. The expected genetic advance under selection was high and ranged from 6.39 to 71.30% under favorable conditions, and from 11.36 to 51.70% under low input conditions for days to heading and number of spikes plant^{-1}, respectively. These results are in agreement with those of Cheema et al. (2006), Khan *et al* (2007), Assefa and Lemma (2009), Mahdy *et al* (2012) and Soliman *et al* (2014).

Grain yield/plant (g) selection

Mean squares, phenotypic, genotypic coefficients of variability and heritability estimates

The family's mean squares due to families for all the studied characters were highly significant for the three generations under favorable and low input conditions (Table 3). This indicates the presence of genetic variability among families for further selection.

Table 3. Mean squares of the selected families F_3, F_4 and F_5 generations for all the studied characters under favorable and low input conditions.

Generation	Environment	SOV	Mean Squares					
			Heading date	Plant height	No. of spikes/plant	No. of kernels/spike	100-kernel weight	Grain yield/plant
F_3	Favorable conditions	Rep	11.9	5.07	26.76	14.43	0.02	33.05
		Families	16.51**	5.84**	1.38*	8.41**	13.33**	8.25**
		Error	1.17	4.049	0.86	10.26	0.04	6.03
	Low input conditions	Rep	1.6	9.14	7.963	7.09	0.01	0.403
		Families	22.21**	3.53*	2.22**	5.84*	5.4**	8.79**
		Error	1.135	6.16	0.35	15.69	0.03	3.59
F_4	Favorable conditions	Rep	2.81	25.01	12.95	5.11	0.012	2.08
		Families	16.29**	20.3**	2.23**	157.09**	0.77**	20.79**
		Error	1.99	5.92	0.61	12.03	0.03	5.94
	low input conditions	Rep	0.35	1.26	2.21	5.61	0.022	1.12
		Families	67.22**	55.1**	1.87*	165.89**	0.35**	7.7*
		Error	1.1	7.95	0.39	21.56	0.05	2.75
F_5	Favorable conditions	Rep	6.03	27.43	6.53	0.633	0.01	1.74
		Families	35.36**	18.23**	2.62**	141.17**	0.9**	36.38**
		Error	5.25	3.47	0.57	12.78	0.022	8.06
	low input conditions	Rep	0.03	1.23	1.6	21.23	0.01	0.02
		Lines	81.85**	59.58**	2.47**	155.73**	0.21*	10.21**
		Error	0.99	7.011	0.48	26.15	0.05	3.32

***, ** Significant at 5% and 1% probability level, respectively.**

On the other side phenotypic variance (σ^2p) and the genotypic variance (σ^2g) generally were smaller under favorable conditions than under low input conditions in the cycles C1, C2 and C3 (**Table 4**). The phenotypic variance (σ^2p) generally was smaller under normal irrigation than under low input conditions in C1, C2 and C3 Table (4). The genotypic variance; (σ^2g) was also smaller under normal condition than under drought stress in C0, C1, C2 and C3. The phenotypic coefficient of variability (PCV) under normal condition was 30.52 % for grain yield/plant in the F2 generation, and decreased to 12.74, 8.49 and 6.82% after C1, C2 and C3, respectively. Likewise, the PCV % under drought stress was slightly more than that under normal irrigation and showed the same trend, this could be due to higher mean grain yield under normal irrigation than under drought stress.

Table 4. Coefficients of variability, heritability and realized heritability of grain yield/plant as affected by three cycles of selection under favorable and low input conditions.

Selection cycle	Treatment	σ^2 p	σ^2 g	PCV%	GCV%	Heritability%	Realized heritability%
F_2 population (C_0)	Favorable conditions	74.53	47.69	30.52	24.00	85.51	--
	low input conditions	52.59	32.49	39.44	33.74	78.72	--
F_3 families (C_1)	Favorable conditions	33.22	31.21	12.74	12.35	93.94	43.81
	low input conditions	21.07	19.87	13.54	13.15	94.31	41.58
F_4 families (C_2)	Favorable conditions	6.93	4.95	8.49	7.63	71.43	54.69
	low input conditions	3.08	1.95	4.91	4.15	73.28	48.73
F_5 lines (C_3)	Favorable conditions	5.82	5.02	6.82	6.33	86.13	72.32
	low input conditions	3.41	2.29	4.47	3.67	67.50	60.45

The high estimates of broad sense heritability estimated from the expected mean squares generated from the evaluation of the selected families at one site in one season, which inflates family's mean squares by the confounding effects of the interactions of families, years and locations. However, the realized heritability of grain yield/plant was 43.81, 54.69 and 72.32% under normal condition, and 41.58, 48.73 and 60.45% under stress condition after C1, C2 and C3, respectively. These results are comparable with the work of (Talbert *et al* 2001), (Ahmed 2006), (Ali 2011), (Mahdy 2012), (Salous *et al* 2014), (Soliman *et al* 2014), (Mohiy 2015) and (Salous

2017) found a reduction in GCV% when they practiced selection for grain yield from F_3 to F_5 generation.

Means and observed gains under favorable conditions

Data in (**Table 5**) showed the selected ten lines for grain yield/plant of the three cycles of selection, either under favorable conditions or low input conditions when they were evaluated in the F_5 generation under non stressed and stressed environments.

Average mean of the group of ten lines which were selected under favorable conditions was 54.38 g/plant and ranged from 44.57 to 56.33 g/plant for line No.1 and line No.27, respectively, which slightly surpassed both bulk samples and the parental genotypes. The observed gain for all the selected families was highly significant observed gain from the better parent and ranged from 8.34 to 36.94% for line No.1 and line No.27, respectively, with an average 32.20% .The same trend was recorded for the bulk sample under optimal conditions with values ranged from -0.11% for line No.1 to 26.26% for family No.27 with an average of 21.89%.

The grain yield of the group of lines which were selected under favorable conditions and evaluated under stress conditions were ranged from 37.00 to 43.07g/plant for line No.25 and family No.14, respectively, with an average of 41.25 g/plant. Nine of the selected families showed highly significant observed gain from the bulk sample and better parent. The mean observed gain ΔG% and expected ΔG% was 19.97 and 16.12% when compared to both bulk and better parent, respectively.

Means and observed gains under low input conditions:

The results in Table (5) also revealed that the group of families which were selected for maximum grain yield/plant after three cycles of selection under low input conditions and evaluated under favorable conditions ranged from 34.25 for family No.1 to 48.00 for line No.15 with an average of 43.34 g/plant. Average of observed gain under favorable conditions was 43.37 and 46.82% from the bulk sample and the better parent, respectively. All the selected lines had a significantly observed gain from the bulk sample and better parent except for family No.7 under both conditions. The highest ΔG% bulk sample and ΔG% better parent values were recorded for lines No.1 and 99.

Table 5. Mean grain yield/plant and observed gain from the bulk sample (ΔG% Bulk) and from the better parent (ΔG% B.P) for the selected families after three cycles of selection under favorable and low input conditions.

Item	Family. No.	Evaluation under favorable conditions			Evaluation under low input conditions		
		Mean	ΔG% Bulk	ΔG% B.P	Mean	ΔG% Bulk	ΔG% B.P
Selection under favorable conditions	1	44.57	-0.11	8.34	42.46	23.50**	19.54**
	10	55.02	23.32**	33.76**	41.85	21.73**	17.82**
	14	54.77	22.76**	33.15**	43.07	25.28**	21.26**
	21	56.07	25.67**	36.30**	42.34	23.15**	19.20**
	25	55.80	25.07**	35.65**	37.00	7.62	4.17
	27	56.33	26.26**	36.94**	41.62	21.06**	17.17**
	49	55.00	23.26**	33.69**	39.83	15.85*	12.13*
	56	55.35	24.05**	34.55**	43.06	25.25**	21.23**
	96	55.47	24.33**	34.85**	40.71	18.41**	14.61**
	99	55.44	24.26**	34.77**	40.52	17.86**	14.08**
	Average	54.38	21.89	32.20	41.25	19.97	16.12
	Sakha94	41.14			35.52		
	Sids13	38.51			33.33		
	Bulk	44.62			34.38		
R.LSD 0.05		4.85			3.11		
R.LSD 0.01		6.63			4.26		
Selection under low input conditions	7	34.25	13.30	16.02	33.23	24.27*	25.63*
	10	44.33	46.64**	50.17**	32.42	21.24*	22.57*
	13	41.80	38.27**	41.60**	35.24	31.79**	33.23**
	15	48.00	58.78**	62.60**	34.67	29.66**	31.08**
	16	45.56	50.71**	54.34**	39.24	46.75**	48.36**
	35	44.05	45.72**	49.22**	37.69	40.95**	42.50**
	36	44.45	47.04**	50.58**	38.76	44.95**	46.54**
	42	43.01	42.28**	45.70**	34.67	29.66**	31.08**
	43	40.95	35.46**	38.72**	32.96	23.26*	24.61*
	99	47.02	55.54**	59.28**	34.65	29.58**	31.00**
	Average	43.34	43.37	46.82	35.35	32.21	33.66
	Sakha94	29.52			26.45		
	Sids13	27.33			24.33		
	Bulk	30.23			26.74		
R.LSD 0.05		2.66			5.92		
R.LSD 0.01		3.64			8.10		

*** and ** significant at 0.05 and 0.01 levels of probability, respectively.**

On the other hand, means of the group of families which were selected for superior grain yield/plant under low input conditions and evaluated under stress for the three cycles of selection, ranged from 21.24 for the family No.10 to 46.75 g/plant for the line No.16 with an average of 35.35 g/plant. The average observed gain under low input stress was 32.21 and 33.66% when compared to the bulk sample and the better parent (29.52), respectively. All the selected lines had a significant observed gain from the bulk sample and better parent .The family No.10 gave the lowest value being 21.24 and 22.57 while family No.16 gave the highest value being 46.75 and 48.36, respectively.

In general we can assure that selection for maximum grain yield plant^{-1} after three cycles under favorable conditions in this instance was useful than selection under low input stress. These results are in agreement with those of Ismail (1995), who mentioned that the observed gains in grain yield over the bulk sample and the better parent was 8.47% and 4.86% in the population and 6.96 and 6.41%, respectively. Kheiralla *et al* (2006) reported that the genetic gain for grain yield after two cycles of selection was 20.21 and 7.62%, respectively from the bulk sample and the better parent. In that respect, Mahdy *et al* (2012) and Soliman *et al* (2014), noted that the observed gains for grain yield after two cycles of selection reached 45.00 and 61.53% over the bulk sample and the better parent, respectively, which is coincide with our results.

Stress susceptibility index for grain yield/plant after three cycles of selection

Stress susceptibility index (SSI) for favorable and stress conditions of the selected lines for maximum grain yield/plant is presented in Table (6). The results of the highest selected lines under favorable conditions after three cycles of selection when evaluated under both conditions revealed that four lines; No; 1, 10, 14 and 56 showed stress susceptibility index (SSI) of 0.20, 0.99, 0.88 and 0.92, respectively and could be considered to be tolerant to stress conditions, while the other lines had (SSI) more than one and consequently had a good performance under favorable conditions.

Table 6. Stress susceptibility index (SSI) and Stress tolerant index (STI) for grain yield/plant after three cycles of selection.

Favorable conditions					low input conditions				
Family No.	Favorable conditions	Low input stress	SSI	STI	Line No.	Favorable conditions	Low input stress	SSI	STI
1	44.57	42.46	0.20	0.64	7	34.25	33.23	0.16	0.61
10	55.02	41.85	0.99	0.78	10	44.33	32.42	1.46	0.77
14	54.77	43.07	0.88	0.80	13	41.80	35.24	0.85	0.78
21	56.07	42.34	1.01	0.80	15	48.00	34.67	1.51	0.89
25	55.80	37.00	1.40	0.70	16	45.56	39.24	0.75	0.95
27	56.33	41.62	1.08	0.79	35	44.05	37.69	0.78	0.88
49	55.00	39.83	1.14	0.74	36	44.45	38.76	0.69	0.92
56	55.35	43.06	0.92	0.81	42	43.01	34.67	1.05	0.79
96	55.47	40.71	1.10	0.76	43	40.95	32.96	1.06	0.72
99	55.44	40.52	1.11	0.76	99	47.02	34.65	1.43	0.87
Mean	54.38	41.25	1.00	0.76	Mean	43.34	35.35	1.00	0.82
(P_1)	41.14667	35.52	0.57	0.49	(P_1)	29.52	26.45	0.56	0.42
(P_2)	38.51667	33.33	0.56	0.43	(P_2)	27.33	24.33	0.60	0.35
Bulk	44.62667	34.38	0.95	0.52	Bulk	30.23	26.74	0.63	0.43

On the other side, low input stress group of lines which were evaluated under both environments showed that the lines No; 7, 13, 16, 35 and 36 gave stress susceptibility index values of 0.16, 0.85, 0.75, 0.78 and 0.69 in the same respective order indicating to be tolerance under low input stress.

Rosielle and Hamblin (1981) mentioned that, selection under stress environment where genetic variance is generally low, will result in a decreased mean yield in non-stress environments, while selection for productivity will generally raise mean yield in both stress and non-stress environments. Kheiralla *et al* (2006) indicated that antagonistic selection decreased susceptibility index of the lines and increased synergistic impacts. They also added that the cultivar Misr1 gave value less than one (0.63) compared to the cultivar Gemmeiza9 and the bulk sample which gave values more than one (1.17 and 1.23), respectively. High magnitude of Stress Tolerance Index (STI) shows an intensive tolerance and the best advantage. Therefore, selection based on STI will result in high-yielding tolerant genotypes (Fernandez 1992) indicated that stress tolerance index (STI) can be used to identify genotypes that have high yield under both stress and non-stress conditions. Results in Table 6 showed that family No. 14 and 56 had the highest STI value being 0.80 and 0.81 under favorable conditions followed by family No. 16 and 36 which recorded (0.95 and 0.92), respectively under stress conditions which agrees with SSI values under both environments. Sanjari (2000) considered that drought stress tolerance index (STI) is appropriate to select the high yielding and drought tolerant wheat genotypes which agree with our finding. In addition, Aghaei *et al* (2004) detected that, when giving out with a large number of genotypes, it is better to screen them in two stages. First, genotypes with high values of STI should be choosed. Second, genotypes from previous phase should be screened for SSI and those with low values should be selected. This case leads to high-yielding genotypes in both stress and non-stress conditions (Ramirez and Kelly 1998).

In conclusion, the families No. 14 and 56 which were selected under both environments gave the highest grain yield. Meanwhile, the two families 16 and 36 which were selected under stress gave the highest grain yield under both environments by both SSI and STI values. Thus these lines were more tolerant under stress conditions as well as were good yielders under favorable conditions.

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إستجابة محصول الحبوب ومكوناته في قمح الخبز للإنتخاب من الجيل الثالث للجيل الخامس تحت ظروف المدخلات الأقل

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أجريت هذه التجربة خلال مواسم الزراعة الثلاثة ، ٢٠١٨/٢٠١٧، ٢٠١٩/٢٠١٨ و ٢٠٢٠/٢٠١٩، بمحطة البحوث الزراعية بالجميزة، مركز البحوث الزراعية ، مصر ، لدراسة الميزة النسبية للإنتخاب المنسب تحت الظروف المثلى وظروف المدخلات الأقل. تم تنفيذ ثلاثة دورات انتخابية لمحصول الحبوب تحت ظروف البيئتين. كانت العشيرة الاساسية عبارة عن الجيل الثانى للهجين سخا٩٤ × سدس١٣. في الجيل الخامس، تم تقييم منتخبات كل من الظروف المثلى وظروف المدخلات الأقل تحت ظروف كلتا البيئتين. ظهر معامل الإختلاف المظهرى لمحصول الحبوب/نبات في الجيل الثاني مرتفعا للغاية وبلغ ٣٩,٤٨% بمدى من ١٠,١٨ إلى ٥٨,١٣%

تحت الظروف المثلى، بينما تحت ظروف المدخلات الأقل وصل إلى ٣٠,٥٣% بمدى من ١٠,٠١ إلى ٤٤,٧٦%. وكان التباين الوراثي أقل قليلا من التباين المظهري في كلتا البيئتين، وانخفض بشكل عام من الجيل الثاني إلى الجيل الخامس. وقدرت درجة التوريث بالمعنى الواسع لمحصول الحبوب/نبات تحت الظروف المثلى وظروف المدخلات الأقل بقيمة ٨٦,١٣ و ٧٦,٥٠% بعد ثلاث دورات من الانتخاب على التوالي. وكانت كفاءة التوريث المحقق مرتفعا تحت الظروف المثلى (٤٣,٨١ و ٥٤,٦٩ و ٧٢,٣٢%) مقارنة بـ (٤١,٥٨ و ٤٨,٧٣ و ٦٠,٤٥%) تحت ظروف المدخلات الأقل للدورات الإنتخابية الأولى، الثانية والثالثة على الترتيب. وكانت الزيادة المحققة من الانتخاب تحت الظروف المثلى (والتي تم تقييمها تحت الظروف المثلى وظروف المدخلات الأقل) زيادة معنوية في محصول الحبوب/نبات عن العينة المجمعة بنسبة ٢١،٨٩ و ٤٣،٣٧% ، وعن الأب الأفضل بنسبة ٣٢،٢٠ و ٤٦،٨٢% تحت الظروف المثلى وظروف المدخلات الأقل على الترتيب. وأظهرت العائلات المنتخبة لمحصول الحبوب تحت ظروف المدخلات الأقل (والتي تم تقييمها تحت الظروف المثلى وظروف المدخلات الأقل) زيادة معنوية في محصول الحبوب/نبات عن العينة المجمعة بنسبة ١٦،١٢ و ٣٢،٢١% وعن الأب الأفضل بنسبة ١٩،٢٧ و ٣٣،٦٦% تحت الظروف المثلى وظروف المدخلات الأقل على الترتيب. وأظهرت النتائج أن الإنتخاب المضاد يقلل من الحساسية للإجهاد تحت ظروف المدخلات الأقل ، على عكس الإنتخاب المتوافق الذي يزيد من الحساسية للإجهاد تحت ظروف المدخلات الأقل. علاوة على ذلك ، كان الإنتخاب لمحصول الحبوب/نبات تحت ظروف المدخلات الأقل أفضل من الإنتخاب تحت الظروف المثلى.

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