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The Performance of some Bread Wheat Genotypes under Normal and Late Sowing Dates for Earliness and Morpho-Physiological Traits

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Cross Mark

ABSTRACT

Six bread wheat genotypes were crossed in half diallel model during 2021/2022 season, to determine the mean performance. Parent and their F_1 were evaluated using a randomized complete block design (RCBD) with 3 replications under normal and late sowing dates in the 2022/2023 season on the research farm of the agronomy division, faculty of agriculture, Mansoura University, Dakahlia Governorate, Egypt. Data were taken on the earliness and morpho-physiological traits. Results revealed that the variance of sowing dates was significant or highly significant for all studied traits except for total chlorophyll content. The sowing date × genotypes interactions were found to be significant for all traits except for grain filling rate. Each additive (D) and dominance (H_1 and H_2) gene effects were significant for most traits under each sowing date except additive gene effects for days to heading, days to maturity under late sowing date and chlorophyll content under normal sowing date, dominance gene effects for days to maturity, grain filling period, grain filling rate, under late sowing date and chlorophyll content under normal sowing date due (H_1 and H_2) and (H_1) for flag leaf area under normal sowing date. All the traits were given large values for heritability in the narrow sense ($h^2_{(n.s)}$) under each sowing date, except days to heading under late sowing date, days to maturity, flag leaf area and chlorophyll content under normal sowing date which had low values of heritability in narrow sense.

Keywords: Wheat (*Triticum aestivum* L.), sowing dates, mean performance, earliness and morph-physiological traits, Hayman analysis

INTRODUCTION

Wheat, also known as *Triticum aestivum* L., is regarded as the most strategic, cultivated crop both locally and internationally. For the large majority of people on the planet, it is their main source of nutrition, and for many others, it is their preferred diet (Hassan and Al Jubouri, 2023). Due to weather conditions varying from season to season, choosing an appropriate sowing date is also one of the requirements for achieving a high yield. One of the major reasons for the low wheat production is climate change. Wheat's low production is caused by a shorter growing season, high temperatures with little humidity, and higher temperature fluctuations (Abdallah *et al.,* 2019). Climate change is a major concern for wheat production, which has declined by 6% as a result of heat stress, particularly as temperatures rise (Abasi *et al.*, 2024). As a crop affected by temperature, late-sown crops are subjected to low temperatures during establishment and high temperatures during the reproductive phase, resulting in rapid crop maturity. This has an impact not just on yield, but also on yield components and other elements, growth, and development of wheat. It is often related to a reduced kernel weight (Shamsabadi *et al.*, 2019). The conditions that the crop will be exposed to throughout vital stages of its developmental cycle such as crucial times for yield and quality components are determined by the planting date. An appropriate planting time is different in various agroecological conditions. Optimum sowing date enhanced yield components and yield to ensure food security worldwide (Singh *et al.*, 2021). An estimate of For a breeding effort to be effective, gene action is essential. When developing crop plant types with high yields, parent selection is crucial for plant breeders. Various methodologies are available for analyzing diallel crosses such as Hayman's methodology which is effective in detecting gene actions such as additive, dominant, and epistatic gene effects (Hayman, 1954). Due to climatic fluctuations that take place during the growing season, constraints lower the production. Heat stress is one of the crucial factors influencing the wheat crop's productivity. Understanding the interactions between genes is essential for improving wheat crops. Considering the previously provided data, we used the diallel analysis described in Hayman methodology to quantify the gene action for many quantitative qualities in bread wheat and to explain the parents' genetic composition concerning numerous traits as a result, By emphasizing resistant genotypes and enhancing breeding methods that serve to promote heat stress resistance and ensure wheat yields from heat stress, attention should be gave to the sustainability of wheat production.

MATERIALS AND METHODS

Six genotypes for bread wheat were selected as parents in this study, indicating a wide range of variability in various traits. Table 1 contains the names of the parents, as well as their pedigree and origin. during the 2021/2022 season, planted the parental genotypes at different dates to compensate for discrepancies in flowering time. All feasible parallel combinations, avoiding reciprocals, formed between the six parents, resulting in fifteen crosses.

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Table 1. Parents names, pedigree, and origin.

No	Genotype	Pedigree	Origin
P_1	SIDS 14	BOW"S"/VEE"S"//BOW"S"/TSI/3/BANI SEWEF 1 SD293-1SD-2SD-4SD-0SD	Egypt
P_2	SAKHA 94	OPATA/RAYON//KAUZ CMBW90Y3180-0TOPM-3Y-010M- 010M-010Y-l0M-0I5Y-0Y-0AP-0S.	Egypt
P_3	SAKHA 95	PASTOR//SITE/MO/3/CHEN/ AEGILOPSSQUARROSA(TAUS)//BCN/4/WBLL1 CMSA01Y00158S-040POY-040M-030ZTM-040SY-26M-0Y-0SY-0S.	Egypt
P_4	GIZA 168	MRL/BUC//Seri CM93046-8M-0Y-0M-2Y-0B.	Egypt
P_5	LINE 1	CBSME4SA-BV05 CMSW96WM00910S-3DNB-010B-4DNB-015B-03DNB-0Y	CIMMYT*
P_6	MISR 3	Rohf 07*2/KiritiCGSS 05 B00123T-099T-0PY-099M-099NJ-6WGY-0B-0BGY-0GZ.	Egypt

In 2022/2023 season, the 21 entries (6 parents and 15 F_1) were examined in 2 sowing dates tests. The first experiment was sown on the normal planting date of 12th November while, the second experiment was sown on late planting date of 14th December.

During soil preparation, every one of the two experiments received fertilization with 15 kg P_2O_5/fad, 24 kg K_2O/fad in single dose, and 75 kg N/fad supplied in two equal doses. Following 27 days from planting, the first dose was 30% with planting and the second was 70% with the first irrigation. After 27 days of seeding, the initial dose was 30%, followed by 70% with the first irrigation. The two tests were carried out in the experimental farm of the agronomy department, faculty of agriculture, Mansoura University, Dakahlia Governorate, Egypt, utilizing RCBD with three replications.

Every replication had 21 rows (genotypes) and two rows (borders) that were 4 m long and 25 cm apart, with a 20 cm spacing among plants. Each row was sown with twenty grains, which were then manually drilled. All other cultural techniques, except planting dates, were followed as indicated for wheat cultivation. To reduce border impact, removed the two outside plants and the two exteriors of each row in each plot.

The examined traits:

Days to heading (DH, day), Days to anthesis (DA, day), Days to maturity (DM, day), Grain filling period (GFP, day), Grain filling rate (GFR, g/day), Flag leaf area (FLA, cm^2), Chlorophyll content (T. Chlo, SPAD), Plant height (PH, cm^2). For each character, ten plants were used to determine the traits, except catalase activity, peroxidase activity, and proline content, were estimates from 5 plants per plot.

Statistical analyses:

Plot mean analysis was used to examine the data. By Snedecor and Cochran (1980), all collected data were statistically analyzed using a randomized complete block design with three replications to examine the variations among different genotypes under each planting date. According to Gomez and Gomez (1984), the means of treatments were compared using the least significant differences values (LSD) at the 5% and 1% level of probability.

The diallel analysis technique was used for assessed additive and dominant genetic impacts and genetic variance was partitioned into consistent components by Hayman (1954 and 1958). Evaluates of the variation in genetics components were as follows: Components of deviation due to dominant gene effects (H1), dominance suggesting a symmetry of positive and negative effects (H2), dominance effects as the sum of algebraic values over all loci in heterozygous are phase in all crosses (h2), components of deviation due to additive gene effects (D), and mean of covariance of additive and dominance effects over the arrays (F) were the evaluations of the genetic variation. Singh and Chaudhary (1985) calculated the standard error to assess each of these elements.

The average degree of dominance at every locus $(H_1/D)^{1/2}$, the proportion of genes with positive and negative effects in the parents ($H_2/4H_1$), the proportion of genes that are recessive in the parents (KD/KR), and an indicator of the number of genes that contribute to parameter performance and indicate dominance to a certain degree (K). Additionally, for the F_1 generations, Mather and Jinks' (1982) formula was utilized to calculate heritability in the broad sense ($h_{2(b.s)}$) and heritability in the narrow sense ($h^2_{(n.s)}$).

Heritability estimates:

Heritability in Broad Sense

The ratio of genetic variance to the overall variance for a characteristic is the general definition of heritability. Heritability values were indicated in a broad sense and according to the following ranges: less than 40% low and more than 60% high. It is represented by the symbol $H^2_{b.s}$.

$$\mathbf{h^2_{(b.s)} = \sigma^2 G / \sigma^2 P}$$

Heritability in Narrow Sense:

the percentage of additive genetic diversity that contributes to the entire phenotypic variance. It shows how much a trait can be inherited from parents to their offspring as a result of the compounding effects of genes. H^2n.s: heritability in the narrow sense, where 20% is low and 50% or above is high.

$$\mathbf{h^2_{(n.s)} = \sigma^2 A / \sigma^2 P}$$

RESULTS AND DISCUSSION

Mean performance of earliness traits:

From the wheat breeder's view, the low values of DH, DA, DM and GFP are preferable. Mean values presented in Table 2 clearly showed that the earliness traits were highly significantly affected by sowing dates. These results are in the same trend with those reported by Aboshosha *et al.,* (2018), Emad (2018), and Ahmed (2021). For days to heading, days to anthesis and days to maturity Giza 168 was the earliest parent, and the earliest cross was obtained from Line1×Misr3 ($P_5 \times P_6$). However, for the grain-filling period among parents, the shortest GFP belonged to Sakha 95 among crosses, the shortest GFP belonged to Sakha 94 × Sakha 95 ($P_2 \times P_3$). While for grain filling rate the behavior of the parent indicated that Sakha 95 recorded high GRF, at the level of the crosses, the highest GFR belonged to Sakha 94 × Misr 3 ($P_2 \times P_6$).

Table 2. Mean of earliness traits affected by genotypes and Sowing dates.

Traits Treatments	Days to heading (day)	Days to Anthesis (day)	Days to maturity (day)	Grain filling period (day)	Grain filling rate (g/day)
Sowing dates effect					
Normal	69.51	78.34	137.12	58.78	0.65
Late	80.25	86.86	131.30	44.44	0.99
F-test	**	**	**	**	**
Genotypes					
(P1)	76.63	84.29	133.79	49.50	0.93
(P2)	82.10	89.00	135.16	46.16	0.85
(P3)	82.83	93.68	137.42	43.73	1.11
(P4)	67.34	75.32	138.15	62.83	0.66
(P5)	72.87	80.23	131.61	51.39	0.64
(P6)	73.51	81.28	134.33	53.06	0.73
P1×P2	76.75	84.14	132.39	48.25	0.79
P1×P3	75.88	82.98	132.38	49.39	0.86
P1×P4	72.24	79.53	136.31	56.78	0.74
P1×P5	73.78	81.44	132.22	50.79	0.80
P1×P6	75.11	82.95	134.93	51.98	0.80
P2×P3	82.87	91.44	136.45	45.01	0.90
P2×P4	72.61	79.03	134.49	55.46	0.85
P2×P5	76.04	82.34	133.05	50.71	0.77
P2×P6	77.93	85.09	132.91	47.82	0.94
P3×P4	69.41	78.81	133.12	54.31	0.86
P3×P5	75.55	82.62	132.04	49.42	0.78
P3×P6	75.36	82.91	134.27	51.36	0.91
P4×P5	74.48	81.18	136.14	54.96	0.70
P4×P6	72.04	79.47	135.39	55.93	0.74
P5×P6	67.21	76.92	131.92	55.00	0.83
F-test	**	**	**	**	**
LSD 5%	1.65	2.15	1.81	2.85	0.17
LSD 1%	2.19	2.85	2.40	3.78	0.22
Interaction					
F-test	**	**	**	**	N.S

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

Morpho-physiological traits:

From the wheat breeder's view, the high values of FLA and T.Chlo are preferable while for PH the low values would be the best. Results presented in Table 3 clearly indicate that the morpho-physiological traits were significantly or highly significantly affected by sowing dates except for chlorophyll content. These outcomes agreed with the findings published by Duby *et al*., (2019), Ahmed (2021). Among the studied parents, Giza 168 exhibited the broadest FLA. While, the cross Sids 14 × Giza 168 (P_1×P_4) produced the highest FLA values. While, the highest total T.Chlo among the parents belonged to Misr 3, the highest total T.Chlo for the F_1 crosses belonged to the cross Sakha 94 × Giza 168 (P_2×P_4). For the plant height among parents, the shortest were Misr 3, and among crosses, the shortest were Sakha 95×Giza 168 (P_3×P_4).

Table 3. Mean of morpho-physiological traits as affected by genotypes and Sowing dates.

Traits Treatments	Flag leaf area (cm^2)	Total chlorophyll (SPAD)	Plant height (cm^2)
Sowing dates			
Normal	40.22	34.50	112.34
Late	55.34	33.86	107.39
F-test	**	N.S	*
Genotypes			
(P1)	49.91	32.49	112.14
(P2)	39.57	34.03	108.50
(P3)	47.79	31.22	109.08
(P4)	53.63	31.00	102.58
(P5)	40.22	36.98	107.22
(P6)	41.80	37.78	101.22
P1×P2	47.26	34.56	113.56
P1×P3	46.99	32.47	114.92
P1×P4	57.61	32.89	108.72
P1×P5	55.40	35.61	114.17
P1×P6	46.78	34.48	110.33
P2×P3	51.48	33.81	112.50
P2×P4	48.79	35.71	108.25
P2×P5	41.53	37.50	110.50
P2×P6	42.14	35.54	111.75
P3×P4	55.54	31.49	107.28
P3×P5	44.76	32.53	110.28
P3×P6	43.04	34.01	111.82
P4×P5	48.24	36.86	111.56
P4×P6	53.84	32.74	108.74
P5×P6	47.05	34.11	112.03
F-test	**	**	**
LSD 5%	5.52	2.22	2.71
LSD 1%	7.32	2.95	3.60
Interaction			
F-test	*	**	**

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

Mean performance of earliness traits and the interaction:

Results presented in Table4 showed that the earliness traits were highly significantly affected by the interaction between wheat genotypes and sowing dates conditions except for GFR.

Table 4. Means of earliness traits as affected by the interaction between genotypes and Sowing dates.

Genotypes	Days to heading (day)		Days to Anthesis (day)		Days to maturity (day)		Grain filling period (day)	
	Normal	Late	Normal	Late	Normal	Late	Normal	Late
(P1)	70.75	82.50	79.67	88.92	136.08	131.50	56.42	42.58
(P2)	81.36	82.83	88.78	89.22	140.32	130.00	51.54	40.78
(P3)	83.07	82.58	99.00	88.37	144.11	130.72	45.11	42.36
(P4)	57.67	77.02	67.67	82.98	141.86	134.44	74.19	51.47
(P5)	64.50	81.23	73.65	86.80	132.11	131.11	58.46	44.31
(P6)	66.32	80.69	75.28	87.27	137.17	131.50	61.88	44.23
P1×P2	71.02	82.49	79.56	88.72	133.33	131.44	53.78	42.72
P1×P3	70.98	80.79	78.25	87.71	133.75	131.00	55.50	43.29
P1×P4	64.08	80.40	73.08	85.97	136.78	135.83	63.69	49.87
P1×P5	67.72	79.83	76.33	86.54	134.11	130.33	57.78	43.79
P1×P6	68.73	81.48	77.17	88.73	138.68	131.18	61.51	42.44
P2×P3	80.93	84.81	93.44	89.43	142.53	130.38	49.08	40.94
P2×P4	65.29	79.93	72.90	85.15	136.95	132.03	64.05	46.88
P2×P5	71.54	80.54	76.22	88.47	134.86	131.24	58.64	42.78
P2×P6	72.15	83.70	80.89	89.30	135.78	130.04	54.89	40.74
P3×P4	65.35	73.47	75.00	82.62	136.47	129.77	61.47	47.15
P3×P5	71.35	79.76	79.00	86.25	134.36	129.72	55.36	43.47
P3×P6	70.51	80.21	78.87	86.96	137.93	130.61	59.07	43.66
P4×P5	70.29	78.67	76.89	85.47	139.22	133.06	62.33	47.59
P4×P6	64.80	79.28	72.33	86.60	138.40	132.39	66.07	45.79
P5×P6	61.39	73.03	71.27	82.57	134.81	129.03	63.54	46.46
Mean	69.51	80.25	78.34	86.86	137.12	131.30	58.78	44.44
F-test	**		**		**		**	
LSD 1%	2.34		3.04		2.56		4.03	
LSD 5%	3.10		4.03		3.40		5.34	

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

These outcomes agreed with the findings published by Al-Ashkar *et al*., (2020) and Ahmed (2021). These results indicated that the wheat genotypes responded distinctly to sowing dates and there is a possibility of selection for the earliest genotypes. Results clearly showed that for DH and DA the earliest parent produced by Giza 168 under both sowing dates. While the earliest crosses was Line 1×Misr 3 (P_5×P_6) under both sowing dates. While for DM the earliest maturing parent was produced by Sakha 94 under late sowing date. While the earliest cross was Sids 14 × Sakha 94 (P_1×P_2) under both sowing dates. While for GFP, the lowest performance was produced by Sakha 95 at normal and late sowing dates, While, the lowest cross Sakha 94 × Misr 3 (P_2×P_6) under late sowing date, as shown in Figures 1, 2, 3, and 4.

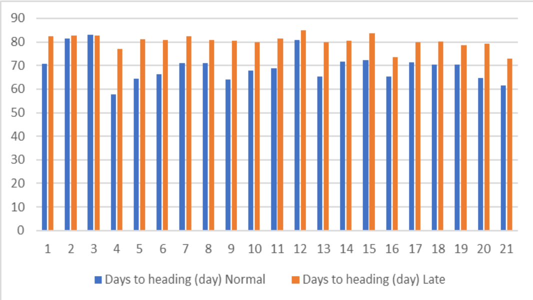

Fig 1. Mean performance of days to heading and the interaction

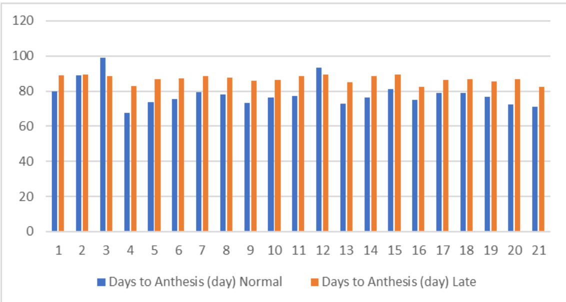

Fig 2. Mean performance of days to anthesis and the interaction

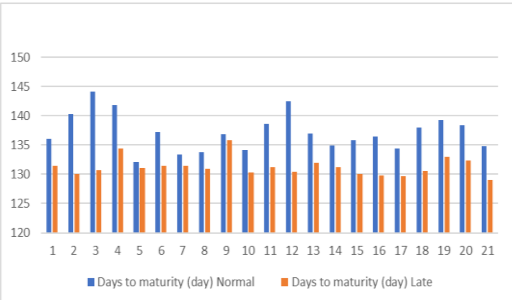

Fig 3. Mean performance of days to maturity and the interaction

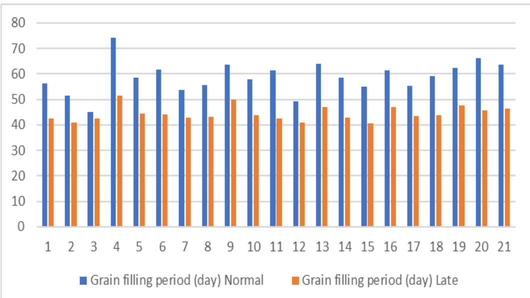

Fig 4. Mean performance of grain filling period and the interaction

Mean performance of morpho-physiological traits and the interaction:

Results presented in Table 5 show that the morpho-physiological traits were significantly or highly significantly affected by the interaction between wheat genotypes and sowing dates. Results clearly showed that parents' performance had the highest values in FLA were produced by Giza 168 under both sowing dates. While the highest crosses were obtained by Sids 14 × Giza 168 (P_1×P_4) under late sowing date. While, the highest parents at total T. Chlo were Misr 3 under both sowing dates respectively, While, the highest cross was Giza 168 × Line 1 (P_4×P_5) under normal sowing date. However, the shortest parent was Misr 3 at both sowing dates, while the shortest crosses were Sakha 95 × Giza 168 (P_3×P_4) under late sowing date, as shown in Figures 5, 6 and 7.

Table 5. Means of morpho-physiological traits as affected by the interaction between genotypes and Sowing dates.

Genotypes	Flag Leaf Area (cm^2)		Chlorophyll content (SPAD)		Plant height (cm^2)	
	Normal	Late	Normal	Late	Normal	Late
(P1)	41.88	57.95	33.54	31.44	115.94	108.33
(P2)	33.12	46.02	32.17	35.90	109.00	108.00
(P3)	45.62	49.96	34.02	28.42	115.11	103.06
(P4)	50.05	57.21	31.53	30.46	104.94	100.22
(P5)	35.17	45.28	36.72	37.24	110.33	104.11
(P6)	34.28	49.33	37.17	38.39	102.17	100.28
P1×P2	38.19	56.33	32.55	36.57	115.72	111.39
P1×P3	38.43	55.56	33.83	31.11	119.33	110.50
P1×P4	46.31	68.90	32.07	33.72	108.44	109.00
P1×P5	43.12	67.67	37.35	33.88	114.44	113.89
P1×P6	37.75	55.81	36.22	32.75	111.11	109.56
P2×P3	43.53	59.43	32.68	34.94	118.72	106.28
P2×P4	40.58	57.00	35.43	35.98	110.33	106.17
P2×P5	32.09	50.96	39.18	35.82	112.61	108.39
P2×P6	34.40	49.87	34.41	36.68	112.83	110.67
P3×P4	49.95	61.12	31.56	31.41	110.33	104.22
P3×P5	36.44	53.08	30.77	34.28	114.39	106.17
P3×P6	36.85	49.24	36.20	31.82	113.44	110.19
P4×P5	36.19	60.29	40.06	33.67	114.17	108.94
P4×P6	47.67	60.00	33.15	32.34	110.00	107.47
P5×P6	42.90	51.20	33.87	34.34	115.72	108.33
Mean	40.22	55.34	34.50	33.86	112.34	107.39
F-test	*		**		**	
LSD 1%	7.80		3.14		3.84	
LSD 5%	10.35		4.17		5.09	

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

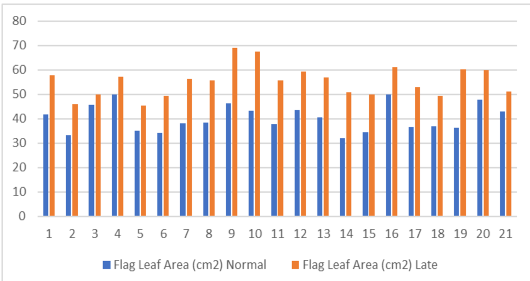

Fig 5. Mean performance of flag leaf area and the interaction

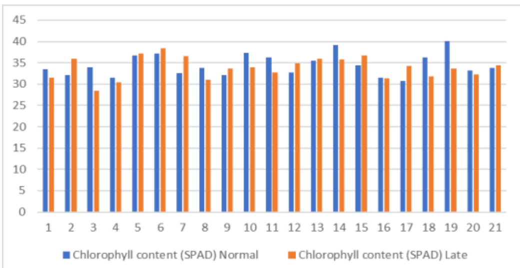

Fig 6. Mean performance of chlorophyll content and the interaction

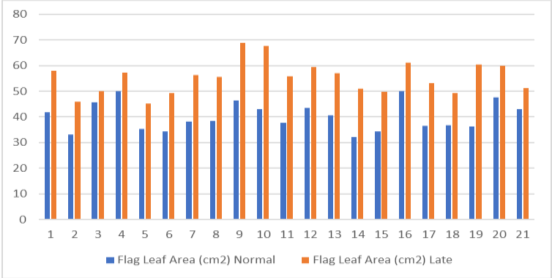

Fig 7. Mean performance of chlorophyll content and the interaction

Hayman analysis:

The outcomes in Table 6 showed that the basic hypotheses for diallel analysis seemed to be accurate for all traits under each sowing date. Table 7 shows that each additive (D) and dominance (H_1 and H_2) gene effects were significant for most traits under each sowing date except additive gene effects for DH and DM under late sowing date, T. Chlo under normal sowing date, dominance gene effect due to (H_1) for FLA under normal sowing date and DM, GFP,GFR under late sowing date due to (H_1 and H_2) effects.

Table 6. values of t^2, regression coefficients of covariance (Wr) on variance (Vr), and t-values for b=0 and b=1 for the earliness traits under normal (N) and late (L) sowing dates.

Traits	Cond	t^2	Regression coefficient	t value for b=0	t value for b=1
Days to heading	N	3.25	1.3±0.27	4.75**	-1.09
	L	3.63	0.31±0.2	1.6	3.5*
Days to anthesis	N	0.51	1.05±0.1	10.87**	-0.51
	L	0.23	0.4±0.35	1.13	1.69
Days to maturity	N	0.04	0.93±0.25	3.76*	0.29
	L	4.31	0.43±0.17	2.58	3.36*
Grain filling period	N	4.6	1.16±0.09	13.47**	-1.83
	L	0.33	1±0.3	3.38*	0.01
Grain filling rate	N	1.71	1.07±0.06	17.27**	-1.14
	L	5.75	1.42±0.41	3.48	-1.04
Flag leaf area	N	0.8	0.86±0.56	1.53	0.25
	L	0.97	0.53±0.26	2.02	1.8
Chlorophyll content	N	0.25	-0.38±0.35	-1.08	3.9*
	L	2.48	1.19±0.16	7.29**	-1.14
Plant height	N	1.21	1.14±0.28	4.01*	-0.5
	L	2.94	0.69±0.13	5.12**	2.35

b=0 and b=1 indicate differences in regression coefficient values from 0 and 1 (unit), respectively. *, = significant at 0.05 and 0.01, probability levels, respectively.**

Table 7. Estimates of genetic components of earliness traits under normal (N) and late (L) sowing dates.

Traits	Cond	D	F	H_1	H_2	h^2	E
Days to heading	N	97.19**±7.37	50.68**±18	44.45* ±18.71	37.51* ±16.71	5.66 ±11.25	1.61 ±2.79
	L	4.27 ±3.17	-2.19 ±7.74	24.08**±8.04	20.98**±7.18	4.04 ±4.83	0.53 ±1.2
Days to anthesis	N	127.41**±5.68	68.71**±13.88	63.84**±14.43	54.16**±12.89	28.08**±8.67	2.61 ±2.15
	L	4.72**±1.24	-1.74 ±3.02	7.35* ±3.14	6.87* ±2.81	0.79 ±1.89	0.55 ±0.47
Days to maturity	N	17.49**±2.33	13.1* ±5.7	23.52**±5.92	20.52**±5.29	11.21**±3.56	1.4 ±0.88
	L	1.18 ±0.83	-1.75 ±2.03	3.39 ±2.11	3.02 ±1.88	-0.21 ±1.27	0.85**±0.31
Grain filling period	N	94.38**±1.88	33.52**±4.59	15.71**±4.77	12.72**±4.26	2.11 ±2.87	3.2**±0.71
	L	11.87**±0.7	-3.76 ±1.71	1.92 ±1.78	2.22 ±1.59	-0.51 ±1.07	1.44**±0.26
Grain filling rate	N	0.0531**±0.001	0.0339**±0.0025	0.0122**±0.0026	0.0069**±0.0023	0.0023 ±0.0016	0.0017**±0.0004
	L	0.032**±0.002	0.012**±0.004	0.004 ±0.004	0.002 ±0.003	-0.002 ±0.002	0.003**±0.001
Flag leaf area	N	35.36**±6.49	-2.01 ±15.86	27.22 ±16.48	32.19* ±14.72	-6.76±9.91	12.55**±2.45
	L	20.23* ±9.22	-23.44 ±22.51	61.07**±23.39	56.63**±20.9	99.6**±14.07	9.4**±3.48
Chlorophyll content	N	4.14 ±4.71	2.22 ±11.51	22.39 ±11.96	20.03 ±10.69	-0.17±7.19	1.24±1.78
	L	15.15**±0.68	11.26**±1.66	7.9**±1.73	3.85* ±1.54	-0.51±1.04	1.4**±0.26
Plant height	N	27.63**±2.77	15.79* ±6.77	32.42**±7.04	27.49**±6.29	40.19**±4.23	2.06* ±1.05
	L	10.05**±1.3	4.14±3.17	24.36**±3.3	21.63**±2.95	61.02**±1.98	2.71**±0.49

D = additive variance. F = Relative frequency of dominant and recessive alleles in the parents. H_1 = dominance variance. H_2 = proportion of positive and negative genes in the parents. h^2 = dominance effect (over all loci in heterozygous phase). E = environmental variance.

Positive and highly significant of dominance effect (h_2) for DA and DM under normal sowing date FLA under late sowing date and PH under both sowing dates. The outcomes revealed that the proportion of dominance and recessive alleles in parents under investigation showed positive and significant or insignificant (F) values for all traits under each sowing date except for DH, DM, GFP under late sowing date and FLA under normal and late sowing date.

Table 8 shows different ratios as well as proportions. The average level of dominance $(H_1/D)^{1/2}$ is less than one for all traits under both sowing dates, except DH, DA, and FLA under late sowing date, DM, and PH under each sowing date. The proportion of genes with positive and negative impacts in parents ($H_2/4H_1$) was approximately equal to the ratio 0.25 for all studied traits under both sowing dates except GFR, PH under both sowing dates, and T. Chlo under late sowing date. For all traits, the ratio of dominant and recessive genes in the parents (K_D/K_R) was more than one under each planting date, except for DH, DA, DM, and GFP under late sowing date and FLA under both sowing dates.

According to the number of gene groups (h^2/H_2), the outcomes obviously demonstrated that each one of the examined traits was controlled at least by one gene group, except for FLA under late sowing date and PH under normal sowing date was governed at least by two gene groups and for PH under late sowing date was governed at least by three gene groups.

Table 8. Proportion of genetic components for the earliness traits under normal (N) and late (L) sowing dates.

Traits	Cond	$(H_1/D)^{1/2}$	$H_2/4H_1$	K_D/K_R	h^2/H_2	h^2(n.s)	h^2(b.s)
Days to heading	N	0.676	0.211	2.255	0.151	0.709	0.957
	L	2.374	0.218	0.805	0.193	0.453	0.95
Days to anthesis	N	0.708	0.212	2.231	0.519	0.679	0.948
	L	1.248	0.234	0.742	0.114	0.605	0.904
Days to maturity	N	1.160	0.218	1.954	0.546	0.361	0.863
	L	1.696	0.223	0.39	-0.071	0.506	0.739
Grain filling period	N	0.408	0.202	2.541	0.166	0.833	0.917
	L	0.402	0.289	0.435	-0.231	0.793	0.851
Grain filling rate	N	0.479	0.141	4.990	0.332	0.785	0.894
	L	0.36	0.123	3.178	-0.853	0.75	0.785
Flag leaf area	N	0.877	0.296	0.937	-0.210	0.440	0.659
	L	1.737	0.232	0.5	1.759	0.505	0.803
Chlorophyll content	N	2.324	0.224	1.261	-0.009	0.255	0.853
	L	0.722	0.122	3.12	-0.132	0.626	0.778
Plant height	N	1.083	0.212	1.716	1.462	0.881	0.484
	L	1.557	0.222	1.305	2.821	0.782	0.347

$(H_1/D)^{1/2}$ = mean degree of dominance. $H_2/4H_1$= The proportion of genes with positive and negative effects in the parents. KD/KR = The proportion of both dominant and recessive alleles in the parents. h^2/H_2 = number of effective genes. $h^2_{(n.s)}$ = Heritability in a narrow sense. $h^2_{(b.s)}$ = Heritability in the broad sense.

Heritability in narrow sense ($h^2_{(n.s)}$) estimates had large values for all traits at both sowing dates except for DH under late sowing date, DM, FLA, and T. Chlo under normal sowing date. Heritability in broad sense ($h^2_{(b.s)}$) estimates were large for all traits under both sowing dates, except for PH under both sowing dates. These outcomes agreed with the findings published by Abd elhady *et al.,* (2018), Al-Timimi *et al.,* (2020), Chaudhari *et al.,* (2023), and Hussien and Zaatar (2024).

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أداء بعض التراكيب الوراثية من قمح الخبز لصفات التبكير و الصفات المورفوفسيولوجية تحت الزراعة المبكرة و المتأخرة

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الملخص

تم تهجين ستة تراكيب وراثية من قمح الخبز في نموذج نصف تبادلي خلال موسم 2022/2021، لتحديد التأثيرات الجينية. تم تقييم الآباء والسلالات الناتجة منها F_1 باستخدام تصميم القطاعات كاملة العشوائية (RCBD) فى ثلاث مكررات في مواعيد الزراعة المبكرة والمتأخرة في موسم 2023/2022 في مزرعة الأبحاث التابعة لقسم المحاصيل، كلية الزراعة، جامعة المنصورة، محافظة الدقهلية، مصر.تم أخذ البيانات عن صفات التبكير والصفات الفسيولوجية. أظهرت النتائج أن تباين مواعيد الزراعة كان معنويا لجميع الصفات المدروسة باستثناء محتوى الكلوروفيل الكلي .ووجد أن تفاعلات مواعيد الزراعة × التراكيب الوراثية كانت معنوية لجميع الصفات باستثناء معدل امتلاء الحبوب. وجد أيضاً ان تباين الجين الإضافى (D) و السيادى (H_1 و H_2) كان معنوياً لجميع الصفات تحت كلا ميعادى الزراعة باستثناء تأثيرات الجينات المضافة لعدد الأيام حتى الطرد وعدد الأيام حتى النضج تحت موعد الزراعة المتأخر ومحتوى الكلوروفيل تحت موعد الزراعة العادي وتأثيرات الجينات السائدة لعدد الأيام حتى النضج وفترة امتلاء الحبوب ومعدل امتلاء الحبوب تحت موعد الزراعة المتأخر ومحتوى الكلوروفيل تحت موعد الزراعة العادي بالنسبة ل (H_1 و H_2) و ل (H_1) لمساحة الورقة الأولى تحت موعد الزراعة العادي. أعطيت جميع الصفات قيم عالية لنسبة التوريث على النطاق الضيق ($h_{2(n.s)}$) تحت كلا معادى الزراعة باستثناء عدد الأيام حتى النضج تحت موعد الزراعة المتأخر وعدد الأيام حتى النضج ومساحة ورقة العلم ومحتوى الكلوروفيل تحت موعد الزراعة العادي والتي كانت قيمها منخفضة لنسبة التوريث على النطاق الضيق.