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Esteimats of the Genetic Parameters for Yield and its Attributes of Wheat under Optimum and Late Sowing Dates

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ABSTRACT

Generation mean analysis was used for study the natural of gene action for yield and its attributes in three hybrids of bread wheat. Six parameters model was used in three wheat hybrids under optimum sown (25^{th} Nov.) and late sown (25^{th} Des.). The results cleared that the (P_1, P_2, F_1, F_2, Bc_1 and Bc_2) mean values in late sown were less than the optimum sown for all the studied characters in all hybrids. Heterosis relative to mid-parent and better parent was found to be positive significant for most characters under optimum and late sowing dates. The relative consequence of additive and dominance effects differed for characters in all hybrids under two different sowing dates. Dominance effects were generally more important than additive for most the characters in all the studied hybrids under two different sowing dates. Indicating, dominant genes played a part in the inheritance of these characters. Dominance × dominance gene interaction was higher in extent than additive × additive and additive × dominance in most the studied traits under two different sowing dates. Indicating, these traits are greatly influenced by dominance and dominance x dominance interactions. Therefore, it is approved to lateness selection to late segregating generations to raise homozygosity. Heritability values in narrow sense were moderate to high for all the studied characters in all hybrids under two different sowing dates. Genetic advance was ranged from low to high for all characters in all hybrids under two different sowing dates.

***Keywords*:** Bread wheat, Six parameter model, Sowing dates, Heterosis, Heritability, Gene action.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the main food and the fist cereal crop in Egypt. It is commonly considered as strategically substantial crop worldwide. The performance of a genotype in suitable environment is more important for wheat cultivation and improvement (Li *et al.*, 2006). One of the main aims of wheat breeders is producing and improvement cultivars capable of expressing their maximum potential yield and quality in diverse environments. Temperature is the important factor for good production of wheat especially during the grain filling period in many parts of the world. In Egypt, the optimum wheat sowing date in the second half of November. In the event of delaying planting during December, it may extend to mid-January. This condition causes great losses of yield due to high temperature during grain filling period. (Hamam, 2014; Raza *et al.*, 2018; Abd El-Rady, 2018; Abdallah *et al.*, 2019 and Koubisy 2019), had confirmed the damaging effect of heat on wheat.

Generation mean analysis is one of the most important technique used in plant breeding for estimating main gene effects (additive and dominance) and their interactions (additive × additive, additive × dominance, dominance × dominance) extended the pattern inheritance of yield and other plant related traits. In the earlier study, Gamble (1962) clearly the function of epistatic gene action (both additive and dominance gene action) in controlling the heredity of yield and yield related characters in different crops.

Estimations of heritability alone do not extend an concept about the expected gain in the next generation, but considered in coupling with estimates of selection response or genetic advance. The utility of heritability therefore increase when used to calculate selection restraint, which indicates the degree of gain in a traits obtained under particular selection pressure (Abd El-Aty *et al.*, 2005; Dawwam *et al.*, 2010; Kumar *et al.*, 2017; Kumar *et al.*, 2020 and Ahmed, 2021).

The aim is to study the nature of gene action, heterosis, inbreeding depression, heritability, as well as predicted genetic advance in three wheat hybrids under optimum and late sowing dates.

MATERIALS AND METHODS

Experimental procedures

This study was executed at the Experimental Farm, Faculty of Agriculture, Menoufia University, Shebin El-Kom, Egypt (latitude 30°31’39’’N, longitude 31°04’03’’E) during the three growing successive seasons of 2018/2019, 2019/2020 and 2020/2021. Six bread wheat cultivars representing a wide range of variety for several agronomic characters were used as parents to obtain the next three hybrids *i.e* Sakha 94 × Gemmeiza 12, Sids 14 × Gemmeiza 10 and Giza 171 × Misr 3. The origin and pedigree of these bread wheat genotypes are presented in Table 1.

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Table 1. The name, pedigree and origin of the studied parental varieties.

Hybrids	Name	Pedigree	Origin
H1	Sakha-94 (P1)	OPATA/RAYON//KAUZ.CMBW90Y3180-0TOM-3Y-010M-010Y-10M-015Y-0Y-0AP-0S.	Egypt
	Gemmeiza-12 (P2)	OTUS/3/SARA/THB//VEE CMSS97Y00227S-5y-010M-010Y-010M-2Y-1M-0Y-OGM	Egypt
H2	Sids-14(P1)	KAUZ"S"//TSI/SNB"S".ICW94-0375-4AP-2AP-030AP-OAPS-3AP.	Egypt
	Gemmeiza-10 (P2)	MAYA74"S"/ON//1160-147/3/BB/GLL/4/CHAT"S"/5/CROW"S".	Egypt
H3	Giza 171(P1)	Sakha 93/ Gemmeiza 9 Gz 2003-101-1Gz- 4Gz-1Gz-2Gz-0Gz	Egypt
	Misr 3 (P2)	CGSS 05 BOO123T-099T-0PY-099M-099NJ-6WGY-0B-0BGY-0GZ.	Egypt

In 2018/2019 season, the parents were crossed to produce F_1 hybrid grains. In 2019/2020 season, the F_1 hybrid plants were backcrossed to their parents to produce Bc_1 (F_1x P_1) and Bc_2 (F_1x P_2) generations. In addition F_1 plants were selfed to produce F_2 grains. In 2020/2021 season, the parents of each cross as well as their, F_1, F_2, Bc_1 and Bc_2 populations were sown under two different sowing dates *i.e* optimum (25th November) and late (25th December) in a randomized complete block design with three replications in rows and 10cm between plants within rows. All the recommended agricultural practices have been applied to both planting dates. Minimum and maximum temperature at Shebin El-Kom for growing season 2020/2021 are presented in Table 2.

Table 2. Maximum and minimum air temperatures (^{0}c) at Shebin El-Kom during 2020/2021 winter season.

Month	Nov. 2020	Dec. 2020	Jan. 2021	Feb. 2021	Mar. 2021	Apr. 2021	May. 2021
Max.	27	21	17	22	25	31	35
Min.	15	11	9	13	16	20	22

Studied traits

Data were recorded on 30 individual plants for non-segregate populations (P_1, P_2 and F_1) and 120 plants for Bc_1 and Bc_2 and 300 plants for F_2 population. The traits studied were heading date (day), maturity date (day), plant height (cm), number of spikes per plant, number of grains per spike, grain yield per spike (g), 1000-grain weight (g) and grain yield per plant (g).

Statistical procedures

The t-test was used to test the presence of genetic variance between parental means. Statistical procedures used herein would only be calculated if the F_2 genetic variance was found to be significant. A one tail (F) ratio was used to test the pressence of genetic variance within the F_2 population. Heterosis (H), was expressed as percent decrease or increase of the F_1 mean performance above the respective better parent and mid-parent. Inbreeding depression (I.d) was measured as the average percent decrease of the F_2 from the F_1. Potence ratio was also calculated according to Peter and Frey (1966). Nature of gene action was computed according to the relationships illustrated by Gamble (1962). In this procedure the means of the six populations of each hybrid were used to assessment six parameters of gene action. A test of significance of these parameters was conducted by the t-test. Heritability was estimated in both broad and narrow senses for F_2 generation, according to Mather's procedure (1949). The predicted genetic advance under selection (ΔG) was computed according to Johnson *et al*. (1955). This genetic gain represented as percentage of the F_2 mean performance was also acquired following Miller *et al*. (1958).

RESULTS AND DISCUSSION

Mean performance

Generation means of the six populations, t-test and f-test for all studied characters in the three hybrids under optimum (O) and late sowing (L) their revealed highly significant differences between parental genotypes for all the studied characters in all hybrids except, grain yield per spike in the 2nd hybrid under late sown and in the 3rd hybrid under two different sowing dates, indicating the presence of insufficient genetic variability. Genetic variance among F_2 plants was found to be significant for all characters under two different sowing dates. Indicates the presence of genetic variability was enough among genotypes.

Table 3, presented means and variances of (P_1, P_2, F_1, F_2, Bc_1 and Bc_2) for eight traits in each hybrid under optimum and late sowing dates. For heading date and maturity date the F_1 means were earlier than the mean of their parents for all hybrids under two different sowing dates. Results provide evidence for the presence of heterotic effects and over-dominance gene effects and the decreasing alleles were more frequent than increasing ones in the genetic rule of wheat genotypes. The F_1 means surpassed the better parent for traits in the three hybrids under two different sowing dates except, plant height and grain yield per spike in the 1st hybrid under two different sowing dates, plant height in the 3rd hybrid under two different sowing dates, number of spikes per plant and grain yield per plant in the 2nd hybrid under two different sowing dates, indicating the presence of over-dominance. Mean performance values of the F_2 population were less than F_1 for all the characters in the three wheat hybrids under two different sowing dates, except grain yield per spike in all hybrids under two different sowing dates, indicating the presence of inbreeding depression and transgressive segregations. However, mean values of Bc_1 and Bc_2 in all hybrids were varied and each tended toward the mean of its recurrent parent. Generally, the P_1, P_2, F_1, F_2, Bc_1 and Bc_2 mean values under late sown were less than the optimum sown for all studied traits, revealing the importance of planting under the optimum date. Pervious results are in a line with those obtained by Amin (2013), Hamam (2014), Raza *et al*. (2018) and Abdallah *et al*. (2019).

Table 3. Mean and variance for all studied traits in the three wheat hybrids (1) Sakha 94 x Gemmeiza 12, (II) Sids 14 x Gemmeiza 10 and (III) Giza 171 x Misr 3 under optimum (O) and late (L) sowing dates.

characters	Hybrid	Statistic	optimum sowing						Late Sowing					
			P_1	P_2	F_1	F_2	BC_1	BC_2	P_1	P_2	F_1	F_2	BC_1	BC_2
1) Heading date (day)	H 1	$\bar{X}$	100.34	95.03	93.82	96.86	99.08	92.65	97.14	93.22	91.56	92.35	94.13	89.76
		S2	10.23	9.22	11.22	46.23	33.25	30.23	9.64	7.56	4.63	37.85	25.64	22.63
	H 2	$\bar{X}$	95.14	97.31	90.66	92.76	91.41	96.04	89.11	92.66	87.43	91.03	86.75	93.12
		S2	9.56	11.03	8.47	66.23	44.23	38.72	12.78	14.22	12.46	79.23	60.23	42.35
	H 3	$\bar{X}$	102.19	100.12	98.43	103.45	105.07	103.87	98.02	95.76	93.11	97.85	102.43	99.33
		S2	10.75	9.63	8.66	86.57	56.23	49.35	16.45	18.63	15.56	87.56	60.18	52.45
2)Maturity date (day)	H 1	$\bar{X}$	156.87	152.34	145.82	143.25	148.67	145.25	147.11	143.56	138.27	140.63	145.47	140.18
		S2	5.43	7.23	6.03	22.23	12.12	17.45	7.63	6.23	3.78	28.68	19.57	17.53
	H 2	$\bar{X}$	149.22	157.36	148.06	144.67	147.14	154.33	133.86	136.72	131.65	134.35	135.07	138.18
		S2	4.33	5.44	8.23	25.45	17.63	14.78	8.67	9.45	7.86	31.06	22.12	19.07
	H 3	$\bar{X}$	152.01	149.03	144.61	147.14	150.03	148.33	141.03	138.41	136.76	139.44	143.06	140.56
		S2	19.03	21.03	17.03	92.24	51.05	70.86	7.86	8.74	5.63	32.45	21.56	19.53
3) Plant height (cm)	H 1	$\bar{X}$	114.33	116.04	115.47	102.38	107.82	113.07	110.14	113.12	112.44	98.64	105.63	111.52
		S2	7.33	8.31	5.23	32.45	21.45	19.26	11.54	9.56	6.78	41.36	30.25	21.15
	H 2	$\bar{X}$	108.11	107.26	104.56	97.32	106.48	109.15	104.08	99.45	97.38	95.64	100.05	103.47
		S2	6.34	10.75	5.16	44.53	24.58	33.17	10.82	13.02	9.63	56.08	36.45	33.06
	H 3	$\bar{X}$	111.82	109.78	113.43	110.02	114.03	112.34	107.34	104.65	109.13	106.14	112.06	110.13
		S2	12.56	18.36	15.63	62.56	42.12	39.45	9.56	8.55	6.78	39.56	27.06	25.63
4) No .of spikes per plant	H 1	$\bar{X}$	12.54	8.08	13.01	10.03	11.04	10.85	9.02	6.33	9.76	7.08	8.16	7.78
		S2	3.75	4.34	1.78	19.26	14.63	9.34	2.44	3.75	2.53	15.47	9.23	10.45
	H 2	$\bar{X}$	12.25	9.12	10.02	8.88	9.53	8.22	9.33	7.01	8.58	7.67	8.02	6.45
		S2	6.47	5.78	3.12	18.67	12.78	11.54	7.23	5.78	4.67	19.34	14.23	12.08
	H 3	$\bar{X}$	9.78	11.56	12.76	10.14	10.97	11.08	8.34	9.11	11.34	7.33	9.85	8.62
		S2	7.45	8.66	9.85	36.44	27.03	20.74	4.36	3.12	6.45	22.56	16.45	12.56
5) No. of grains per spike	H 1	$\bar{X}$	74.77	67.74	81.64	72.45	69.75	73.12	62.11	54.61	73.45	68.75	66.87	59.65
		S2	51.03	58.32	49.23	223.45	105.76	176.23	47.62	52.67	36.48	219.25	107.23	165.87
	H 2	$\bar{X}$	75.12	64.08	79.64	61.23	73.14	78.65	66.53	53.64	68.31	57.14	61.37	69.81
		S2	55.81	45.61	41.35	178.65	101.02	144.37	58.23	65.32	64.32	216.45	122.45	167.35
	H 3	$\bar{X}$	79.66	74.82	80.05	77.06	81.34	78.18	66.23	63.54	69.42	70.66	67.03	68.44
		S2	33.23	36.56	26.45	99.36	74.66	59.76	18.33	20.75	21.45	94.56	60.23	67.33
6) Grain yield per spike (g)	H 1	$\bar{X}$	4.17	3.88	2.99	3.37	2.66	3.08	3.24	2.47	2.66	3.02	2.33	2.89
		S2	0.88	1.11	0.75	4.02	1.78	3.56	0.41	0.32	0.23	2.13	1.65	1.02
	H 2	$\bar{X}$	2.78	2.11	3.66	4.02	2.45	2.03	2.22	1.99	2.87	3.12	2.13	1.86
		S2	1.32	0.98	2.23	6.11	4.33	3.77	0.88	2.03	0.84	6.11	3.88	4.88
	H 3	$\bar{X}$	4.45	4.17	4.51	5.12	3.18	2.89	3.36	3.11	3.51	3.78	2.18	2.02
		S2	2.47	3.03	2.23	9.11	5.66	6.33	1.63	1.05	0.98	5.03	4.02	2.44
7) 1000. grain weight (g)	H 1	$\bar{X}$	55.42	52.75	57.63	49.86	48.62	51.74	49.38	45.65	53.47	46.56	44.89	50.15
		S2	14.23	10.68	8.63	48.63	24.56	36.75	13.68	11.23	15.23	46.89	32.45	28.65
	H 2	$\bar{X}$	59.76	52.98	61.43	51.08	55.22	49.66	53.11	49.35	55.21	47.63	50.73	48.78
		S2	12.52	10.61	9.78	38.23	28.45	23.15	10.67	15.81	13.52	45.14	35.47	25.12
	H 3	$\bar{X}$	48.22	46.44	51.23	49.77	50.67	47.35	44.56	42.46	46.06	43.44	45.33	43.15
		S2	8.46	6.42	4.55	42.12	33.45	20.56	7.23	9.56	7.11	42.23	26.78	28.46
8) Grain yield per plant(g)	H 1	$\bar{X}$	26.56	24.06	27.31	23.33	22.76	24.67	23.85	20.64	24.81	19.76	21.36	18.57
		S2	13.02	10.45	9.07	52.45	28.74	37.15	11.35	10.35	9.11	66.56	38.47	41.26
	H 2	$\bar{X}$	31.06	25.46	28.64	21.35	24.64	22.82	24.33	21.67	23.85	19.87	22.57	20.86
		S2	27.35	24.12	18.23	78.15	55.74	52.09	24.63	22.12	19.63	71.47	45.31	53.23
	H 3	$\bar{X}$	28.03	26.79	32.22	25.34	30.75	27.08	24.56	22.47	26.31	23.67	27.12	25.02
		S2	12.56	14.86	12.33	72.56	44.23	47.53	11.34	14.02	16.03	57.15	33.02	42.11

Gene action

Testing for non-allelic interaction (A, B and C) together with the six parameters model and type of epistasis was done. The results revealed the existence of non-allelic interaction for all studied traits in all the studied hybrids. It is valuable to remind that at least one of the A, B and C tests was significant for the former traits, indicating the sufficiency of the six-parameters model to dissect the type of gene action controlling the trait in these hybrids.

Estimates of the six parameters *i.e* F_2 mean (m), additive (a), dominance (d), additive × additive (aa), additive × dominance (ad) and dominance × dominance (dd) are given in Table 4. The estimated mean effect parameter (m) was found to be highly significant. First, it is clear that all studied characters were quantitatively inherited. The same results were obtained by Abd El-Aty *et al.* (2005), Dawwam *et al.* (2010) and Koubisy (2019).

Additive gene effects (a) was significant positive for heading date in the 1st hybrid under optimum sowing date and the 1st and 3rd hybrids under late sowing date, maturity date in the 1st and 2nd hybrids under two different sowing dates, plant height in the 3rd hybrid under two different sowing dates, number of spikes per plant in the 2nd hybrid under two different sowing dates, number of grains per spike in the 3rd hybrid under optimum sowing date and the 1st hybrid under late sown, grain yield per spike in the 2nd hybrid under optimum sown, 1000- grain weight in the 2nd and 3rd hybrids under two different sowing dates and grain yield per plant in the 2nd and 3rd hybrids under optimum sowing and all hybrids under late sowing.

Also, additive gene effects (a) was negative significant for heading date and maturity date in the 2nd hybrid under two different sowing dates, plant height in the 1st and 2nd hybrids under two different sowing dates. Subsequently, phenotypic selection was more effective for improving earliness and shortness traits in these hybrids. Similar results were reported by Hamam (2014), El-Hawary (2016) and Koubisy (2019).

Dominance gene effect (d) was positive significant for heading date in the 3rd hybrid under late sowing date, maturity date in the 1st and 2nd hybrids under optimum sowing date and the 2nd and 3rd hybrids under late sowing date, plant height in all hybrids under two different sowing dates, number of spikes per plant in the 1st and 3rd hybrids under two different sowing dates, number of grains per spike in the 2nd and 3rd hybrids under optimum sown and the 2nd hybrid under late sown, 1000- grain weight in the 1st and 2nd hybrids under optimum sown and all hybrids under late sowing and grain yield per plant in the 2nd and 3rd hybrids under two different sowing dates. Meanwhile, negative significant effects were listed for heading date in the 1st hybrid under optimum sowing and the 1st and 2nd hybrids under late sowing date, number of grains per spike in the 1st and 2nd hybrids under late sowing date and grain yield per spike in all hybrids under two different sowing dates. Results clear that the great prominence of the dominance gene effects in the inheritance of these characters. Negative sign for dominance influence indicates that the alleles accountable of less value for these characters were dominant over the alleles controlling high value. Abd El-Rady (2018) recorded a negative sign for dominance for 1000- grain weight under late sown.

The type of epistatic gene effects additive × additive (aa) were found to be significant and positive for heading date in the 3rd hybrid under late sown, maturity date and plant height in all hybrids under two different sowing dates, number of spikes per plant in the 1st and 3rd hybrids under both sowing dates, number of grains per spike in the 2nd and 3rd hybrids under optimum sowing date and the 2nd cross under late sowing date, 1000-grain weight in the 2nd hybrid under optimum sown and the 1st and 2nd hybrids under late sowing and grain yield per plant in the 2nd and 3rd hybrids under two different sowing dates, reporting that these characters have rising genes and selection for refinement could be efficient. Results are a line in with Koubisy (2019) and Abd El-Rady (2018). On the other hand, significant and negative values of additive × additive gene effects were reported for heading date in the 1st hybrid under optimum sowing, number of grains per spike in the 1st and 3rd hybrids under late sowing and grain yield per spike in all hybrids under two different sowing dates. Negative additive × additive gene influence were recorded for days to heading and number of spikes per plant (Hamam 2014).

For additive × dominance (ad) type of epistatic gene effects, significant and positive were found for heading date and maturity date in the 1st hybrid under optimum sowing and in the 1st and 3rd hybrids under late sowing, number of spikes per plant in the 3rd hybrid under late sowing, number of grains per spike in the 1st hybrid under late sowing, 1000-grain weight in the 2nd and 3rd hybrids under optimum sowing and grain yield per plant in the 3rd hybrid under optimum sowing. Additive × dominance resort to segregate in the next generations, it would be better to retard selection to later generations to increase homozygosity. Results are in a line with those obtained by Hamam (2014), Abd El-Rady (2018) and Koubisy (2019).

However, significant and negative additive × dominance were found for heading date and maturity date in the 2nd hybrid under both sowing dates, plant height in the 1st and 2nd hybrids under two different swing dates, number of spikes per plant, grain yield per spike and 1000-grain weight in the 1st hybrid under optimum and late swing dates, number of grains per spike in the 1st and 2nd hybrids under optimum sowing and the 2nd and 3rd hybrids under late sowing and grain yield per plant in the 1st hybrid under optimum sowing. Results cleared that the inheritance of these characters were efficient by recurrence influence of epistatic gene.

Dominance × dominance (dd) interactions were significant and positive for heading date in the 1st hybrid under late sowing date, number of spikes per plant in the 2nd hybrid under two different sowing dates, number of grains per spike in the 1st hybrid under optimum sowing and the 1st and 3rd hybrids under late sowing, grain yield per spike in all hybrids under two different sowing dates, 1000-grain weight in the 1st and

2nd hybrids under optimum sowing date and the 1st hybrid under late sowing date and grain yield per plant in the 1st and 2nd hybrids under optimum sowing date and the 1st hybrid only under late sowing date. Results confirmed that the importance of dominance × dominance gene action in the genetic system controlling these traits so, selection should be efficient in delayed generations. Negative and significant of dominance × dominance interactions were obtained for heading date in the 3rd hybrid under two different sowing dates, maturity date in all hybrids under two different sowing dates except the 1st hybrid under optimum sown, plant height in all hybrids under two different sowing dates, number of spikes per plant in the 3rd hybrid under late sowing, number of grains per spike in the 2nd and 3rd hybrids under optimum sowing and the 2nd hybrid under late sowing and grain yield per plant in the 3rd hybrid only under two different sowing dates, indicating their reducing effect in the expression of these traits and there is no breeding importance in proceeding generations. Previous results are in convention with those acquired by Abd El-Rady (2018), Koubisy (2019) and Ahmad (2021).

Table 4. Gene action parameters in the three wheat hybrids under optimum (O) and late (L) sowing dates.

characters	Sowing dates s	Hybrid	Gene action parameters					
			m	a	d	aa	ad	dd
1) Heading date (day)	O	H1	96.86**	6.43**	-7.84**	-3.98*	3.77**	3.53
		H2	92.76**	-4.63**	-1.71	3.86	-3.55**	-4.99
		H3	103.45**	1.20	1.35	4.08	0.16	-22.79**
	L	H1	92.35**	4.37**	-5.24**	-1.62	2.41**	7.32*
		H2	91.03**	-6.37**	-7.84**	-4.38	-4.59**	1.27
		H3	97.85**	3.10**	8.34**	12.12**	1.97*	-35.64**
2)Maturity date (day)	O	H1	143.25**	3.42**	6.05**	14.84**	1.15*	-1.83
		H2	144.67**	-7.19**	19.03**	24.26**	-3.12**	-24.50**
		H3	147.14**	1.70*	2.25	8.16**	0.21	-14.62**
	L	H1	140.63**	5.29**	1.72	8.78**	3.52**	-12.87**
		H2	134.35**	-3.11**	5.46**	9.10**	-1.68*	-21.72**
		H3	139.44**	2.50**	6.52**	9.48**	1.19*	-23.76**
3) Plant height (cm)	O	H1	102.38**	-5.25**	32.55**	32.26**	-4.39**	-12.73**
		H2	97.32**	-2.67**	38.85**	41.98**	-3.09**	-48.75**
		H3	110.02**	1.69*	15.29**	12.66**	0.67	-16.94**
	L	H1	98.64**	-5.89**	40.55**	39.74**	-4.40**	-25.90**
		H2	95.64**	-3.42**	20.09**	24.48**	-5.74**	-33.23**
		H3	106.14**	1.93**	22.95**	19.82**	0.58	-33.95**
4) No .of spikes per plant	O	H1	10.03**	0.19	6.36**	3.66**	-2.04**	-0.80
		H2	8.88**	1.31**	-0.68	-0.02	-0.26	5.93**
		H3	10.14**	-0.11	5.63**	3.54*	0.78	-0.78
	L	H1	7.08**	0.38	5.64**	3.56**	-0.96*	-0.57
		H2	7.67**	1.57**	-1.33	-1.74	0.41	6.30**
		H3	7.33**	1.23*	10.23**	7.62**	1.62**	-4.43*
5) No. of grains per spike	O	H1	72.45**	-3.37*	6.33	-4.06	-6.88**	24.11**
		H2	61.23**	-5.51**	68.70**	58.66**	-11.03**	-63.76**
		H3	77.06**	3.16**	13.61**	10.80**	0.74	-15.26**
	L	H1	68.75**	7.22**	-6.87*	-21.96**	3.47*	32.54**
		H2	57.14**	-8.44**	42.03**	33.80**	-14.88**	-39.37**
		H3	70.66**	-1.41	-7.16*	-11.70**	-2.75*	9.37*
6) Grain yield per spike (g)	O	H1	3.37**	-0.42*	-3.04**	-2.00**	-0.57**	4.55**
		H2	4.02**	0.42*	-5.89**	-7.11**	0.08	10.35**
		H3	5.12**	0.29	-8.14**	-8.34**	0.15	13.84**
	L	H1	3.02**	-0.56**	-1.84**	-1.64**	-0.95**	2.23**
		H2	3.12**	0.27	-3.74**	-4.50**	0.15	6.47*
		H3	3.78**	0.16	-6.45**	-6.72**	0.04	11.81**
7) 1000-Grain weight (g)	O	H1	49.86**	-3.12**	4.83**	1.28	-4.46**	21.43**
		H2	51.08**	5.56**	10.50**	5.44**	2.17**	20.40**
		H3	49.77**	3.32**	0.86	-3.04	2.43**	4.12
	L	H1	46.56**	-5.26**	9.79**	3.84*	-7.13**	8.05*
		H2	47.63**	1.95**	12.48**	8.50**	0.07	5.36
		H3	43.44**	2.18**	5.75**	3.20	1.13	-1.02
8) Grain yield per plant(g)	O	H1	23.33**	-1.91**	3.54	1.54	-3.16**	8.84*
		H2	21.35**	1.82*	9.90**	9.52**	-0.98	9.36*
		H3	25.34**	3.67**	19.11**	14.30**	3.05**	-10.70*
	L	H1	19.76**	2.79**	3.38	0.82	1.18	13.43**
		H2	19.87**	1.71*	8.23**	7.38**	0.38	-0.54
		H3	23.67**	2.10**	12.39**	9.60**	1.05	-14.23**

***, ** Significant at 0.05 and 0.01 probability levels, Respectively.**

Heterosis, inbreeding depression and potence ratio

Percentages of heterosis over mid-parents and better parent, inbreeding depression, and potence ratio under optimum and late sowing dates are given in Table 5.

Negative and significant heterosis over mid and better parent values were obtained for heading date and maturity date in all hybrids under two different sowing dates, plant height in the 2nd hybrid under two different sowing dates and grain yield per plant in the 1st hybrid under optimum sown. Also, number of spikes per plant in the 2nd hybrid under optimum sown, grain yield per spike in the 1st hybrid under late sowing and grain yield per plant in the 2nd hybrid under optimum sowing were found to be negative significant heterosis over better parent only. However, positive significant heterosis over mid parent values were found for plant height in the 3rd hybrid and number of spikes per plant in the 1st and 3rd hybrids under two different sowing dates, number of grains per spike and 1000-grain weight in all hybrids under two different sowing dates, grain yield per spike in the 2nd hybrid and grain yield per plant in the 1st and 3rd hybrids under two different sowing dates. Moreover, positive and significant heterosis over better parent were found for plant height in the 1st and 3rd hybrids under two different sowing dates, number of spikes per plant in the 1st and 3rd hybrids on late sowing, number of grains per spike in all hybrids under optimum sown and the 1st and 3rd hybrids on late sowing, grain yield per plant in the 2nd hybrid under two different sowing dates, 1000-grian weight in all hybrids under two different sowing dates and grain yield per plant in the 3rd hybrid only under two different sowing dates. Also, Abd El-Aty et al. (2005), Hamam (2014), Koubisy (2019) and Kumar et al. (2020) found that significant positive heterosis effects relative to mid parent and better parent.

Table 5. Heterosis(%), inbreeding depression (%) and potence ratio, in all the studied hybrids under optimum (O) and late (L) sowing dates.

characters	Sowing dates	Hybrid	Heterosis % MP	Heterosis % BP	Inbreeding depression %	Potence ratio
1) Heading date (day)	O	H1	-3.95**	-1.27	-3.24**	1.45
		H2	-5.78**	-4.71**	-2.32**	5.12
		H3	-2.69**	-1.68*	-5.10**	2.63
	L	H1	-3.80**	-1.78**	-0.86	1.85
		H2	-3.80**	-1.88*	-4.12**	1.95
		H3	-3.90**	-2.76*	-5.09**	3.34
2)Maturity date (day)	O	H1	-5.68**	-4.28**	1.76**	3.87
		H2	-3.41**	-0.77*	2.29**	1.28
		H3	-3.92*	-2.96**	-1.75**	3.96
	L	H1	-4.86**	-3.68**	-1.71**	3.98
		H2	-2.69**	-1.65**	-2.05**	2.55
		H3	-2.25**	-1.19*	-1.96**	2.25
3) Plant height (cm)	O	H1	0.250	6.79**	11.33**	-0.04
		H2	-2.90**	-2.52**	6.92**	7.35
		H3	2.37*	3.33**	3.01**	-2.57
	L	H1	0.730	4.75**	12.27**	-0.18
		H2	-4.31**	-2.08*	1.78*	1.89
		H3	2.95**	4.28**	2.74**	-2.33
4) No .of spikes per plant	O	H1	26.18**	3.74	22.91**	1.21
		H2	-6.22	-18.20**	11.37**	-0.42
		H3	19.58**	10.38	20.53**	2.35
	L	H1	27.16**	8.20*	27.45**	1.55
		H2	5.02	-8.04	10.61*	0.35
		H3	29.97**	24.47**	35.36**	6.79
5) No. of grains per spike	O	H1	14.57**	9.18**	11.25**	2.95
		H2	14.42**	6.02**	23.11**	1.82
		H3	3.63*	12.69**	3.74**	-0.45
	L	H1	25.85**	18.25**	6.39**	4.02
		H2	13.68**	2.67	16.35**	1.27
		H3	6.98**	4.82**	-1.78	3.37
6) Grain yield per spike (g)	O	H1	-25.71**	-28.29**	-12.71*	-7.14
		H2	49.69**	31.65**	-9.84	1.92
		H3	4.64	1.34	-13.53*	1.43
	L	H1	-6.83	-17.90**	-13.53**	-0.51
		H2	36.34*	29.27*	-8.71	6.65
		H3	8.50	4.46	-7.69	2.20
7) 1000. Grain weight (g)	O	H1	6.55**	3.98**	13.48**	2.65
		H2	8.97**	2.79*	16.84**	1.49
		H3	8.24**	6.24**	2.85**	4.38
	L	H1	12.53**	8.28**	12.92**	3.19
		H2	7.76**	3.95*	13.73**	2.11
		H3	5.86**	3.36*	5.68**	2.42
8) Grain yield per plant(g)	O	H1	7.90*	2.82	14.57**	1.60
		H2	1.34	-37.06**	25.45**	0.02
		H3	17.54**	14.94**	21.35**	7.75
	L	H1	11.53**	4.03	20.35**	1.59
		H2	3.69	-1.97	16.68**	0.64
		H3	11.88**	7.13*	10.03**	2.67

***, ** Significant at 0.05 and 0.01 probability levels, Respectively.**

Inbreeding depression (I.d) measured as reduction in performance of F_2 generation relative to F_1 is given in Table 5.

Results showed significant positive inbreeding depression values for all traits under two different sowing dates, except heading date and grain yield per spike in all hybrids under two different sowing dates, maturity date in the 3rd hybrid under optimum sowing and all hybrids under late sowing and number of grains per spike in the 3rd hybrid under late sowing only. These results are predictable because the term of heterosis in F_1 will be decreased in F_2 generation due to selfing and beginning homozygosity. Similar results were obtained by El-Hawary (2016) and Kumar *et al.* (2017).

Potence ratio values refers to over dominance in all hybrids under both sowing dates for most studied characters, where its values exceeded unity. Meanwhile, potence ration values for plant height in the 1st and 3rd hybrids, number of spikes per plant in the 2nd hybrid, grain yield per spike in the 1st hybrid and grain yield per plant in the 2nd hybrid under two different sowing dates and number of grains per spike in the 3rd hybrid under optimum sowing only were less than unity, indicating partial dominance for these traits. Previous results were harmony with those procured by Abd-El-Aty and Katta (2007), Dawwam *et al.* (2010), Hamam (2014) and Koubisy (2019).

Heritability and genetic advance

Heritability assessment in broad and narrow-senses and genetic advance are given in Table 6.

Table 6. Heritability estimates and genetic advance expressed as a percent of the F_2 mean (∆g %) for all studied traits in the three hybrids under optimum (O) and late (L) sowing dates.

Characters	Sowing dates	Hybrid	Heritability % Broad sense	Heritability % Narrow sense	∆g%
1) Heading date (day)	O	H1	77.88	62.68	9.06
		H2	85.37	74.75	13.51
		H3	88.82	78.04	14.45
	L	H1	80.77	72.47	9.95
		H2	83.39	70.53	14.21
		H3	80.72	71.36	14.05
2)Maturity date (day)	O	H1	71.97	66.98	4.54
		H2	76.42	72.65	5.23
		H3	79.36	67.83	9.12
	L	H1	79.49	70.64	5.54
		H2	72.12	67.38	5.75
		H3	77.16	73.37	6.17
3) Plant height (cm)	O	H1	78.56	74.55	8.54
		H2	83.34	70.31	9.93
		H3	75.19	69.61	10.31
	L	H1	77.53	75.72	10.17
		H2	80.11	76.05	12.27
		H3	79.02	66.81	8.15
4) No .of spikes per plant	O	H1	82.92	75.55	68.09
		H2	72.55	69.74	69.90
		H3	76.25	68.91	84.51
	L	H1	81.21	72.78	83.29
		H2	69.53	63.96	75.55
		H3	79.42	71.41	95.32
5) No. of grains per spike	O	H1	76.34	73.80	31.36
		H2	73.36	62.64	28.16
		H3	67.71	64.71	17.24
	L	H1	79.21	75.43	33.47
		H2	71.06	66.11	35.06
		H3	78.66	65.10	18.45
6) Grain yield per spike (g)	O	H1	77.28	67.16	82.32
		H2	75.28	67.43	85.41
		H3	71.71	68.38	83.04
	L	H1	84.97	74.65	74.31
		H2	79.54	56.62	92.42
		H3	75.74	71.57	87.47
7) 1000. grain weight (g)	O	H1	77.01	73.92	21.29
		H2	71.31	65.03	16.22
		H3	84.62	71.77	19.27
	L	H1	71.46	69.69	21.12
		H2	70.46	65.77	19.11
		H3	81.13	69.19	21.32
8) Grain yield per plant(g)	O	H1	79.32	74.37	47.56
		H2	70.27	62.02	52.90
		H3	81.74	73.54	50.93
	L	H1	84.57	80.21	68.22
		H2	69.04	62.12	54.45
		H3	75.85	68.53	45.09

Heritability values in broad sense were relatively high for all studied traits in all hybrids. Heritability ranged from 67.71%for number of grains per spike to 88.82% for heading date in the 3rd hybrid under optimum sown, from 69.04% for grain yield per plant in the 2nd hybrid to 84.97% for grain yield per spike in the 1st hybrid under late sowing. Heritability values in narrow sense were moderate to high for all characters in all hybrids, ranged from 62.02% for grain yield per plant in the 2nd hybrid to 78.04% for heading date in the 3rd hybrid under optimum sown, from 56.62% for grain yield per spike in the 2nd hybrid to 80.21% for grain yield per spike under late sowing. Indicating, these traits were extremely influenced by non-additive and environmental influences. Previous results were contract with those acquired by Abd El-Aty *et al.* (2005), Abd-El-Aty and Katta (2007), Dawwam *et al.* (2010) and Abdallah *et al.* (2019).

Genetic advance as percent of F_2 means was low to high for all studied traits in all hybrids (Table 6). The expected genetic advance as percent of F_2 means ranged from 4.54% for maturity date in the 1st hybrid to 85.41% for grain yield per spike in the 2nd hybrid under optimum sown and ranged from 5.54% for maturity date in the 1st hybrid to 95.32% for number of spikes per plant under late sowing. Indicated the prospect of practicing selection for high genetic advance traits in early generations and obtain high yielding genotypes. El-Hawary (2016) and Ahmed (2021).

CONCLUSION

Wheat plants in late cultivation conditions are affected by high temperature and this affects the yield. The mean values for six parameters under late swing date (25th Dec.) were less than optimum sowing date (25 Nov.) for all traits in all hybrids. The parental cultivars Sids 14 and Gemmeiza 12 were earlier than the other parents under two different sowing dates. The three hybrids studied were higher in extent which had high genetic advance related with high heritability for number of spikes per plant, number of grains per spike, grain yield per spike, 1000-grain weight and grain yield per plant under late sowing date. So, the selection in segregating generations could be efficient to develop early maturing lines that have high yielding ability under optimum and late sowing date.

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تقدير الثوابت الوراثية للمحصول ومكوناته في القمح تحت ميعادي الزراعة المناسب والمتأخر

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أجري هذا البحث بهدف دراسة قوة الهجين ودرجة السيادة والسلوك الوراثي ودرجة التوريث والتحسين الوراثي المتوقع بالانتخاب وطبيعة الفعل الجيني لصفة المحصول ومكوناته في ثلاث هجن من قمح الخبز هي (١) سخا ٩٤ × جميزة ١٢ ، (٢) سدس ١٤ × جميزة ١٠ ، (٣) جيزة ١٧١ × مصر ٣ تحت ميعاد الزراعة المناسب (٢٥ نوفمبر) و ميعاد الزراعة المتأخر (٢٥ ديسمبر) ، وذلك من خلال موديل العشائر الستة. أجري هذا البحث في المزرعة البحثية لكلية الزراعة بشبين الكوم – جامعة المنوفية في ثلاث مواسم متتالية هي ٢٠١٩/٢٠١٨ ، ٢٠٢٠/٢٠١٩ ، ٢٠٢١/٢٠٢٠ ، وكانت الصفات المدروسة هي :- ميعاد طرد السنابل (يوم) – ميعاد النضج (يوم) – طول النبات (سم) – عدد سنابل النبات – عدد حبوب السنبلة – محصول السنبلة (جم) – وزن ١٠٠٠حبة (جم) – محصول النبات الفردي (جم). وفيما يلي أهم النتائج المتحصل عليها:- أظهرت النتائج وجود قوة هجين عالية ومعنوية لمعظم الصفات المدروسة عند مقارنتها بمتوسط الأبوين والأب الأعلى تحت ميعادي الزراعة المناسب والزراعة المتأخرة. اختلفت الأهمية النسبية لتأثير كلا من الفعل الوراثي المضيف والسيادي بإختلاف الصفات والهجن تحت ميعادي الزراعة المناسب والزراعة المتأخرة. كان الفعل السيادي بصفة عامة أكبر من الفعل المضيف لمعظم الصفات تحت ميعادي الزراعة المناسب والزراعة المتأخرة. كان الفعل ألتفوقي (السيادي × السيادي) ذو تأثير أكبر من تأثير الفعل (المضيف × المضيف ، المضيف × السيادي) في معظم الصفات تحت الزراعة المناسب والزراعة المتأخرة ، مما يوضح الدور الأكبر للتأثير السيادي والتفاعلات الغير أليلية. كانت قيم درجة التوريث بالمعني الضيق تتراوح بين المتوسطة والعالية لكل الصفات المدروسة في كل الهجن تحت ميعادي الزراعة المناسب والزراعة المتأخرة. كانت قيم التحسين الوراثي المتوقع بالانتخاب مصاحبة للقيم العالية لدرجة التوريث بالمعني الدقيق لصفات عدد السنابل للنبات وعدد حبوب السنبلة و محصول السنبلة ووزن الألف حبة ومحصول النبات الفردي تحت ميعادي الزراعة المناسب والزراعة المتأخرة.وجد من هذه الدراسة أن الصنفين سدس١٤ وجميزة ١٢ مبكرين في كلا من ميعاد طرد السنابل وميعاد النضج ، ويمكن الاستفادة من هذه الهجن لاستنباط سلالات من قمح الخبز مبكرة النضج وعالية المحصول تحت ميعاد الزراعة المتأخر. بصفة عامة كانت قيم المتوسطات للجيل الأول والثاني والآباء منخفضة في الزراعة في الميعاد المتأخر عن الزراعة في الميعاد المناسب لكل الصفات المدروسة مما يؤكد علي أهمية الزراعة في الميعاد المناسب لمحصول القمح.