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Discriminating of Some Early Maturing Wheat Genotypes under Late Sowing in North Delta of Egypt

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Present study work has been undertaken to evaluate the productivity and quality of early maturity wheat genotypes under optimum and late sowing conditions. For this purpose, two field experiments were conducted on the experimental farm of Sakha Agricultural Research Station, Field Crop Res. Inst., ARC, Kafr El-Sheikh, Egypt, during the two winter growing seasons of 2019/20 and 2020/21. The experimental design was a randomized complete block with four replications to study the influence of two sowing dates on earliness, yield, and its components and quality characters of 22 early maturing beard wheat genotypes and two check cultivars (Misr 3 and Sakha 95) were studied. Each sowing date was sown in a separate experiment; the first experiment was planted on 23rd Nov. (optimum sowing date), while, the second one was on 23rd Dec. (late sowing date) in both seasons. Results indicated that optimum sowing date had significantly higher mean values for all studied characters except grain protein, wet gluten, dry gluten, and grain ash. Sakha 95 was the highest grain yield under the two sowing dates without significant differences from Line-2, Misr 3, and Line-5 under the optimum sowing date, and Line-4, Line-5, Line-2, Misr 3, Line-18, and Line-17 under late sowing date. Discriminant analysis results indicated that growing

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degree days played the most dominant discriminatory role in explaining the variation of the 24 wheat genotypes. Also, it could be effective in the identification of the wheat genotypes of desirable traits for late sowing date conditions. Discriminant scores used as selection index based on earliness, yield, and its components and quality characters were suggested that the superior genotypes under overall both sowing dates were Line-2, Misr 3, and Sakha 95 in addition to Line-17 and Line-5 under late sowing date. These superior genotypes could be used under late sowing date conditions.

Keywords: Wheat; sowing date; yield and its components; quality characters; discriminant analysis.

1. INTRODUCTION

Egypt's total production of wheat is still far below the consumption needs and annual demand. In 2020, Egypt's wheat cultivated was 1.37 million hectares, which produced 9 million metric tons. This local production is about 50% of the local requirement. Thus, 9.04 million metric tons were imported [1].

In North Egypt, the wheat optimum sowing date is from the second half to the end of November. Planting in the optimum date produced the highest grain yield by enhanced germination per unit area, No spikes per unit area, plant height, No of spikelet's spike-1, No of kernels spike-1, and 1000 kernel weight. This may be due to an increase in the period of vegetative growth and escape from the high temperature at the grain filling stage.

Many Egyptian farmers choose delayed planting wheat till after 25th December or even sometimes up to 15th January in the case of cultivation after vegetable crops like potato, onion, etc. This condition causes a reduction in grain yields by 33-54% [2]. This reduction may be due to exposed plants to heat stress during grain formation stages, which leads to abnormal/shriveled grain and low production [3,4,2,5].

Furthermore, the sowing date influences grain quality primarily by determining the thermal conditions during the grain-filling period, because late sown genotypes, push the grain filling time to coincide with high temperatures and water stress. Delayed the sowing date had a significant impact on the grain's protein, carbohydrate, and ash content, which could be related to changes in heat conditions during grain filling [6-8].

Therefore, using the high-yielding and short duration (early maturing) selection lines may be a good solution to decrease the reduction of yields in late planting. Also, it can help to increase the wheat cultivated area and national wheat production.

Discriminant analysis (DA) has shown to be a promising tool among several methods applied for classification, especially when dealing with the complexities of datasets. [9] Developed the selection index by using the discriminate function approach, also [10] was used to discriminate the genotypes based on all the characters.

[11] Suggests the use of discriminant analysis in screening a large number of genotypes (Thirty-four genotypes) for heat tolerance with morph physiological traits. As [12,13] revealed that the discriminant function making selections in plants appeared to be the most useful and making the selection for yield advancement in wheat.

The present study aimed to 1- evaluates the productivity and quality of the twenty-two early maturity wheat genotypes and two checks cultivars under optimum and late sowing. 2- develop a selection index approach that considers the information of several wheat traits using the discriminant analysis to better understand the relationship between the characters and yield. 3- Select superior genotypes based on earliness, yield components and quality traits to reduce the reduction of grain yield due to late sowing under the North delta of Egypt and other nearby areas with similar environmental conditions.

2. MATERIALS AND METHODS

Two field trials were conducted at Sakha Agricultural Research Station (31^o 06 N, 30^o 56 E), ARC, Egypt, during the winter growing seasons of 2019/20 and 2020/21. At optimum (23rd November) and late (23rd December) sowing dates, twenty-two early matured bread wheat genotypes and two checks cultivars (Table 1) were tested.

Each experiment design was laid out in randomized complete block design in four replications. The plot area was 4.2 m^2. It consisted of 6 rows with 3.5 meter length and 20 cm apart. Planting was done using sowing rate of 350 seeds m^{-2}. Phosphorus fertilizer in the form of calcium superphosphate (15% P_2O_5) at the rate of 100 kg/fed was incorporated in the soil after the leveling. Nitrogen fertilizer at the rate 75 kg N/fed was split in two portions and applied before the first and second irrigation. All cultural practices for growing wheat were applied as recommended.

The monthly mean air temperature (C^o) during the two growing seasons is depicted in (Fig. 1).

Table 1. Name, pedigree and selection history of the twenty-four tested bread wheat genotypes

Ser	Genotype	Abb.	Pedigree and selection history
1	Line-1	L 1	HUBARA-21 /8/ KVZ /4/ CC / INIA /3/ CNO // ELGAU / SON 64 /5/ SPARROW "S" / BROCHIS"S" /6/ BAYA "S" / IMU /7/ HUBARA-2 S.2013-92-018S-012S-1S
2	Line-2	L 2	KIRITATI//SERI/RAYON/6/ SAKHA 93 /5/ PFAU / VEE# 9 // URES /3/ ESDA / KAUZ /4/ FRTL S.2013-116-06S-02S-4S
3	Line-3	L 3	PRL/2*PASTOR//PBW343*2/KUKUNA/3/WAXWING*2/HEILO S.2013-129-015S-012S-6S
4	Line-4	L 4	PRL/2*PASTOR//PBW343*2/KUKUNA/3/WAXWING*2/HEILO S.2013-129-015S-012S-8S
5	Line-5	L 5	PRL/2*PASTOR//PBW343*2/KUKUN/3/WAXWING*2/HEILO S.2013-129-015S-012S-9S
6	Line-6	L 6	ATTILA *2 / GIZA 168 /6/ SAKHA 93 /3/ VEE / PJN // 2*KAUZ /5/ MAI "S" / PJ // ENU "S" /3/ KITO / POTO. 19 // MO / JUP /4/ K 134 (60) / VEE S.2013-201-019S-015S-4S
7	Line-7	L 7	ATTILA *2 / GIZA 168 /6/ BL1133 /3/ CMH 79A.955*2/ CNO 79 // CMH 79A.955 / BOW"s"/4/GIZA 164/ SAKHA 61 /5/ ATTILA *2 / GIZA 168 S.2013-202-025S-019S-6S
8	Line-8	L 8	ATTILA *2 / GIZA 168/6/ BL1133 /3/ CMH 79A.955*2/ CNO 79 // CMH 79A.955 / BOW"s"/4/GIZA 164/ SAKHA 61 /5/ ATTILA *2 / GIZA 168 S.2013-202-025S-019S-7S
9	Line-9	L 9	BL1133 /3/ CMH 79A.955*2/ CNO 79 // CMH 79A.955 / BOW"s"/4/GIZA 164/ SAKHA 61 /7/ BL1133 /3/ CMH 79A.955*2/ CNO 79 // CMH 79A.955 / BOW"s"/4/GIZA 164/ SAKHA 61 /6/ GIZA 168 /5/ MAI "S" / PJ // ENU "S" /3/ KITO / POTO. 19 // MO / JUP /4/ K 134 (60) / VEE S.2013-206-021S-04S-5S
10	Line-10	L 10	KAUZ / ATTILA /7/ KVZ /4/ CC / INIA /3/ CNO // ELGAU / SON 64 /5/ SPARROW "S" / BROCHIS "S" /6/ BAYA "S" / IMU /8/ SAKHA 61 /6/ SAKHA 12 /5/ KVZ // CNO 67 / PJ 62 /3/ YD "S" / BLO "S" /4/ K 134 (60) / VEE /7/ CHEN / AEGILOPS SQUARROSA (TAUS) // FCT /3/2*WEAVER S.2013-218-05S-05S-9S
11	Line-11	L 11	SIDS1/ ATTILA // GOUMRIA-17 S. 16498-042S-013S-21S -0S
12	Line-12	L 12	KAUZ / ATTILA /7/ KVZ /4/ CC / INIA /3/ CNO // ELGAU / SON 64 /5/ SPARROW "S" / BROCHIS "S" /6/ BAYA "S" / IMU /8/ SAKHA 93 /3/ VEE / PJN // 2*KAUZ /5/ MAI "S" / PJ // ENU "S" /3/ KITO / POTO. 19 // MO / JUP /4/ K 134 (60) / VEE S.2013-219-012S-05S-7S
13	Line-13	L 13	MAI "S" / PJ // ENU "S" /3/ KITO / POTO. 19 // MO / JUP /4/ K 134 (60) / VEE / / Sc Mutation2 S.2013-222-013S-02S-6S
14	Line-14	L 14	MAI "S" / PJ // ENU "S" /3/ KITO / POTO. 19 // MO / JUP /4/ K 134 (60) / VEE /8/ D 6301/ HEINEVII // ERA /3/ BUC/4/ LIRA /5/ SPB /6/ GIZA 144// PJN"s"/ BOW"s" /7/ GIZA 168 /5/ MAI "S" / PJ // ENU "S" /3/ KITO / POTO. 19 // MO / JUP /4/ K 134 (60) / VEE S.2013-223-024S-013S-3S
15	Line-15	L 15	MAI "S" / PJ // ENU "S" /3/ KITO / POTO. 19 // MO / JUP /4/ K 134 (60) / VEE /7/ BL1133 /3/ CMH 79A.955*2/ CNO 79 // CMH 79A.955 / BOW"s"/4/GIZA 164/ SAKHA 61 /6/ GIZA 168 /5/ MAI "S" / PJ // ENU "S" /3/ KITO / POTO. 19 // MO / JUP /4/ K 134 (60) / VEE S.2013-224-019S-02S-2S

Ser	Genotype	Abb.	Pedigree and selection history
16	Line-16	L 16	MAI "S" / PJ // ENU "S" /3/ KITO / POTO. 19 // MO / JUP /4/ K 134 (60) / VEE /7/ BL1133 /3/ CMH 79A.955*2/ CNO 79 // CMH 79A.955 / BOW"s"/4/GIZA 164/ SAKHA 61 /6/ GIZA 168 /5/ MAI "S" / PJ // ENU "S" /3/ KITO / POTO. 19 // MO / JUP /4/ K 134 (60) / VEE S.2013-224-019S-02S-3S
17	Line-17	L 17	MINO /6/ SAKHA 12 /5/ KVZ // CNO 67 / PJ 62 /3/ YD "S" / BLO "S" /4/ K 134 (60) / VEE S. 16869 -010S -07S-1S-2S -0S
18	Line-18	L 18	SAKHA 12 /5/ KVZ // CNO 67 / PJ 62 /3/ YD "S" / BLO "S" /4/ K 134 (60) / VEE /6/ HUBARA-1 /8/ SAKHA 93 /3/ VEE / PJN // 2*KAUZ /6/ SAKHA 12 /5/ KVZ // CNO 67 / PJ 62 /3/ YD "S" / BLO "S" /4/ K 134 (60) / VEE /7/IRENA /4/ V763.2312 / V879.C8.11.11.11(36) // STAR /3/ STAR S.2013-230-020S-09S-6S
19	Line-19	L 19	SAKHA 12 /5/ KVZ // CNO 67 / PJ 62 /3/ YD "S" / BLO "S" /4/ K 134 (60) / VEE /6/ HUBARA-1 /8/ SAKHA 93 /3/ VEE / PJN // 2*KAUZ /6/ SAKHA 12 /5/ KVZ // CNO 67 / PJ 62 /3/ YD "S" / BLO "S" /4/ K 134 (60) / VEE /7/IRENA /4/ V763.2312 / V879.C8.11.11.11(36) // STAR /3/ STAR S.2013-230-020S-09S-8S
20	Line-20	L 20	Gemmeiza9//ATTILA*2/GIZA168 S. 17137 - 26S - 1S - 1S - 0S
21	Line-21	L 21	Gemmeiza9//ATTILA*2/GIZA168 S. 17137 - 35S - 1S - 1S - 0S
22	Line-22	L 22	Gemmeiza9//ATTILA*2/GIZA168 S. 17137 - 55S - 6S - 2S - 0S
23	Misr 3	----	ATTILA*2/PBW65*2/KACHU CMSS06Y00582T-099TOPM-099Y-099ZTM-099Y-099M-10WGY-0B-0EGY
24	Sakha 95	----	PASTOR // SITE / MO /3/ CHEN / AEGILOPS SQUARROSA (TAUS) // BCN /4/ WBLL1. CMSA01Y00158S-040POY-040M-030ZTM-040SY-26M-0Y-0SY-0S.

2.1 Studied Characters

Earliness characteristics: Days to heading (DH), Days to maturity (DM), grain filling period (GFP), grain filling rate (GFR), The growing degree days (GDD) calculated according to [14], in which $GDD = \sum[(Tmaxi + Tmini)/2 - Tb]$ where T max i and T min i are the maximum and minimum daily air temperature on the ith day and Tb is the base temperature below which the rate of development is assumed to be zero.

Yield components characteristics: plant height in cm (PH), number of spikes m^{-2} (SM^{-2}), number of kernels $spike^{-1}$ (KS^{-1}), 1000 kernels weight (g , 1000-KW), grain yield (GY, Kg $plot^{-1}$).

Quality characteristics: Hectoliter weight (g, HLW), grain protein% (GP), wet gluten% (WG), dry gluten% (DG) and grain ash% (GA) were measured according to [15]. Total grain carbohydrate% (TC) was measured according to [16].

2.2 Statistical Analysis

Collected data in the two seasons were subjected to individual analysis of variance (ANOVA) of randomized complete block design for each season was done. Data was performed to test the homogeneity of individual error before combined analysis [17]. Then, combined analysis over the seasons and sowing dates was done according to [18]. The least significant differences (LSD) at the level of 0.05 of probability were used to compare the differences among the treatment means according to [19].

Based on average yield under late sowing date stress over two seasons, among 22 bread wheat genotypes and two check cultivars (Table 1), the highest 12 yield genotypes and the rest 12 low yield genotypes were selected as group one and group two. This classification could differentiate groups and then discriminant function analysis (DA) was performed using IBM SPSS software. Discriminant function analysis (DA) supply an equation that gives maximum separation or discrimination between two groups of 22 bread wheat genotypes and two check cultivars. All characters values were standardized before running discriminant analysis. Discriminant function can be thought of as multiple regression equation.

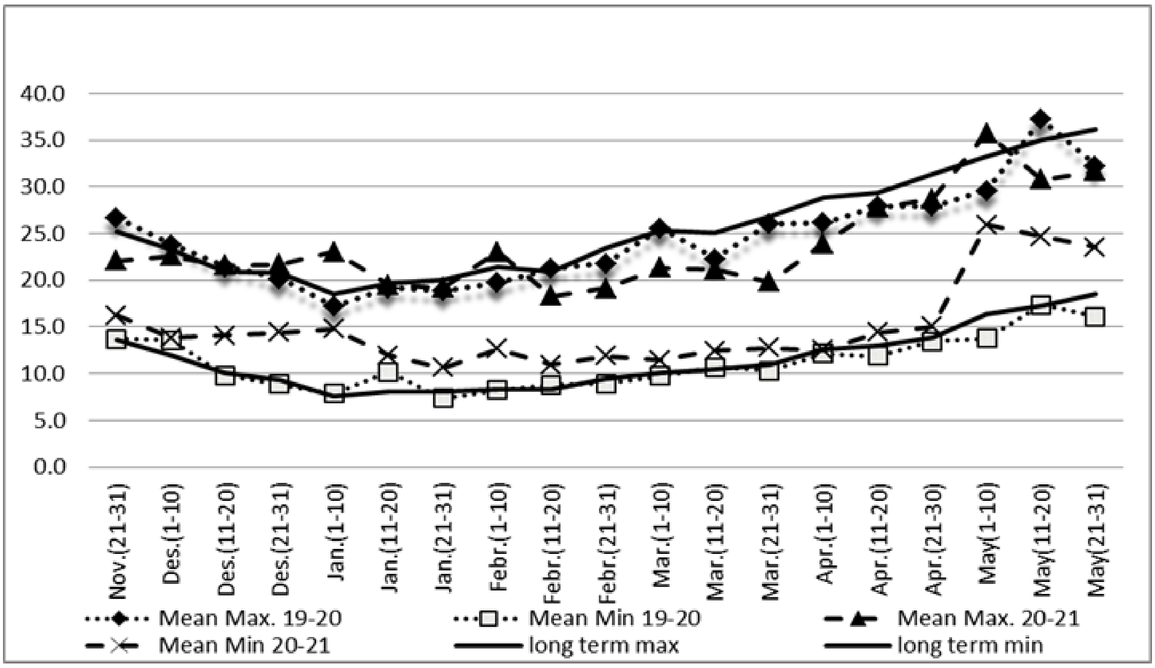

Fig. 1. Average of 10 days minimum (Min) and maximum (Max) temperature during Nov. to June in 2019/2020 and 2020/2021 at Sakha Agricultural Research Station

Before proceeding with the analysis, as a part of our data exploration, we test the multicollinearity for all studied traits (independent variables). Discriminant function analysis (DA) should only include variables that show no multicollinearity. The canonical correlation is the multiple associations between the predictor's independent variables (thirteen measured characters as nine earliness, yield components characters, and four quality characters) and the discriminant function. It provides an index of overall model fit which is interpreted as being the proportion of variance explained (R^2).

Wilks' lambda is used to test the significance of the discriminant function as a whole. The value of Wilks' lambda ranges between 0 and 1. When Wilks' lambda value closes to be 0 and significant, it is meaning that the DA has goodness of fit to differentiate the genotypes in two groups and vice versa. Therefore, it tells us the variance of dependent variable (two groups of 22 early maturing bread wheat genotypes and two check cultivars) that is not explained by the discriminant function. Finally, we get discriminant scores as a weighted linear combination of the discriminating variables. Based on these discriminant scores, we ranked genotypes in our investigation (selection index) at late sowing date and overall sowing date (both optimum and late sowing dates).

3. RESULTS

3.1 Analyses of Variance

The analyses of variance for all studied characters are presented in Tables 2 and 3. The combined analysis indicated the presence of high significant effect of seasons, sowing date and the interaction of season x sowing date for most characters. Genotype effects were highly significant for all studied characters. The interactions of season x genotype were significantly different for all studied characters except GA. The interactions of genotype x sowing date were highly significant for all studied characters except PH, SM^{-2} and GA. The interactions of season x sowing date x genotype had significant effect on all studied characters except PH, GY and GA.

3.2 Effect of Seasons

All earliness, yield components and quality characters were significantly higher in the second season except DH, DM, GFR, GDD and TC which were significantly higher in the first season as a compared with results in the second one, while, GFP and GA was insignificant (Tables 4,56).

Table 2. Mean square values for earliness and yield components characters of the twenty four bread wheat genotypes over the two seasons of 2018/2019 and 2020/2021

SOV	df	DH	DM	GFP	GFR	GDD	PH	SM^{-2}	KS^{-1}	1000KW	GY
Seasons (S)	1	11378.89**	1809.91**	4112.51**	56.57	98379.2**	4606.51**	75672**	1048.29**	680.05**	11.92**
Sowing dates (S.D)	1	0.278	7737.08**	7830.12**	14463.32**	719866.8**	4606.51**	285977**	4689.16**	5557.01**	144.82**
S x S.D	1	97.67**	125.66**	1.76	4863.59**	99345.1**	66.67	32695*	0.73	78.73**	11.40**
Error a	12	6.12	9.176	4.58	167.46	4633.6	49.61	4291	16.83	6.03	0.65
Genotypes (G)	23	551.49**	143.86**	194.17**	2202.38**	80668.4**	436.78**	24567**	647.70**	322.60**	3.52**
S x G	23	11.80**	12.230**	9.73**	101.43**	7633.8**	72.81**	6055**	48.26**	19.93**	0.22*
S.D x G	23	19.39**	6.49**	9.34**	158.07**	2365.1**	19.55	2165	27.74**	17.32**	0.47**
S x S.D x G	23	17.93**	4.15**	17.57**	122.91**	2606.6**	18.84	2327*	16.14*	19.30**	0.192
Pooled Error (Eb)	276	1.57	1.37	2.04	42.19	794.2	13.42	1425	9.35	5.58	0.13
Total	**383**										

DH = Days to heading (day), DM = Days to maturity (day), GFP= Grain filling period (day), GFR= Grain filling rate (g day^{-1} plot^{-1}), GDD =growing degree days (c^{o}), PH = Plant height (cm), SM^{-2}= no. of spikes m^{-2} (spike), KS^{-1} = no. of kernels spike^{-1}(kernel), 1000KW = 1000 kernel weight (g) and GY = Grain yield plot^{-1}(Kg plot^{-1})

Table 3. Mean square values for quality characters of the twenty four bread wheat genotypes over the two growing seasons of 2018/2019 and 2020/2021

SOV	df	HLW	GP	WG	DG	GA	TC
Seasons (S)	1	589.35**	343.13**	1644.74**	27.42**	0.11	361.92**
Sowing dates (S.D)	1	998.72**	143.06**	1633.92**	247.20**	5.33**	158.89**
S x S.D	1	10.51	0.04	0.65	0.03	0.16	7.62**
Error a	12	2.78	0.12	1.53	0.50	0.10	0.25
Genotypes (G)	23	41.15**	13.83**	188.95**	21.17**	0.19**	22.18**
S x G	23	9.96**	5.49**	26.21**	4.89**	0.14	5.63**
S.D x G	23	13.73**	2.22**	18.98**	2.87**	0.09	2.04**
S x S.D x G	23	5.71**	1.94**	10.92**	1.40**	0.11	2.52**
Pooled Error (Eb)	276	1.47	0.04	0.65	0.21	0.09	0.21
Total	**383**						

HLW= hectoliter weight (g), GP= grain protein%, WG= Wet gluten%, DG= Dry gluten%, GA= Grain ash% and TC= total grain carbohydrate%

Table 4. Mean effects of earliness characters for twenty four bread wheat genotypes grown under the two sowing dates during the two growing seasons of 2019/2020 and 2020/2021

Season	DH	DM	GFP	GFR	GDD
1	83.82	136.97	53.14	64.34	2470.06
2	72.94	132.63	59.69	63.57	2438.05
F-test	**	**	N.S	**	**
Sowing date					
S.D 1	78.35	139.28	60.93	70.09	2497.35
S.D 2	78.41	130.31	51.90	57.82	2410.76
F-test	N.S	**	**	**	**
Genotype					
Line-1	80.56	135.56	55.00	63.01	2471.19
Line-2	79.88	134.63	54.75	76.19	2447.82
Line-3	87.06	137.48	50.42	78.58	2521.72
Line-4	85.63	137.03	51.41	78.24	2509.18
Line-5	84.19	137.04	52.85	77.71	2510.90
Line-6	74.60	134.88	60.27	50.79	2456.09
Line-7	78.31	133.81	55.50	57.64	2431.80
Line-8	76.38	131.27	54.89	56.17	2373.14
Line-9	74.65	133.94	59.29	45.03	2432.52
Line-10	75.38	134.88	59.50	64.06	2453.75
Line-11	78.48	135.25	56.77	69.63	2464.63

Season	DH	DM	GFP	GFR	GDD
Line-12	78.56	135.69	57.13	61.43	2474.17
Line-13	71.19	133.13	61.94	45.86	2412.81
Line-14	72.63	134.06	61.44	53.38	2434.11
Line-15	74.77	132.00	57.23	61.53	2390.02
Line-16	74.21	131.63	57.42	59.57	2381.31
Line-17	74.88	135.38	60.50	62.48	2466.39
Line-18	76.00	133.69	57.69	66.19	2425.45
Line-19	71.00	129.00	58.00	49.97	2322.40
Line-20	75.69	133.44	57.75	61.49	2420.00
Line-21	76.81	133.44	56.63	65.66	2419.17
Line-22	76.00	133.53	57.53	57.93	2426.11
Misr 3	92.50	143.38	50.88	81.89	2673.47
Sakha 95	91.81	141.00	49.19	90.49	2579.20
Mean	78.38	134.80	56.41	63.95	2454.06
L.S.D $G_{0.5\%}$	0.90	0.80	1.00	4.50	19.61

S.D 1 = Optimum sowing date, S.D 2 = Late sowing date, DH = Days to heading (day), DM = Days to maturity (day), GFP= Grain filling period (day), GFR= Grain filling rate (g day^{-1} $plot^{-1}$), GDD =growing degree days (c^o)

3.3 Effect of Sowing Dates

Sowing dates had significant effect on all studied characters except DH (Tables 4, 5 and 6). The optimum sowing date (23rd Nov.) had considerably higher mean values for all studied characters except GP, WG, DG and GA which they were had significantly higher mean values in the late sowing date (23rd Dec.)

3.4 Effect of Genotypes

Results obtained highly significant effect among genotypes for all studied characters (Tables 4, 5 and 6). Results in Table (4) showed Line-19 was the earliest genotype in DH (71 day) and DM (129 day). Moreover, it had the lowest GDD which matured after the accumulation of the smallest thermal units (2322.40). Additionally, Line-19 had the heaviest kernels (62.67 g). Meanwhile, Sakha 95 had the shortest GFP (49.19 day), the highest in both GFR (90.49 g day^{-1} $plot^{-1}$) and GY (4.40 kg $plot^{-1}$). In addition, Sakha 95 produced the tallest plants (111.88 cm). Meanwhile, the highest number of SM^{-2} was recorded by Line-5 (398.09), while, the greatest KS^{-1} (63.63) was recorded by Line- 2 (Table 5).

Table 5. Mean effects of yield components characters of the twenty four bread wheat genotypes grown under the two sowing dates during the two growing seasons of 2019/2020 and 2020/2021

Season	PH	SM^{-2}	KS^{-1}	1000 KW	GY
1	94.24	326.01	48.37	50.47	3.42
2	101.17	354.08	51.67	53.14	3.77
F-Test	**	**	**	**	**
Sowing date					
S.D 1	101.17	367.34	53.51	55.61	4.21
S.D 2	94.24	312.76	46.52	48.00	2.98
F-Test	**	**	**	**	**
Genotype					
Line-1	96.25	342.13	50.58	48.41	3.48
Line-2	94.38	337.93	63.63	48.25	4.25
Line-3	98.13	368.75	55.85	46.53	3.99
Line-4	100.63	386.41	54.65	46.95	4.02
Line-5	102.50	398.09	51.42	48.87	4.18
Line-6	90.94	294.12	49.61	51.13	3.11
Line-7	96.88	351.03	48.35	46.19	3.23
Line-8	97.50	356.55	46.45	52.59	3.10
Line-9	99.38	246.40	49.78	53.88	2.70

Season	PH	SM^{-2}	KS^{-1}	1000 KW	GY
Line-10	90.63	359.19	48.99	55.46	3.85
Line-11	95.94	356.53	52.21	50.12	3.98
Line-12	103.44	336.79	49.72	48.74	3.50
Line-13	103.44	269.36	41.66	58.79	2.88
Line-14	102.81	321.00	44.21	58.09	3.31
Line-15	95.94	341.30	41.76	55.87	3.55
Line-16	91.88	331.67	44.79	56.85	3.44
Line-17	102.19	307.94	58.23	53.51	3.80
Line-18	93.44	386.54	43.63	54.70	3.82
Line-19	91.88	277.03	36.98	62.67	2.90
Line-20	91.56	364.49	45.28	51.48	3.56
Line-21	94.06	352.94	51.70	49.84	3.73
Line-22	96.56	319.03	53.92	46.17	3.33
Misr 3	102.81	391.54	57.17	47.21	4.19
Sakha 95	111.88	364.34	59.89	51.02	4.40
Mean	97.71	340.05	50.02	51.81	3.60
L.S.D G $_{0.5\%}$	2.50	26.27	2.12	1.64	0.25

S.D 1 = Optimum sowing date, S.D 2 = Late sowing date, PH = Plant height (cm), SM^{-2}= no. of spikes m^{-2} (spike), KS^{-1} = no. of kernels $spike^{-1}$ (kernel), 1000KW = 1000 kernel weight (g) and GY = Grain yield $plot^{-1}$(kg $plot^{-1}$)

According to the data in Table (6), the HLW mean values indicated that the highest values were recorded by Line-5 (104.64), Line-11 (104.86) and Line-22 (104.04). The highest value of GP was obtained from Misr 3 (15.57) followed by Line-10 (15.20) and Line-13 (14.85). Meanwhile, Line-16 and Line-19 had the highest levels of WG (36.68 and 36.19, respectively). Line-13 and Line-19 produced the highest content of DG (13.11 and 12.80, respectively). Line-19 and Line-12 had the highest GA percentage value (2.02 and 1.82, respectively). Finally, Line-7 the largest percentage of TC recorded by (82.05).

3.5 Interaction Effects

In addition, the sowing dates × genotypes interactions, was the most interesting objective in this study, therefore, it was only presented and discussed.

According to the interaction effect shown in Tables 7 and 8, indicated that Line-19 and Line-13 recorded the lowest values for DH under both sowing dates. Also, Line-19 recorded the lowest values for DM and GDD under the same conditions. Meanwhile, Sakha 95 was the shortest GFP, the highest GFR and that tallest genotypes under both sowing dates. Meanwhile, the highest SM^{-2} under optimum sowing date was Misr 3. While, under Late sowing date the highest SM^{-2} was Line-4 without significant different from Lines 3, 5, 8, 11,18, 20, Misr 3 and Sakha 95.

The highest KS^{-1} was recorded by Line-2 in both sowing dates without significant different from Sakha 95 under optimum sowing date. Meanwhile, the highest values of 1000-KW was recorded by Line- 19 in the both sowing dates.

Table 6. Mean effects of quality characters of the twenty four bread wheat genotypes grown under the two sowing dates during the two growing seasons of 2019/2020 and 2020/2021

Season	HLW	GP	WG	DG	GA	TC
1	100.82	12.87	28.82	10.58	1.62	80.94
2	103.30	14.76	32.96	11.11	1.66	79.00
F-test	**	**	**	**	N.S	**
Sowing date						
S.D 1	103.67	13.20	28.83	10.04	1.52	80.62
S.D 2	100.45	14.42	32.96	11.65	1.76	79.33
F-test	**	**	**	**	**	**
Genotype						
Line-1	102.80	14.38	27.37	9.67	1.62	78.80
Line-2	102.04	12.49	23.21	8.93	1.70	81.08

Season	HLW	GP	WG	DG	GA	TC
Line-3	103.89	12.90	31.68	10.72	1.57	81.39
Line-4	103.55	13.94	32.51	11.48	1.68	80.17
Line-5	104.64	13.88	30.36	10.64	1.47	79.76
Line-6	99.40	12.45	28.38	9.66	1.57	81.69
Line-7	102.03	11.71	30.54	11.28	1.65	82.05
Line-8	102.67	13.40	32.28	10.75	1.67	80.40
Line-9	99.51	14.07	31.60	11.06	1.65	79.77
Line-10	100.64	15.20	29.34	10.44	1.62	78.47
Line-11	104.86	12.46	28.41	9.88	1.55	81.48
Line-12	102.04	13.73	28.96	10.52	1.82	79.57
Line-13	100.49	14.85	35.66	13.11	1.58	78.87
Line-14	101.27	13.46	27.68	10.24	1.62	81.43
Line-15	102.34	14.56	34.81	11.47	1.75	78.70
Line-16	101.30	14.26	36.68	12.33	1.60	79.09
Line-17	102.60	14.27	33.58	11.59	1.61	79.04
Line-18	102.53	13.86	30.94	10.31	1.69	80.75
Line-19	98.49	14.68	36.19	12.80	2.02	78.27
Line-20	102.34	13.16	28.39	9.95	1.67	80.59
Line-21	101.51	14.20	30.31	10.50	1.61	80.61
Line-22	104.04	13.96	34.97	12.62	1.62	79.80
Misr 3	101.41	15.57	32.43	11.65	1.53	77.99
Sakha 95	103.03	14.03	25.16	8.71	1.53	79.55
Mean	102.06	13.81	30.89	10.84	1.64	79.97
L.S.D $G_{0.5\%}$	0.84	0.14	0.56	0.32	0.22	0.32

S.D 1 = Optimum sowing date, S.D 2 = Late sowing date, HLW= hectoliter weight (g), GP= grain protein %, WG= Wet gluten %, DG= Dry gluten %, GA= Grain ash % and TC= total grain carbohydrate %.

The highest grain yield was obtained by Sakha 95 under the two sowing dates without significant different from Line-2, Misr 3, and Line-5 under the optimum sowing date (23rd Nov.), and from Line-4, Line-5, Line-2, Misr 3, Line-18, and Line-17 under late sowing date (23rd Dec.).

Table 7. Mean values over the two growing seasons (2019/20 and 2020/21) for earliness characters of the twenty four bread wheat genotypes grown under the two sowing dates

Genotypes	DH		DM		GFP		GFR		GDD	
	S.D 1	S.D 2	S.D 1	S.D 2	S.D 1	S.D 2	S.D 1	S.D 2	S.D 1	S.D 2
Line-1	78.6	82.5	139.5	131.6	60.9	49.1	67.6	58.4	2499.3	2443.0
Line-2	80.3	79.5	139.3	130.0	59.0	50.5	85.6	66.8	2494.9	2400.7
Line-3	87.9	86.3	142.0	133.0	54.1	46.7	88.6	68.6	2556.1	2487.3
Line-4	86.6	84.6	141.9	132.2	55.3	47.6	83.5	73.0	2554.1	2464.2
Line-5	85.4	83.0	141.8	132.3	56.5	49.3	86.1	69.3	2554.3	2467.4
Line-6	72.9	76.3	138.6	131.1	65.8	54.8	58.0	43.5	2482.6	2429.5
Line-7	79.6	77.0	137.9	129.8	58.3	52.8	67.7	47.6	2468.9	2394.7
Line-8	76.8	76.0	135.1	127.4	58.4	51.4	60.4	52.0	2411.9	2334.3
Line-9	73.4	75.9	138.5	129.4	65.1	53.5	48.6	41.5	2479.8	2385.1
Line-10	75.1	75.6	139.5	130.3	64.4	54.6	71.3	56.9	2499.6	2407.8
Line-11	77.3	79.7	139.3	131.3	62.0	51.5	75.6	63.7	2495.6	2433.6
Line-12	78.4	78.8	139.5	131.9	61.1	53.1	64.1	58.8	2499.3	2449.0
Line-13	71.3	71.1	137.9	128.4	66.6	57.3	51.7	40.0	2466.3	2359.2
Line-14	72.8	72.5	138.9	129.3	66.1	56.8	58.4	48.4	2485.9	2382.2
Line-15	73.3	76.3	136.0	128.0	62.8	51.7	65.1	58.0	2429.5	2350.4
Line-16	73.6	74.8	135.8	127.5	62.1	52.7	61.5	57.6	2425.0	2337.6
Line-17	74.0	75.8	139.4	131.4	65.4	55.6	66.5	58.4	2496.6	2436.1
Line-18	76.4	75.6	138.6	128.8	62.3	53.1	70.9	61.5	2481.3	2369.5
Line-19	70.6	71.4	133.5	124.5	62.9	53.1	49.6	50.4	2378.5	2266.2
Line-20	76.1	75.3	138.1	128.8	62.0	53.5	69.3	53.7	2471.0	2368.9
Line-21	77.4	76.3	138.3	128.6	60.9	52.4	73.5	57.8	2473.3	2365.0

Genotypes	DH		DM		GFP		GFR		GDD	
	S.D 1	**S.D 2**	**S.D 1**	**S.D 2**	**S.D 1**	**S.D 2**	**S.D 1**	**S.D 2**	**S.D 1**	**S.D 2**
Line-22	74.9	77.1	137.1	129.9	62.3	52.8	62.4	53.4	2451.7	2400.4
Misr 3	94.6	90.4	149.6	137.1	55.0	46.8	92.8	70.9	2747.5	2599.4
Sakha 95	93.5	90.1	146.9	135.1	53.4	45.0	103.4	77.5	2632.6	2525.7
Mean	78.4	78.4	139.3	130.3	60.9	51.9	70.1	57.8	2497.3	2410.7
L.S.D G X S.D $_{0.5\%}$	1.3		1.3		1.4		6.8		30.4	

S.D 1 = Optimum sowing date, S.D 2 = Late sowing date, DH = Days to heading (day), DM = Days to maturity (day), GFP= Grain filling period (day), GFR= Grain filling rate (g day^{-1} $plot^{-1}$), GDD =growing degree days(c^o)

The results in Tables (9 and 10) indicated that Line-11 and Sakha 95 had the highest HLW under the optimum sowing date, while, the highest values under the late sowing was produced by Line-3, Line-5 and Line-11. The highest percentage of GP was obtained from Line-10 under optimum sowing date and Misr 3 under both sowing dates. The highest WG was obtained from Line-16 under the optimum sowing date, while, Lines 13 and 19 had the highest WG under the late sowing date. In addition, Lines 22 and 19 under the optimum sowing date had the highest DG weight. Lines 13 and 19 under the late sowing date had the highest DG weight. Line-19 had the greatest GA percentage under the both sowing dates. Meanwhile, under the first sowing date, Line-7 and Line-11 had the greatest grain TC. On the other hand, Lines 3, 6 and 7 had a highest TC values under the late sowing date.

Table 8. Mean values over the two growing seasons (2019/20 and 2020/21) for yield components characters of the twenty four bread wheat genotypes grown under the two sowing dates

Genotype	PH		SM^{-2}		KS^{-1}		1000 KW		GY	
	S.D 1	**S.D 2**	**S.D 1**	**S.D 2**	**S.D 1**	**S.D 2**	**S.D 1**	**S.D 2**	**S.D 1**	**S.D 2**
Line-1	100.6	91.9	371.7	312.5	52.2	49.0	53.6	43.2	4.10	2.87
Line-2	98.1	90.6	360.2	315.7	66.9	60.4	51.0	45.5	5.13	3.38
Line-3	103.1	93.1	397.5	340.0	59.5	52.2	50.0	43.1	4.76	3.22
Line-4	105.0	96.3	407.8	365.0	57.6	51.7	50.2	43.7	4.56	3.48
Line-5	104.4	100.6	439.9	356.3	53.7	49.2	51.6	46.1	4.92	3.43
Line-6	93.8	88.1	327.2	261.1	54.8	44.4	56.5	45.7	3.81	2.40
Line-7	101.3	92.5	387.2	314.9	51.8	44.9	49.6	42.8	3.94	2.52
Line-8	101.9	93.1	374.5	338.6	52.8	40.1	55.9	49.3	3.52	2.69
Line-9	103.8	95.0	273.4	219.4	52.2	47.3	56.9	50.9	3.17	2.23
Line-10	92.5	88.8	392.9	325.4	51.9	46.1	60.5	50.4	4.58	3.11
Line-11	99.4	92.5	381.5	331.6	58.3	46.2	51.9	48.3	4.69	3.28
Line-12	105.6	101.3	348.5	325.1	52.1	47.3	52.7	44.8	3.88	3.13
Line-13	107.5	99.4	293.5	245.2	45.1	38.3	61.8	55.8	3.44	2.31
Line-14	105.6	100.0	360.1	281.9	46.5	41.9	61.8	54.4	3.85	2.76
Line-15	99.4	92.5	359.0	323.6	45.4	38.1	59.2	52.5	4.07	3.02
Line-16	94.4	89.4	347.6	315.7	48.3	41.3	62.2	51.5	3.82	3.05
Line-17	107.5	96.9	337.5	278.4	63.0	53.5	56.5	50.5	4.35	3.25
Line-18	96.3	90.6	395.6	377.5	47.9	39.4	58.8	50.6	4.37	3.27
Line-19	93.8	90.0	280.4	273.7	39.8	34.1	66.3	59.1	3.12	2.69
Line-20	93.8	89.4	390.1	338.9	48.3	42.3	56.5	46.5	4.28	2.85
Line-21	96.3	91.9	389.0	316.9	53.1	50.3	56.0	43.7	4.45	3.01
Line-22	100.6	92.5	360.3	277.7	56.3	51.5	49.8	42.6	3.86	2.80
Misr 3	106.9	98.8	446.8	336.3	62.1	52.3	50.9	43.5	5.08	3.31
Sakha 95	116.9	106.9	393.9	334.8	64.9	54.9	54.5	47.6	5.29	3.52
Mean	101.2	94.2	367.3	312.8	53.5	46.5	55.6	48.0	4.21	2.98
L.S.D G X S.D $_{0.5\%}$	3.8		38.6		3.1		2.3		0.38	

S.D 1 = Optimum sowing date, S.D 2 = Late sowing date, PH = Plant height (cm), SM^{-2}= no. of spikes m^{-2} (spike), KS^{-1} = no. of kernels $spike^{-1}$ (kernel), 1000KW = 1000 kernel weight (g) and GY = Grain yield $plot^{-1}$ (kg $plot^{-1}$)

Discriminant function analysis: Discriminant function analysis (DA) is usually used to answers the question: can a combination of variables be used to predict group membership. Several variables are included in this investigation to see which ones contribute to the discrimination between groups (24 genotypes). Discriminant function analysis is divided into steps process: (1) testing significance of discriminant function, and; (2) classification. So, we were shown and interpreting our results under the following titles:

Accuracy assessment, standardized canonical coefficient: Results Table 11, showed highly significant of both canonical correlation (0.90) and Wilks' lambda (0.196) .Also; a large eigenvalue is associated with a strong function. Discriminant function's formula was fitted, according to standardized data of thirteen effective characters as follows: Discriminant Score =2.77 GDD -1.68 DM+ 1.37 1000KW +1.35 KS^{-1} + 1.33 GFP +1.02 SM^{-2} + 0.96 GFR + 0.99 TC + 0.64 GP +0.62 GA+ 0.61GY + 0.29 PH + 0.17 HLW.

Table 9. Mean values over the two growing seasons (2019/20 and 2020/21) for hectoliter weight, grain protein and wet gluten of the twenty four bread wheat genotypes grown under the two sowing dates

Genotype	HLW		GP		WG	
	S.D 1	**S.D 2**	**S.D 1**	**S.D 2**	**S.D 1**	**S.D 2**
Line-1	104.63	100.97	14.32	14.45	25.61	29.14
Line-2	103.29	100.79	12.03	12.94	21.84	24.58
Line-3	104.89	102.89	11.97	13.84	30.18	33.18
Line-4	104.79	102.31	13.29	14.59	31.28	33.74
Line-5	105.56	103.71	12.85	14.91	29.21	31.51
Line-6	102.88	95.93	11.96	12.94	23.92	32.84
Line-7	104.31	99.74	11.17	12.25	28.05	33.03
Line-8	103.94	101.40	12.16	14.63	31.41	33.15
Line-9	102.68	96.35	12.92	15.21	29.66	33.54
Line-10	101.94	99.35	14.96	15.44	27.17	31.51
Line-11	106.18	103.54	11.17	13.75	27.00	29.83
Line-12	102.78	101.30	13.60	13.86	25.51	32.42
Line-13	101.24	99.74	14.46	15.24	32.39	38.93
Line-14	102.05	100.48	13.09	13.84	24.94	30.42
Line-15	103.58	101.10	14.44	14.68	31.84	37.78
Line-16	102.01	100.59	13.71	14.80	35.53	37.83
Line-17	104.00	101.20	13.98	14.55	32.35	34.82
Line-18	104.35	100.70	13.29	14.44	30.16	31.71
Line-19	99.31	97.68	14.43	14.93	33.93	38.44
Line-20	105.05	99.64	12.20	14.12	26.00	30.79
Line-21	104.26	98.76	13.66	14.75	28.28	32.34
Line-22	105.41	102.68	13.08	14.84	33.55	36.39
Misr 3	102.18	100.65	14.84	16.30	27.73	37.13
Sakha 95	106.84	99.23	13.10	14.95	24.41	25.91
Mean	103.67	100.45	13.20	14.42	28.83	32.96
L.S.D G X $S.D_{0.5\%}$	1.21		0.21		0.82	

S.D 1 = Optimum sowing date, S.D 2 = Late sowing date, HLW= hectoliter weight (g), GP= grain protein% and WG= Wet gluten%

3.6 Classification Based on Discriminant Function

The procedure of applying Discriminant Function to the data grouped in each of these two ways (late sowing date and overall sowing date) generated discriminant Score for genotypes. These results were shown in Table 12 and Figs. 2,3.

Table 10. Mean values over the two seasons (2019/20 and 2020/21) for dry gluten , grain ash and total grain carbohydrate of the twenty four bread wheat genotypes grown under the two sowing dates

Genotypes	DG		GA		TC	
	S.D 1	**S.D 2**	**S.D 1**	**S.D 2**	**S.D 1**	**S.D 2**
Line-1	8.82	10.52	1.51	1.73	78.88	78.71
Line-2	8.31	9.54	1.55	1.85	81.57	80.59
Line-3	10.20	11.24	1.45	1.69	81.64	81.15
Line-4	10.64	12.32	1.64	1.72	80.45	79.89
Line-5	10.26	11.02	1.41	1.52	80.77	78.75
Line-6	8.11	11.21	1.45	1.69	82.25	81.12
Line-7	10.46	12.10	1.48	1.82	82.48	81.62
Line-8	10.41	11.08	1.60	1.74	81.62	79.18
Line-9	10.37	11.75	1.55	1.76	80.95	78.58
Line-10	9.57	11.32	1.45	1.79	79.04	77.89
Line-11	9.25	10.51	1.44	1.65	82.76	80.20
Line-12	9.47	11.57	1.59	2.05	79.76	79.38
Line-13	11.26	14.96	1.51	1.64	79.37	78.38
Line-14	9.19	11.29	1.50	1.74	81.86	80.99
Line-15	10.69	12.24	1.61	1.89	78.90	78.50
Line-16	11.63	13.03	1.52	1.68	79.59	78.60
Line-17	11.07	12.11	1.51	1.70	79.46	78.61
Line-18	10.00	10.61	1.56	1.81	81.28	80.22
Line-19	11.78	13.81	1.61	2.43	78.92	77.63
Line-20	9.06	10.83	1.56	1.77	81.65	79.53
Line-21	9.81	11.19	1.58	1.64	81.27	79.96
Line-22	12.30	12.95	1.54	1.69	80.76	78.84
Misr 3	9.93	13.38	1.46	1.60	78.90	77.08
Sakha 95	8.46	8.96	1.46	1.60	80.63	78.46
Mean	10.04	11.65	1.52	1.76	80.62	79.33
L.S.D G X S.D $_{0.5\%}$	0.46		0.31		0.45	

S.D 1 = Optimum sowing date S.D 2 = Late sowing date, DG= Dry gluten %, GA= grain ash %, TC= total grain carbohydrate%

Table 11. Standardized canonical discriminant function coefficients

Variables	Standardized canonical discriminant function coefficient	Variables	Standardized canonical discriminant function coefficient
GDD	2.77	GFR	0.96
DM	-1.68	GP	0.64
1000 KW	1.37	GA	0.62
KS^{-1}	1.35	GY	0.61
GFP	1.33	PH	0.29
SM^{-2}	1.02	HLW	0.17
TC	0.99		
Model sig.	**		
Canonical correlation	0.90**		
Wilks Lambda	0.196**		
Eigenvalue	4.11		

Abbreviations: GDD: growing degree days, DM: Days to maturity, 1000 KW: 1000 Kernels weight, KS^{-1}: number of kernel spike^{-1}, GFP: grain filling period, SM^{-2} : number of spikes m^{-2}, TC: total grains carbohydrate, GFR: grain filling rate, GP: grain protein, GA: grain ash, GY: grain, PH: plant height and HLW: hectoliter weight.

Table 12. Discriminant score and classification for two groups of high and low yield genotypes

Late Sowing			Overall		
Genotype Code	**Group**	**Discriminant Score Late Sowing**	**Genotype Code**	**Group**	**Discriminant Score Overall**
Misr 3	High yielding	3.1	L2	High yielding	3.05
L17	High yielding	2.96	Sakha 95	High yielding	2.79
L2	High yielding	2.47	Misr 3	High yielding	2.65
L5	High yielding	2.37	L10	High yielding	2.2
Sakha 95	High yielding	2.35	L18	High yielding	2.19
L11	High yielding	2.12	L3	High yielding	2.09
L10	High yielding	1.99	L4	High yielding	2.01
L4	High yielding	1.98	L11	High yielding	1.89
L18	High yielding	1.7	L21	High yielding	1.6
L3	High yielding	1.53	L5	High yielding	1.36
L12	High yielding	0.71	L17	High yielding	1.07
L14	Low yielding	-0.24	L20	High yielding	0.04
L16	Low yielding	-0.25	L14	Low yielding	-0.28
L15	Low yielding	-0.26	L16	Low yielding	-0.63
L1	Low yielding	-0.91	L15	Low yielding	-0.95
L21	Low yielding	-1.34	L22	Low yielding	-1.05
L20	Low yielding	-1.46	L1	Low yielding	-1.26
L22	Low yielding	-2.14	L6	Low yielding	-1.32
L19	Low yielding	-2.16	L12	Low yielding	-1.73
L8	Low yielding	-2.27	L8	Low yielding	-2.42
L6	Low yielding	-2.4	L7	Low yielding	-2.83
L7	Low yielding	-2.85	L19	Low yielding	-3.16
L9	Low yielding	-3.47	L13	Low yielding	-3.54
L13	Low yielding	-3.54	L9	Low yielding	-3.78

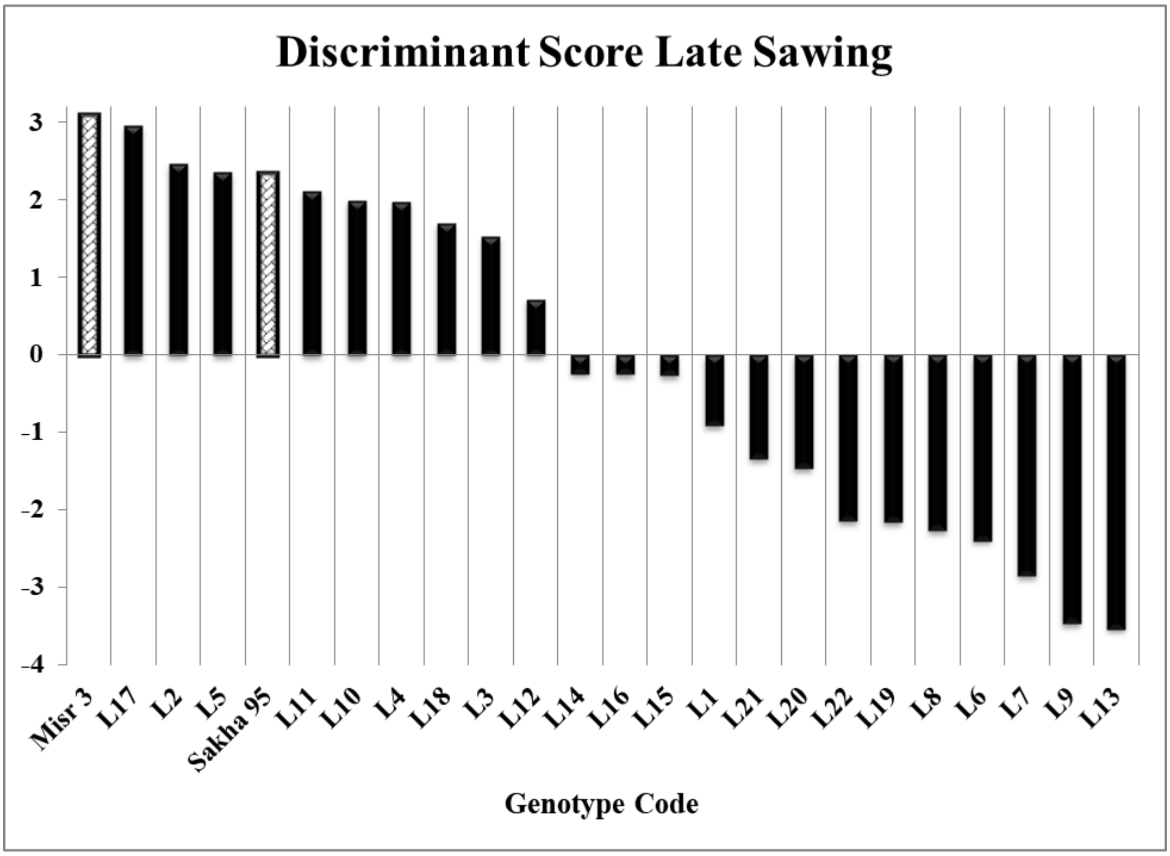

Fig. 2. Ranking genotypes based on discriminant scores across late sowing date

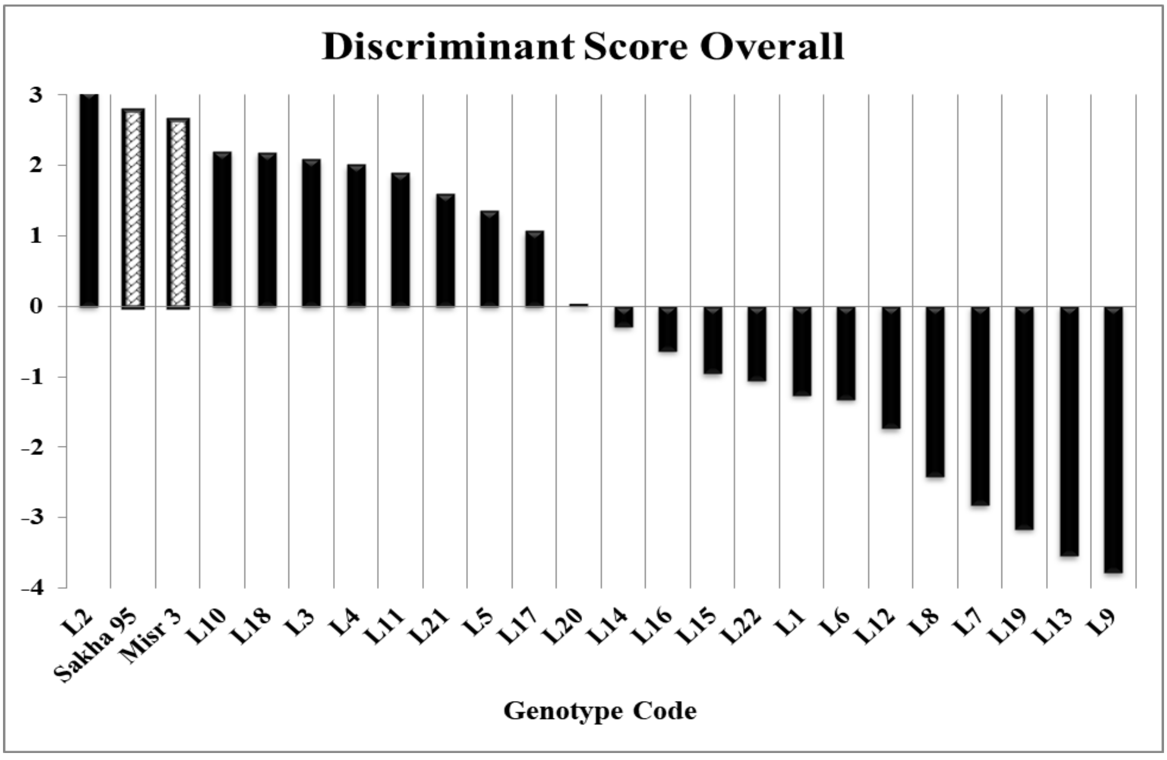

Fig. 3. Ranking genotypes based on discriminant scores overall sowing date

According to the Table 12 with consideration to the values of discriminant scores, it is clear that from 24 genotypes, 11 genotypes, belong to the high yielding group (group 1) and 13 genotypes belong to the low yielding group (group 2). All genotypes belonging to group 1 have a positive weight (score higher than zero), and genotypes of group 2 have a negative weight (score lower than zero). Original grouped cases correctly classified with 95.8% at late sowing date. While, 12 genotypes, belong to the high yielding group (group 1) and 12 genotypes belong to the low yielding group (group 2) with 98.9% original grouped cases correctly classified at both optimum and late sowing date (overall). As the decision is based on discriminant scores, it is clear those genotypes, Misr 3 (check), Line-17, Line-2, Line-5 and Sakha 95 (check) were elite genotypes under late sowing date conditions. As well, those genotypes, Line- 2, Sakha 95 and Misr 3 were elite genotypes under overall sowing dates (optimum and late sowing dates).

4. DISCUSSION

The significant changes due to seasons revealed the reflection climate differences during the two growing seasons (Tables 2 and 3, Fig. 1). The importance of genotype differences and their interactions with sowing date and seasons revealed that genotypes differently ranked based on sowing date. These findings are in Line- with those of Hagras [21,22,2,23].

Most of studied characters were significantly higher in the second season than in the first one (Tables 4, 5 and 6). Gheith et al (2013) reported that yield and yield components were reduced according to the climate changes from year to year [24]. On the other hand, Bendidi et al (2016) found that agronomic characters values were increased in the 2nd season compared with the 1st season due to climate changes [25]. The mean values for DH did not differ significantly between the optimum and late sowing dates. These results may be due to the appropriate temperature at different developmental stages.

Present study showed that DM and GFP decreased by 9 days when sowing date were shifted from 23rd Nov. to 23rd Dec. The reason for decreasing the DM and GFP could be due to the high temperature in late sowing which reduces the growing period. [26] Found that high temperature decreased the DM which leads to decrease the yield.

High temperatures persisted under the late sowing date, especially during the grain filling period, resulting in a reduction of GFR and GY. This reduction may due to the reduction of grain weight and the short of maturity period under late sowing [27,21,22,2,28,23].

Late planting reduced plant height, photoperiod, and shorten the growth cycle as a result to increased temperatures [22]. While, tallest plants were produced under optimum sown condition may due to the long vegetative growth period and appropriate temperature and solar radiation [29,21,2,28,23].

All wheat cultivars were produced highest SM^{-2} under optimum sowing (23rd Nov.) as a compared with late sown may due to the reduction of temperature at germination and through the seedling stage, which resulting in a poor germination and reduction of tillers. These results are in a harmony with [22, 30, 28 and 23]**.** The results showed decrease in KS^{-1} under late sown condition might due to decrease in photosynthetic production as a result to short of growing period. Baloch et al (2012) reported the differences among genotypes for KS^{-1} might be due to their genetic variability [31]. Higher 1000 KW was recorded at the optimum sowing (23rd Nov.) and decreased in late planting as shown in Table 8. It may be due to increased temperature at reproductive phase under late sown which caused shortening in grain filling phase and finally reduced the grain weight and ultimately lead to reduce in grain yield [32].

On the other hand, the high GY under optimum sowing date 23rd November may be due to the increased of growing and grain filling duration. However, decreased in yield under late sowing may result from reduced of growing degree days, photosynthetic active radiation and efficiency of source-sink relationship. Wheat planted at suitable time produced high yielding due to increase the photosynthesis assimilation [33]. Wheat growing under late sowing faces terminal heat stress. This heat stress during grain formation stages leads to abnormal/shriveled grain and low production [31]. The higher grain yield in timely sown condition as a compared with late planting is due to maximum number of spikes m^{-2}, more number of kernels spike^{-1}, maximum weight of kernels spike^{-1} and favorable solar radiation [5].

In general, results showed that yield components characters were higher at optimum sowing (23rd

Nov.) as a compared with late planting (23rd Dec.) as shown in Table (8). These results could be attributed to the optimum temperature at the recommended time during different growth stages, which, resulting in an increased the rate of net assimilation. These results are consistent with these findings from [2 and 5]

The reduction of hectoliter weight in late sown is due to low grain filling period and hot air wind and high temperature prevailing in the environment [34]. Meena et al (2016) showed that prevailing in optimum sowing is responsible for quality of bread wheat with good hectoliter weight [35]. Grain crude protein, wet and dry gluten are the most important parameter which had significantly affected by change in sowing date, sowing date effect on grain protein content mainly through its determination of the thermal conditions prevailing during the grain-filling period. Thus, late sown material generally flowers late and causing the grain-filling period to coincide with a high ambient temperature. These results are in Line- with results of [6] who reported that the late sowing date caused heat stress during flowering phase. Which, resulting in reducing grain size and increasing in protein accumulation compared to starches and vice versa. [8] Reported that the highest grain protein percentage, wet gluten and dry gluten were observed for late sowing date. Also, high temperature during post anthesis and grain filling period in late sowing is resulting in a smaller endosperm, lower grain weight and increased protein content**.** Thapa et al 2020 Indicated that shortened duration from flowering to maturity might have contributed to reduction of protein accumulation [34].

Earlier study defecated that delayed sowing date increased grain protein and grain ash than optimum sowing date and there are differences between genotypes [7]. The reports showed that ash (minerals) content value was increased with delayed sowing date and were significant differences between the cultivars and the sowing dates [36 and 37].

The grain carbohydrate decreased with delayed sowing. These results are in agreement with [38], who found that significant differences in total soluble carbohydrate for all the genotypes with respect to all dates of sowing. The reduction in the carbohydrate percentage in the produced wheat grains after the exposure to high temperature stress may be attributed to a reduction in endosperm cell size.

The results cleared the superiority of cultivar Sakha 95 in grain filling period, grain filling rate, plant height and grain yield; 49.19 day, 90.49 g day^{-1} $plot^{-1}$,111.88 cm and 4.40 Kg $plot^{-1}$, respectively.

These differences between genotypes might be due to the genetic factors and seed chemical composition influence the grain yield, yield component, grain protein content, wet and dry gluten.

Superiority of selection based on index increases with an increase in the number of characters under selection [13]. A type of selection that is based on multiple characters is an important option in breeding programs to improve grain yield under stress condition.

The objectives of discriminate function analysis are achieved in three points, firstly, to investigate differences between groups and discriminate groups effectively; secondly to identify important discriminating variables; and finally to classify genotypes into pre-existing groups. In the present study, discriminate analysis was performed to discriminate earliest, highest yielder and best quality genotypes from those with different performance. Discriminant function analysis has been utilized, as a comprehensive criterion, in order to discriminate the genotypes related to both groups (high and low yield) and also to select superior genotypes [20].

Also, discriminante function model explains 90.0% of the variation among the 24 genotypes under late sowing date. A highly canonical correlation and significant function (Table 11) indicates a function that discriminates groups had a goodness of fit. Wilks' lambda provides the proportion of total variability not explained, i.e. it is the converse of the squared canonical correlation. So we have 19.6% unexplained total variability.

Discriminant functions are interpreted by means of standardized coefficient (Table 11). The larger standardized coefficient indicates greater contribution of the groups (24 genotypes). It is possible to classify the studied cultivars and applications using these characters, which use the coefficients from various canonical distributions. Abu-Ellail et al (2020) said that if a coefficient is higher than ± 0.5, that character is defined as distinguishing factor [39]. Regarding the existence of two data groups (high and low yield), only one discriminant function was obtained for the separation of data in two groups.

This function clarifies the most decisive earliness, yield components characters and quality characters for discriminating high and low yield genotypes in wheat under late sowing date conditions.

GDD character which had the largest absolute coefficients played the most dominant discriminatory role in explaining the variation of the 24 wheat genotypes by linear discriminant analysis. Also, could be effective in the identification of the wheat genotypes of desirable characters for late sowing date condition. Furthermore, they were known as the most valuable characters which is due to the high standardized coefficient, not affected by measure unit, with the greater contribution to discrimination between groups (24 genotypes).

Growing degree days (GDD) was illustrating the relationship between growth duration and temperature. As important factors relating to crop phenology, heat unit requirements, such as growing degree days (GDD), influence crop growth and development [40]. So, it is clear the importance of GDD to segregation between two groups (24 genotypes) and placement good performance genotypes.

The highest rate of Discriminant Score belonged to Misr 3 (check 3.10), Line-17 (2.96), Line-2 (2.47) and Line-5 (2.37) these results refer to positive responses to late sowing date and the lowest was for Line-13 (-3.54) and Line-9 (-3.47), respectively, and vice versa results indicted to negative responses to late sowing date. One of the most attractive features of discriminant function is its ability to select superior genotypes as shown in Table 12 and Fig. 2.

On the other hand, superior genotypes under overall sowing dates belonged to Line-2, Misr 3 (check), Sakha 95 (check) and Line-10 with highest rate of Discriminant Score (3.05, 2.79, 2.65 and 2.20 respectively) and vice versa lowest rate of Discriminant Score belonged to Line-9, Line-13, Line-19 and Line-17 (Table 3 and Fig. 3) . These results illustrated the importance of these genotypes in breeding programs under late sowing date condition. Several researchers use Discriminant function analysis to distinguish between genotypes and make selection index for breeding programs. Aram et al (2018) used Discriminant function analysis (DA) to distinguish between drought tolerant genotypes with secondary traits in barley [41]. Also, Chauhana et al (2020) presented a discriminante analysis approach to integrate method from satellite data to distinguish between different lodging severities in wheat genotypes [42]. The DA method was used to explore the driving climatic factors of winter wheat yield responses to different time-scale droughts [43]**.** Discriminant analysis was used as a powerful multivariate method to find an integrated selection criterion using all studied characters not only the yield.

5. CONCLUSION

In this research, we used discriminant analysis (DA), to discriminate and classify superior genotypes wheat from 24 genotypes. Discriminant analysis results indicated that growing degree days played the most dominant discriminatory role in explaining the variation of the 24 wheat genotypes. Also, it could be effective in the identification of the wheat genotypes of desirable characters for late sowing date condition. Discriminant scores used as selection index based on all studied characters not only the yield was suggested that the genotypes Line-17, Line-2, Line-5 in addition to Misr 3 and Sakha 95 were recognized as the superior genotypes at late sowing date. Meanwhile, Line-2, Misr 3 and Sakha 95 genotypes were the superior genotypes under overall the both sowing dates.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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