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PERFORMANCE OF SOME SOYBEAN GENOTYPES UNDER DIFFERENT SOWING DATES

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ABSTRACT

The present study was carried out at two locations, i.e., Sakha and Mallawy Agricultural Research Stations, within two successive summer seasons (2022 and 2023), to evaluate four soybean genotypes (Giza22, H_1L_3, H_4L_4 and Giza111) under three different sowing dates (first of May, Mid of May, first of June). GGE model pattern analysis was used to determine the best genotypes for seed yield and its components. To identify the best genetic architecture and the most important features in the yield trait, Genotype by Yield*Trait (GY*T) analysis was also conducted using the GGE model. The results revealed notable variations among the criteria under investigation. The optimal date for yield and its components was determined to be the first planting date. The genotypes (Giza 22, H_1L_3) recorded the highest values for physiological traits and yield respectively.

Key words: ***Glycine max, Sowing date, GGE-biplot, GYT-biplot, LAI, RGR and NAR.***

INTRODUCTION

Soybean (*Glycine max* L.) is the world's most widely cultivated and economically successful legume. The plant is classed more as an oil seed crop than a pulse; it contain 20% Oil and 40% protein. Soybeans considered an affordable source protein for human and animals (Rahman and Haque 1978). In recent years, soybeans have become a strategic crop in Egypt, an interest in its cultivation has increased. The cultivated area has increased from 3.261feddan with a productivity of 0.311 ton/feddan in 1970 to 150.000 feddan with productivity of 1.25 ton/feddan in 2022 (Economic Affairs Sector 2022). Mortzinis *et al* (2019) stated that climate change had an important impact on crop production. Therefore, identifying the factors that affect crop yield has a great importance. Planting dates are considered as determinant of crop growth and productivity whears, it affects the construction of vegetative and fruiting parts (Setiyono *et al* 2007 and Nico *et al* 2019) and final biomass (Divito *et al* 2016).

Understanding the importance of sowing dates in soybean cultivation is crucial for optimizing yield. The timing of planting affects growth, development, and eventual yield of the soybean crop. Different sowing dates can have varying effects on soybean production, influencing yield, growth, and seed quality (Ibrahim, 2009, Jarecki and Bobrecka-Jamro 2021). Sowing soybeans at of April and May can result in the highest seed yields (Fordonski *et al* 2023). Delayed sowing can lead to seed yield reduction (Mohod *et al* 2023). However, Serafin-Andrzejewska *et al* (2024)

found that the sowing date of soybean did not significantly impact soybean seed yield.

Early sowing can promote greater plant height, more branches, and root nodules. Meanwhile, delayed sowing can result in inferior growth and yield. Also, delayed sowing can decrease plant height, number of pods per plant, and seed yield per plant (Mohod *et al* 2023). Later sowing dates may result in higher protein concentrations in soybean seeds (Fordonski *et al* 2023). Very late sowing can produce decrease seeds weight (Fabiano *et al* 2024). Seed yield from early sowing is significantly correlated with total precipitation in June and July, while later sowing dates correlate with total precipitation in August (Borowska and Prusiński 2021). Temperature is the most significant climatic factor affecting soybean yield (Fordonski *et al* 2023). The effect of sowing date can also depend on the soybean cultivar, with mid-early cultivars potentially yielding the highest seed and protein yield as well as protein content (Borowska and Prusiński 2021). This study explores different sowing dates and their impacts on soybean production and determining the best sowing date and genotype.

MATERIALS AND METHODS

Field experiment were conducted during two seasons 2022 (S 1) and 2023 (S 2) at two locations, Sakha "L 1" (31.08808° N, 30.94588° E) and Mallawy "L 2" (27.7359° N, 30.8448° E) Agricultural Research Stations, ARC, Egypt. Three sowing dates were scheduled each season at about 15-day intervals (first of May "D 1", Mid of May "D 2", first of June "D 3") in both seasons. Four genotypes of soybean were used (Giza22, H_4L_4, H_1L_3 and Giza111). The Origin, pedigree and some features of studied genotypes are presented in Table (1).

The experimental design was a split-plot design in RCBD arrangement with three replications. Sowing dates were allocated to the main plots, while genotypes were distributed in the sub-plots. Each plot consisted of five ridges (3.5 m length x 60 cm apart). Two seeds were sown on one side of the ridge at a distance of 20 cm; the plot area was 10.5 m^2. Soybean seeds were inoculated with the bacterial culture Nitragina containing strains of *Bradyrhizobium japonicum*. All agriculture practices were carried out following the standard recommendations.

Table 1. Origin, pedigree and some features of studied genotypes.

Parent	Origin	Pedigree	Characters
Giza 22 (G1)	FCRI-ARC	Forest x Crawford	High yielding, moderate tolerant to cotton leave warm, purple flower, Cream colored seed and black hilum
H_1L_3 (G2)	FCRI-ARC	$H_{20}L_3$ x Gasoy 17	High yielding, tolerant to cotton leave warm, purple flower, Cream colored seed, black hilum, tolerant to water deficit and moderate maturing
H_4L_4 (G3)	FCRI-ARC	D R 101 x Lamar	High yielding, tolerant to cotton leave warm, purple flower, Cream colored seed, light brown hilum, and moderate maturing
Giza111 (G4)	FCRI-ARC	Crawford x Celest	High yielding, tolerant to cotton leave warm, purple flower, Cream colored seed and light black hilum

***FCRI= Field Crops Research Institute, ARC, Egypt.**

At vegetative stage, six guarded plants were taken randomly from the two inner ridges of each plot at 50, 65 and 80 days after sowing to record the growth characters. Crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) was estimated according to Radford (1967). Leaf area index (LAI) was measured according to Watson (1952). Five guarded plants were taken from each plot to determine the means of days to flowering (FD) and to days to maturity (MD), plant height (PH), number of branches/plant (branches), number of pods/plant (pods), seed weight/plant (SW/P) ,100-seed weight (100-SW/P). The three middle ridges of each plot were harvested to determine seed yield/ fed., (SY/F). The average of temperature during 2022 and 2023 growing seasons at Sakha and Mallawy is shown in Figure (1).

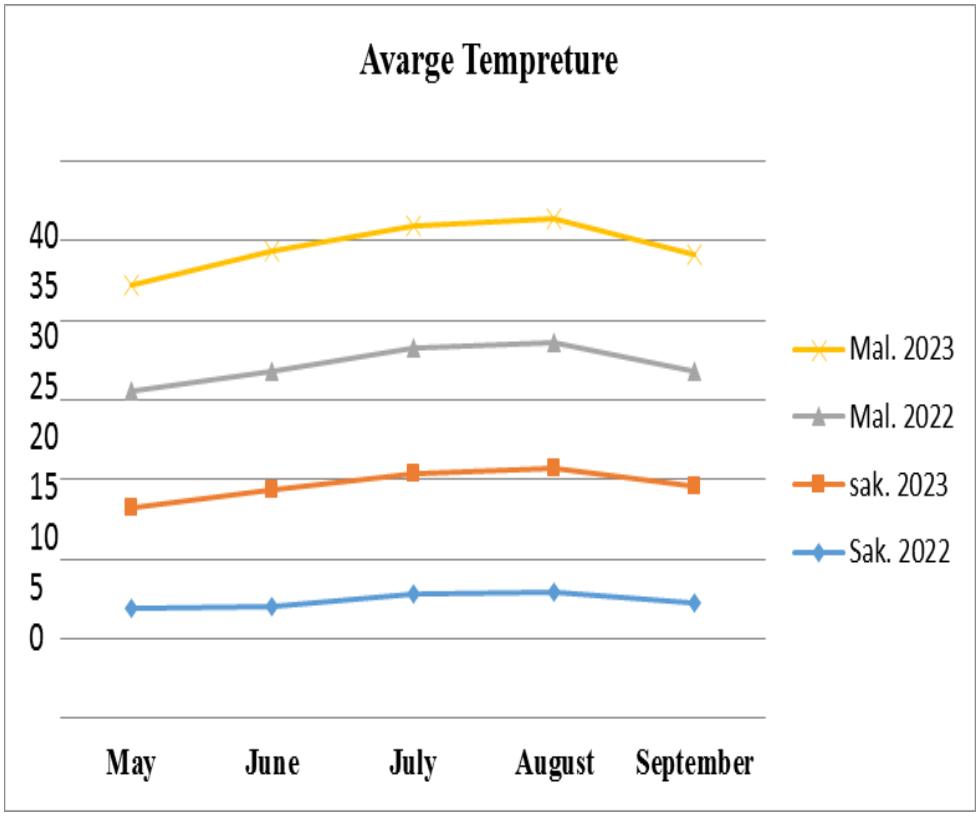

Fig. 1. The average of temperature during 2022 and 2023 growing seasons.

Statistical analysis

Data were subjected to the statistical analysis by GenStat 21th Ed statistical software (GENSTAT 2009). Analysis of variance was performed according to Gomez and Gomez (1984). The homogeneity of variances across studied traits was performed using Bartlett's test (1937).

Combined analysis of locations and seasons was performed. Genotype x yield*trait bi-plot (GYT bi-plot) was performed according to the procedure of Yan and Fregeau (2018). All statistical analyses were performed

RESULTS AND DISCUSSIONS

The main effects of location, sowing date and genotype

The main effects of Location, sowing date and genotype are presented in Table (2). The effect of location on yield traits of soybean was significant and multifaceted, primarily due to environmental factors such as latitude, photoperiod and temperature, which influence the expression of yield-related traits. Sakha location (L1) was superior in all studied traits where it recorded the highest values for all studied traits except for FD and MD, pods, 100-SW, LAI 2 and RGR 2 and with an average of 32.2, 114.2, 49.0, 16.4, 2.740, 0.029 respectively. There were significant differences among locations in all traits except for CGR 2. Li *et al* (2020) reported that number of pods and 100-seed weight varied with location which correlate positively with yield. These traits tend to be influenced both directly and indirectly by environmental conditions at different sites. For instance, pods, seeds, and 100-seed weight had direct positive effects on yield, while traits like plant height and growth period indirectly affect yield. Yoon *et al* (2021) reported that warmer temperatures limits soybean vegetative development (leaf area index) by achieving the maximum heat unit sooner, which decreased soybean production. Also the higher temperature causes the lighter plants which reflect on CGR and RGR (Oh-E *et al* 2007).

The soybean yield attributes significantly differed among three sowing dates as shown in Table (2). The highest values of all studied traits were exhibited in D 1 except for LAI 1, RGR 1, RGR 2, and NAR 2 with an average of 1.985, 0.024, 0.031 and 0.099 respectively According to Serafin-Andrzejewska *et al* (2021) the delay in sowing reduces the vegetative and reproductive periods, which negatively impacts total production where earlier sowing tends to produce better outcomes. In case of the genotypes there were significant differences between genotypes for all yield traits as presented in Table (2) as an average of the combined analysis. G_1 followed by G_2 achieved the superiority in all studied traits with exception of CGR 1, RGR 1, RGR 2, NAR 1 and NAR 2. While, G_1 and G_3 were the earliest genotypes with an average of 32.8 and 33.4 for FD and 114.4 and 113.3 for MD respectively. These findings are in agreement with results obtained by Mohamed and Faiza (2005) and Soliman *et al* (2007).

Table 2. The effect of location, sowing date and genotype (combined analysis across two seasons).

Traits	FD	MD	PH	Branch	Pods	SW/P	100-SW	SY/fed	LAI 1
Locations									
L 1	33.6	115.1	112.2	3.6	47.3	15.7	15.1	1.600	2.084
L 2	32.8	114.2	105.2	2.5	49.0	15.2	16.4	1.300	1.809
LSD $_{0.05}$	0.34	0.48	0.34	0.07	1.22	0.36	0.17	0.32	0.074
Sowing dates									
D 1	34.9	116.1	110.1	3.20	49.7	19.0	17.2	1.690	1.949
D 2	33.1	114.2	109.7	3.04	45.9	16.5	15.8	1.480	1.985
D 3	31.7	112.3	90.8	2.90	31.4	10.8	14.6	1.230	1.871
LSD $_{0.05}$	0.46	0.39	0.46	0.18	1.20	0.55	0.22	0.34	0.102
Genotypes									
G 1	32.8	114.4	110.0	3.6	54.9	17.3	17.1	1.400	2.155
G 2	33.5	116.4	110.5	3.0	49.9	16.1	15.9	1.800	2.087
G 3	33.4	113.3	87.5	2.7	40.8	13.0	14.6	1.500	1.795
G 4	33.3	114.6	105.9	2.9	47.0	15.3	15.2	1.200	1.704
LSD $_{0.05}$	0.50	0.52	0.50	0.19	1.29	0.47	0.26	0.40	0.090

Traits	LAI 2	LAI 3	CGR 1	CGR 2	RGR 1	RGR 2	NAR 1	NAR 2
Locations								
L 1	2.502	3.793	0.643	0.648	0.034	0.015	0.202	0.150
L 2	2.740	3.506	0.135	0.640	0.013	0.029	0.010	0.034
LSD 0.05	0.179	0.178	0.028	0.031	0.028	Ns	0.005	0.006
Sowing dates								
D 1	2.980	4.255	0.450	0.737	0.023	0.026	0.115	0.093
D 2	2.834	3.546	0.364	0.619	0.024	0.026	0.091	0.085
D 3	2.050	3.147	0.353	0.576	0.023	0.031	0.112	0.099
LSD 0.05	0.100	0.106	0.022	0.042	0.022	0.042	0.007	0.008
Genotypes								
G 1	2.992	4.108	0.271	0.452	0.016	0.021	0.111	0.059
G 2	2.774	3.966	0.436	0.789	0.023	0.022	0.113	0.111
G 3	2.337	3.252	0.442	0.686	0.023	0.023	0.100	0.089
G 4	2.383	3.271	0.324	0.575	0.024	0.021	0.101	0.088
LSD 0.05	0.093	0.115	0.025	0.052	0.025	0.052	0.007	0.009

FD = Days to flowering, MD = Days to maturity. PH = Plant height, SW/P = Sees weight/ plant, 100-SW/p = 100- Seed weight/plant, SY/fed = Seed yield feddan, LAI= Leaf area index CGR= Crop Growth Rate, R.G.R = Relative growth rate, NAR= Net assimilation rate

The interaction between location and sowing date

The interactions between locations and sowing dates obtained on the studied traits are presented in Table (3).

Table 3. The effect of location x sowing date interaction (combined analysis across two seasons).

Locations	Dates	FD	MD	PH (cm)	Branch	Pods	SW/P (g)	100-SW (g)	SY/fed (ton)	
L 1	D 1	35.3	118.2	138.9	3.7	63.8	19.7	16.1	1.800	
	D 2	33.3	115.0	100.5	3.6	56.5	16.4	15.4	1.600	
	D 3	32.1	112.0	97.0	3.4	41.6	11.0	13.8	1.500	
L.S.D $_{0.05}$		0.73	0.69	3.53	0.35	1.96	1.03	0.609	0.090	
L 2	D 1	34.4	116.1	112.1	2.8	49.7	18.3	18.4	1.600	
	D 2	33.0	114.2	119.0	2.4	45.9	16.5	16.2	1.400	
	D 3	31.2	112.3	84.6	2.2	31.4	10.6	14.4	1.000	
L.S.D $_{0.05}$		0.93	0.44	4.97	0.22	2.32	0.83	0.66	0.10	
Dates	Gen.	LAI 1	LAI 2	LAI 3	CGR 1	CGR 2	RGR 1	RGR 2	NAR 1	NAR 2
L 1	D 1	2.094	2.711	4.351	0.728	0.754	0.033	0.015	0.219	0.153
	D 2	2.134	2.617	3.370	0.566	0.561	0.034	0.015	0.171	0.137
	D 3	2.025	2.178	3.657	0.634	0.628	0.036	0.016	0.218	0.159
L.S.D $_{0.05}$		0.181	0.166	0.378	0.064	0.103	0.002	0.002	0.014	0.020
L 2	D 1	1.903	3.247	4.160	0.171	0.720	0.013	0.027	0.011	0.032
	D 2	1.904	3.052	3.721	0.162	0.676	0.015	0.029	0.011	0.033
	D 3	1.620	1.922	2.636	0.072	0.524	0.010	0.032	0.007	0.039
L.S.D $_{0.05}$		0.177	0.168	0.144	0.0241	0.0785	0.0020	0.0038	0.0028	0.0042

FD = Days to flowering, MD = Days to maturity. PH = Plant height, SW/P = Sees weight/ plant, 100-SW/p = 100- Seed weight/plant, SY/fed = Seed yield feddan, LAI= Leaf area index CGR= Crop Growth Rate, R.G.R = Relative growth rate, NAR= Net assimilation rate

D 1 in both locations achieved the highest values of all studied traits except LAI 1, RGR 1and NAR 1 in D 2 in L 2, 100-SW in D 1 in L2. In the case of FD and MD the situation was different, where the lowest value (the earliest) the preferable values: D 3 was the earliest in both locations with average of 31.2 days in D 3 L 2 for FD date and 112.0 days in D 3 L 1 for MD. This result is due to the delay in sowing which exposes soybeans to

shorter photoperiod and higher temperatures earlier, leading to faster progression to flowering and maturity (Safina et *al* 2025).

The interaction between location and genotype

Table 4 clarified the impact of interaction between locations and genotypes for the studied traits of combined analysis across two seasons. In both locations G 1 achieved the highest values of all studied traits, except PH, LAI 1, CGR 1 and NAR 2 (L 1), LAI 2, CGR 2, RGR 2 and NAR 2 (L 2).

Table 4. The effect of location x genotype interaction (combined analysis across two seasons).

Location	Gen.	FD	MD	PH (cm)	Branch	Pods	SW/P (g)	100-SW	SY/fed (ton)	
L 1	G 1	33.9	114.2	109.1	3.7	60.53	17.57	15.97	2.267	
	G 2	33.5	117.4	113.3	3.5	55.07	16.40	15.23	1.433	
	G 3	32.6	113.0	84.5	3.1	49.07	13.67	14.67	1.333	
	G 4	34.4	115.7	107.9	3.5	51.17	15.57	14.53	1.433	
L.S.D $_{0.05}$		0.79	0.86	4.42	0.43	4.25	1.25	0.92	0.12	
L 2	G 1	31.7	114.6	108.3	3.4	49.30	17.00	18.30	1.367	
	G 2	33.4	115.3	107.8	2.5	44.70	15.90	16.73	1.467	
	G 3	34.2	113.6	90.6	2.3	32.60	12.37	14.57	1.067	
	G 4	32.1	113.3	107.1	2.3	42.70	15.03	15.83	1.333	
L.S.D $_{0.05}$		1.05	0.57	5.67	0.25	2.75	0.69	0.72	0.12	
Location	**Gen.**	**LAI 1**	**LAI 2**	**LAI 3**	**CGR 1**	**CGR 2**	**RGR 1**	**RGR 2**	**NAR 1**	**NAR 2**
L 1	G 1	2.01	2.730	1.994	0.665	0.913	0.034	0.018	0.211	0.1907
	G 2	2.38	2.667	1.979	0.660	0.660	0.035	0.014	0.217	0.1403
	G 3	1.82	2.182	3.230	1.077	0.509	0.035	0.015	0.190	0.1373
	G 4	2.04	2.429	2.179	0.726	0.510	0.035	0.014	0.192	0.1303
L.S.D $_{0.05}$		0.194	0.271	0.468	0.098	0.131	0.002	0.0023	0.019	0.0220
L 2	G 1	2.30	3.253	1.084	0.509	0.665	0.013	0.023	0.010	0.0300
	G 2	1.80	2.880	0.960	0.428	0.712	0.012	0.029	0.009	0.0370
	G 3	1.77	2.491	0.830	0.129	0.641	0.014	0.030	0.010	0.0370
	G 4	1.37	2.337	0.779	0.350	0.543	0.013	0.028	0.010	0.0340
L.S.D $_{0.05}$		0.201	0.192	0.174	0.027	0.089	0.002	0.0030	0.0020	0.005

FD = Days to flowering, MD = Days to maturity. PH = Plant height, SW/P = Sees weight/ plant, 100-SW/p = 100- Seed weight/plant, SY/fed = Seed yield feddan, LAI= Leaf area index CGR= Crop Growth Rate, R.G.R = Relative growth rate, NAR= Net assimilation rate

In the case of flowering and maturity dates the situation is different where the lowest value (the earliest) the preferable values; D 3 was the earliest in both locations with an average of 31.7 days for FD and 113.0 days for MD.

Interaction of sowing dates x genotypes

The results in Table (5) revealed that G1 had the highest values for all studied traits in all sowing dates, except for PH, LAI 1& 2 in D 2. For FD, G 1 was the earliest genotype in D 2 and D3, while G3 was the earliest genotype in D 1. For MD, G3 was the earliest in all sowing dates. There were significant differences between genotypes for most studied traits except for FD, CGR 2 and RGR 2 in D 1, RGR 1 in D3.

Table 5. The effect of sowing date x genotype interaction (combined analysis across two seasons).

Dates	Gen.	FD	MD	PH (cm)	Branch	Pods	SW/P (g)	100-SW (g)	SY/fed (ton)
D 1	G 1	35.2	117.3	117.89	3.9	64.2	21.15	17.80	1.95
	G 2	35.1	119.1	117.63	3.2	58.3	19.55	17.40	1.70
	G 3	34.4	115.5	95.84	2.7	48.5	15.90	16.55	1.40
	G 4	34.9	117.0	108.01	3.2	56.1	19.50	17.25	1.70
L.S.D $_{0.05}$		1.35	1.02	8.52	0.61	8.38	2.15	0.66	0.23
D 2	G 1	32.4	113.90	108.90	3.55	59.70	18.30	17.70	1.65
	G 2	33.5	116.40	113.17	2.95	54.80	17.35	15.70	1.60
	G 3	33.2	113.25	98.40	2.80	41.85	14.00	14.50	1.20
	G 4	33.4	114.75	118.48	2.85	48.35	16.35	15.20	1.45
L.S.D $_{0.05}$		1.14	1.17	9.61	0.69	7.43	1.92	1.20	0.18
D 3	G 1	30.8	112.1	103.1	3.25	40.85	12.40	15.90	1.85
	G 2	31.8	113.6	100.8	2.90	36.60	11.55	14.85	1.05
	G 3	32.7	111.2	68.3	2.55	32.15	9.15	12.80	1.00
	G 4	31.5	111.9	91.2	2.70	36.40	10.05	13.10	1.00
L.S.D $_{0.05}$		1.57	1.15	7.97	0.58	4.28	1.34	1.17	0.11

Table 5. Cont.

Dates	Geno.	LAI 1	LAI 2	LAI 3	CGR 1	CGR 2	RGR 1	RGR 2	NAR 1	NAR 2
D 1	G 1	2.239	3.623	5.171	0.587	1.050	0.024	0.0215	0.124	0.123
	G 2	1.921	3.455	4.397	0.481	0.697	0.024	0.0195	0.124	0.074
	G 3	1.960	3.048	3.936	0.401	0.629	0.024	0.021	0.116	0.082
	G 4	1.676	2.864	3.516	0.328	0.570	0.023	0.0205	0.096	0.093
L.S.D $_{0.05}$		0.141	0.225	0.396	0.0832	0.19217	0.0024	0.0049	0.0174	0.0279
D 2	G 1	2.1995	3.499	3.762	0.378	0.7025	0.023	0.0195	0.095	0.101
	G 2	2.4835	3.157	4.1245	0.474	0.7035	0.0235	0.02	0.105	0.086
	G 3	1.711	2.754	2.9865	0.268	0.5705	0.025	0.024	0.077	0.086
	G 4	1.5455	2.796	3.3095	0.337	0.499	0.0255	0.019	0.089	0.068
L.S.D $_{0.05}$		0.0194	0.0194	0.0194	0.0194	0.0194	0.0194	0.0194	0.0194	0.0194
D 3	G 1	2.026	2.638	3.391	0.343	0.613	0.023	0.021	0.113	0.108
	G 2	1.856	2.028	3.377	0.371	0.657	0.022	0.0255	0.110	0.107
	G 3	1.712	1.672	2.832	0.302	0.525	0.024	0.0235	0.108	0.095
	G 4	1.890	1.351	2.987	0.395	0.509	0.023	0.023	0.119	0.086
L.S.D $_{0.05}$		0.367	0.376	0.385	0.0893	0.10871	0.0022	0.0043	0.0172	0.027

FD = Days to flowering, MD = Days to maturity. PH = Plant height, SW/P = Sees weight/ plant, 100-SW/p = 100- Seed weight/plant, SY/fed = Seed yield feddan, LAI= Leaf area index CGR= Crop Growth Rate, R.G.R = Relative growth rate, NAR= Net assimilation rate

Interaction of locations x sowing dates x genotypes

The data presented in Tables (6 and 7) showed that there were significant differences in physiological and all yield attributes due to the interaction among the three factors. There was a variation in the tested genotypes' responses to FD and MD. The earliest genotype was G3 in D3 in L 1 and recorded 30.80 days, while the latest one was G4 in D_1 (36.70 days). Regarding L 2 (Mallawy), the earliest genotype was G_1 in D_3 (29.00 days) whereas the latest was G2 in D_1 (36.00 days). Generally, flowering date ranged from 30.8 days for G_1 in D_3 to 35.20 days G_1 in D $_1$.

Table 6. Mean Performance of soybean genotypes under different sowing dates for flowering date, maturity date, plant height and branches (across seasons).

Sowing date	Genotype	FD		overall	MD		overall
		L 1	L 2		L 1	L 2	
D 1	G 1	35.7	34.7	35.2	118.2	116.3	117.3
	G 2	34.2	36.0	35.1	121.0	117.2	119.1
	G 3	34.8	34.0	34.4	115.7	115.2	115.5
	G 4	36.7	33.0	34.9	118.2	115.7	117.0
D 2	G 1	33.5	31.3	32.4	113.3	114.5	113.9
	G 2	33.2	33.8	33.5	117.3	115.5	116.4
	G 3	32.2	34.2	33.2	113.0	113.5	113.2
	G 4	34.3	32.5	33.4	116.3	113.2	114.7
D 3	G 1	32.5	29.0	30.8	111.2	113.0	112.1
	G 2	33.0	30.5	31.8	113.8	113.3	113.6
	G 3	30.8	34.5	32.7	110.3	112.0	111.2
	G 4	32.2	30.7	31.5	112.7	111.0	111.9
Mean		33.6	32.9	33.2	115.1	114.2	114.6
LSD 0.05	L			0.3			0.5
	D			0.5			0.4
	G			0.5			0.5
	L X D			0.6			0.6
	L X G			0.7			0.8
	D X G			0.9			0.8
	L X D X G			1.2			1.2

Sowing date	Genotype	PH (cm)		overall	Branches		overall
		L 1	L 2		L 1	L 2	
D 1	G 1	119.1	109.2	117.9	3.9	3.8	3.9
	G 2	121.9	113.3	117.6	3.2	3.1	3.2
	G 3	92.5	99.17	95.8	3.5	1.9	2.7
	G 4	108.8	116.7	108.0	4.2	2.2	3.2
D 2	G 1	101.1	116.7	108.9	3.6	3.5	3.5
	G 2	109.7	116.7	113.2	3.4	2.5	2.9
	G 3	95.9	100.8	98.4	2.7	2.9	2.8
	G 4	121.7	115.9	118.5	3.9	1.8	2.8
D 3	G 1	107.0	99.2	103.1	3.5	3.0	3.2
	G 2	108.2	93.3	100.8	3.8	2.0	2.9
	G 3	65.0	71.7	68.3	3.0	2.1	2.5
	G 4	93.1	89.3	91.2	2.5	2.9	2.7
Mean		101.9	105.2	103.1	3.60	2.48	3.04
LSD 0.05	L			2.8			0.1
	D			3.4			0.2
	G			3.1			0.2
	L X D			4.6			0.2
	L X G			4.6			0.2
	D X G			5.7			0.3
	L X D X G			7.9			0.4

FD = Days to flowering MD = Days to maturity PH = Plant height

Table 7. Mean Performance of soybean genotypes under different sowing dates for pods, SW/p. 100-seed weight (g) and Seed yield/fed (across seasons).

Sowing date	Genotype	Pods		Overall	SW/P (g)		Overall	100-SW/p (g)		Overall	SY/fed (ton)		Overall
		L 1	L 2		L 1	L 2		L 1	L 2		L 1	L 2	
D 1	G 1	73.6	54.8	64.2	23.3	19.0	21.1	16.7	18.9	17.8	2.800	1.700	1.950
	G 2	52.0	64.5	58.3	18.2	20.9	19.5	16.3	18.5	17.4	1.500	1.900	1.700
	G 3	60.3	36.7	48.5	16.6	15.2	15.9	14.6	18.5	16.5	1.600	1.200	1.400
	G 4	69.3	42.8	56.1	21.8	17.2	19.5	16.7	17.8	17.2	2.000	1.400	1.700
D 2	G 1	68.1	51.3	59.7	18.7	17.9	18.3	17.0	18.4	17.7	2.200	1.500	1.650
	G 2	67.5	42.1	54.8	19.2	15.5	17.3	14.2	17.2	15.7	1.800	1.400	1.600
	G 3	47.0	36.7	41.8	14.2	13.8	14.0	15.8	13.2	14.5	1.300	1.100	1.200
	G 4	43.3	53.4	48.3	13.8	18.9	16.3	14.5	15.9	15.2	1.300	1.600	1.450
D 3	G 1	39.9	41.8	40.8	10.7	14.1	12.4	14.2	17.6	15.9	1.800	0.900	1.850
	G 2	45.7	27.5	36.6	11.8	11.3	11.5	15.2	14.5	14.8	1.000	1.100	1.050
	G 3	39.9	24.4	32.1	10.2	8.1	9.1	13.6	12.0	12.8	1.100	0.900	1.000
	G 4	40.9	31.9	36.40	11.1	9.0	10.0	12.4	13.8	13.1	1.000	1.000	1.000
Mean		53.96	42.33	48.14	15.72	15.16	15.44	15.1	16.4	15.7	1.62	1.31	1.460
LSD 0.05	L			1.2			0.4			0.2			0.320
	D			1.2			0.5			0.2			0.340
	G			1.3			0.5			0.3			0.400
	L X D			1.7			0.7			0.3			0.480
	L X G			1.9			0.7			0.3			0.560
	D X G			2.2			0.8			0.4			0.680
	L X D X G			3.2			1.3			0.6			0.960

SW/P = Seed weight/plant, 100-SW/p = 100- Seed weight/plant, SY/fed = Seed yield feddan.

The earliest maturing genotypes were G_3 in D_3 (110.3 days) and G 4 in D_3 (111 days) in both locations. While, G_2 was the latest one in both locations with 121.0 and 117.2 days respectively. The overall mean ranged from 111.2 days for G3 in D3 to 119.10 days for G2 in D1. The results showed that the decrease in flowering and maturity dates occurred in D2 and D3; this can be attributed to climate conditions. According to Serafin-Andrzejewska *et al* (2021), the delay of soybean planting also affected variations in the average temperature during the development stage.

The results of plant height (Table 6) showed high variability among the genotypes and between sowing dates. The mean values ranged in Sakha from 65.0 cm for G 3 in D3 to 121.9 cm for G 4 in D1. It ranged in L 2 from 71.67 cm for G 3 in D3 to 116.67 cm for G 1 and G2 in D2. The mean values ranged from 68.3 cm for G 3 in D3 to 117. 9 cm for G 1 in D1. The genotype (G3) was the shortest in both locations as well as in relation to the overall mean. Plant height varied with respect to when it was sown; early and optimal date produces the tallest plants as reported by (Fordonski *et al* 2023).

Results presented in Table (6) revealed that there were significant differences between studied genotypes and sowing dates for branches plant $^{-1}$. In L 1, G3 in D1 had the highest value 4.2 while G4 in D3 had the lowest branches plant $^{-1}$ value (2.5). In L 2, G4 in D2 had the lowest branches plant $^{-1}$ value 1.8, while also the highest overall mean values for branches obtained by G1 in D1 (3.9) while the lowest was G3 in D3 had the (2.5).

Nwofia *et al* (2016) mentioned that number of pods per plant was the main element influencing the seed production among the crop components. For pods plant^{-1}, in L 1, G1 and G4 in D3 had the lowest number of pods plant^{-1} by (39.9). G1 had the highest no, of pods (73.6) in D1. In L 2, G3 in D3 recorded the lowest number of pods plant^{-1} (24.4). While, G2 in D1 recorded highest number of pods (64.5). While, the overall mean values ranged between 32.1 for G3 in D3 to 64.20 for G1 in D1. These results were agreed with Jarecki and Bobrecka-Jamro (2021), who reported that the number of pods per plant was higher when sowing at an early date compared to optimal. Delays in soybean seeding led to a notable decrease in seed yield, as shown by Ibrahim (2012). This resulted from a shorter growing season leading to a decrease in number of pods per plant. For seed weight plant $^{-1}$ presented in Table 7, there were variation among studied genotypes and sowing dates. The best seed weight plant-^{1} was recorded from sowing in D1 for G1 in L1 and G4 in L2 (23.3 and 20.9 g). Meanwhile, the lowest seed weight plant-^{1} was obtained from G3 in D3 in both locations (10.2 and 8.1 g), respectively (Table 7). Regarding overall means G1 at D1 had the highest seed yield plant $^{-1}$ (21.15g) and the lowest was G3 at D3 (9.1 g).

Based on 100-seed weight plant^{-1} values in G2 x D3 x L 1 recorded the lowest 100-seed weight^{-1} (g) with an average of 12.4 g, and G1 x D2 recorded the highest value with an average of 17.00 g. Regarding L 2, 100-seed weight values ranged from (12.00g) for G3 in D3 to 18.9 g for G1 in D1. For overall mean, G4 in D3 possessed lowest mean (12.80g), while G1 D1 possessed the highest mean (17.8g) (Table 7). Statistically significant differences were found for 100-seed weight of soybean due to sowing date. The average 100-seed weight from early sowing was higher than that from late sowing that may be due to early planted genotypes which got more time and growth period to accumulate more photo-assimilates. This result agreed with (Kundu *et al* 2016). Regarding, SY/fed presented in Table (7), significant differences between sowing dates, as well as varieties and interactions between them. Early sowing (D1) in both locations produced the highest SY/fed which possessed by G1 and G 2 (2.8 and 1.9 ton.fed) respectively. In the contrast, the lowest SY/fed was obtained by G 3 and G 4 in L1 (1 ton/fed), and G1 and G 3 in L2 (0.9 ton/fed) in D3. Overall seed yield/fed varied from 1.950 ton for G 1 at D1 to 1 ton at D 3 for each of G 3 and G 4. As noted by Calviño *et al* (2003), early soybean seeding improved the fullness of harvested seeds, which translated into 100-seed weight and seed yield. Delays in seeding soybeans led to a decrease in yield and its constituent parts, as validated by Yagoub and Hamed (2013).

There were significant differences between the sowing dates, locations, and genotypes under study, as well as the interactions between them. Both the G 1 and G 2 outperformed each other in all yield parameters with the exception of flowering and maturity, where the G 3 was the earliest combined with D 3. The percentage of increase in the yield traits of plant height, branches, pods, SW/p, 100- SW and SY/fed were as follows: 12.55%, 17.95%, 36%, 41.23%, 10.67%, and 5.13% for G 1. While % of increase for G 2 was 14.28%, 9.38%, 37.22%, 41.02%, 14.94% and 38.23% respectively.

The interaction among sowing dates, genotypes and locations affected statistically CGR, RGR, NAR and LAI (Tables 8 and 9).

Table 8. Mean Performance of soybean genotypes under different sowing dates for Leaf area index and C.G.R (g/day/plant) across seasons.

Sowing date	genotype	L A I 1 (cm)		Overall	L A I 2 (cm)		Overall	L A I 3 (cm)		Overall	C.G.R 1 g/day/plant)		overall	C.G.R 2 (g/day/plant)		Overall
		L 1	L 2		L 1	L 2		L 1	L 2		L 1	L 2		L 1	L 2	
D 1	G 1	2.208	2.27	2.239	3.539	3.623	3.581	5.722	4.620	5.171	0.950	0.225	0.587	1.348	0.753	1.050
	G 2	2.008	1.835	1.921	2.833	3.455	3.144	4.547	4.247	4.397	0.798	0.165	0.481	0.558	0.837	0.697
	G 3	1.903	2.017	1.960	2.300	3.048	2.674	3.860	4.012	3.936	0.654	0.149	0.401	0.537	0.721	0.629
	G 4	1.864	1.488	1.676	2.174	2.864	2.519	3.274	3.759	3.516	0.509	0.147	0.328	0.574	0.567	0.570
D 2	G 1	2.012	2.387	2.199	2.597	3.499	3.048	3.188	4.336	3.762	0.565	0.191	0.378	0.673	0.732	0.702
	G 2	2.717	2.250	2.483	2.967	3.157	3.062	4.561	3.688	4.124	0.790	0.158	0.474	0.708	0.699	0.703
	G 3	1.700	1.722	1.711	2.313	2.754	2.533	2.614	3.359	2.986	0.379	0.157	0.268	0.456	0.685	0.570
	G 4	1.833	1.258	1.545	2.590	2.796	2.693	3.118	3.501	3.309	0.531	0.143	0.337	0.408	0.59	0.499
D 3	G 1	1.806	2.247	2.026	2.054	2.638	2.346	3.642	3.140	3.391	0.588	0.098	0.343	0.717	0.509	0.613
	G 2	2.412	1.301	1.856	2.201	2.028	2.114	4.046	2.708	3.377	0.684	0.059	0.371	0.713	0.601	0.657
	G 3	1.844	1.581	1.712	1.932	1.672	1.802	3.215	2.449	2.832	0.524	0.081	0.302	0.534	0.516	0.525
	G 4	2.428	1.352	1.890	2.524	1.351	1.937	3.727	2.247	2.987	0.740	0.050	0.395	0.548	0.471	0.509
Mean		2.061	1.809	1.935	2.502	2.740	2.621	3.793	3.506	3.649	0.643	0.135	0.389	0.648	0.640	0.644
LSD 0.05	L			0.074			0.179			0.177			0.028			0.031
	D			0.102			0.100			0.106			0.022			0.041
	G			0.090			0.092			0.115			0.025			0.052
	L X D			0.133			0.201			0.203			0.035			0.054
	L X G			0.128			0.202			0.215			0.039			0.069
	D X G			0.166			0.168			0.199			0.042			0.087
	L X D X G			0.229			0.274			0.311			0.062			0.121

LAI = Leaf area index, CGR = Crop Growth Rate.

Table 9. Mean Performance of soybean genotypes under different sowing dates for R.G.R (g/day/plant) and NAR (g/cm^2/day) across seasons.

Sowing date	Genotype	R.G.R 1 (g/day/plant)		Overall	R.G.R (g/day/plant)		Overall	NAR 1 (g/cm^2/day)		Overall	NAR 2 (g/cm^2/day)		Overall
		L 1	L 2		L 1	L 2		L 1	L 2		L 1	L 2	
D 1	G 1	0.033	0.014	0.023	0.020	0.023	0.021	0.235	0.013	0.124	0.215	0.030	0.123
	G 2	0.036	0.012	0.024	0.012	0.027	0.019	0.238	0.010	0.124	0.112	0.036	0.074
	G 3	0.034	0.013	0.023	0.013	0.029	0.021	0.221	0.010	0.116	0.129	0.034	0.082
	G 4	0.031	0.014	0.022	0.016	0.025	0.020	0.180	0.012	0.096	0.158	0.028	0.093
D 2	G 1	0.032	0.014	0.023	0.017	0.022	0.019	0.178	0.011	0.095	0.170	0.031	0.101
	G 2	0.033	0.014	0.023	0.014	0.026	0.020	0.200	0.010	0.105	0.138	0.033	0.086
	G 3	0.034	0.016	0.025	0.018	0.030	0.024	0.141	0.012	0.077	0.135	0.036	0.086
	G 4	0.035	0.016	0.025	0.013	0.025	0.019	0.165	0.012	0.089	0.105	0.030	0.068
D 3	G 1	0.037	0.01	0.023	0.018	0.024	0.021	0.219	0.007	0.113	0.187	0.029	0.108
	G 2	0.035	0.009	0.022	0.016	0.035	0.025	0.212	0.008	0.110	0.171	0.042	0.107
	G 3	0.036	0.012	0.024	0.015	0.032	0.023	0.208	0.008	0.108	0.148	0.041	0.095
	G 4	0.038	0.009	0.023	0.012	0.034	0.023	0.231	0.006	0.119	0.128	0.044	0.086
Mean		0.035	0.013	0.024	0.015	0.028	0.022	0.202	0.010	0.106	0.150	0.035	0.092
LSD 0.05	L			0.001			0.001			0.005			0.005
	D			0.002			0.002			0.007			0.008
	G			0.001			0.002			0.007			0.009
	L X D			0.002			0.002			0.009			0.010
	L X G			0.002			0.002			0.009			0.012
	D X G			0.003			0.003			0.011			0.015
	L X D X G			0.004			0.004			0.016			0.021

R.G.R = Relative growth rate, NAR= Net assimilation rate.

The superiority of G22 variety in the first sowing date under Sakha location on LAI in the 3rd sample, CGR and NAR (5.722, 1.348 g/day and 0.215 g/cm^2/day) in the last selective period respectively; this clearly reflects the ability of this genotype to supply the highest vegetative growth under these conditions. This could be due to the thermo period refers to daily temperature change; however, plants produce maximum growth when exposed to a day temperature that is about 10 to 15C° higher than the night temperature. This encourage the plant to enhance photosynthesis (build up) and respire (break down) during an optimum daytime temperature, and to limit the rate of respiration during night (Tunçtürk and Oral 2021). These results are in a good accordance with those reported by Moustafa (2011) and Ibrahim (2012). Moreover, Shaun *et al* (2025) surveyed that LAI may need to reach 5 or 6 before the crop intercepts nearly all of the sunlight. Light interception, canopy photosynthesis, and crop growth rates increase as the canopy develops, with light interception increasing from less than 1% of the amount of sunlight that falls on an acre as plants emerge, to nearly 100% during pod filling. An early start and rapid pace of canopy development means more rapid increases in crop growth rate.

Genotype by Yield*Trait (GYT) biplot

GYT analysis refers to the Genotype by Yield*Trait (GYT) biplot method a powerful, integrated approach to genotype evaluation that improves the selection of superior crop varieties by considering yield in combination with multiple agronomic traits Adhikari *et al* (2016) and Yan and Fregeau (2018).

GY*T biplot is erected based on the first (83.96%) and second (12.23%) components (PC1 and PC2) of principal components analysis (PCA). In this study, PC1 and PC2 explained 96.19% of the total variation. The results of GY*T biplot showed the rank for the studied genotypes based on their performance and stability across all test environments, considering all yield trait combinations.

The GY*T graphs (Fig. 2) illustrated that G 1 is the first performing genotype based on superiority index of the yield traits combination followed by G 2. Notably, G 1 is the best performing genotypes but it is less stable than G 2 (Ebrahimi 2023).

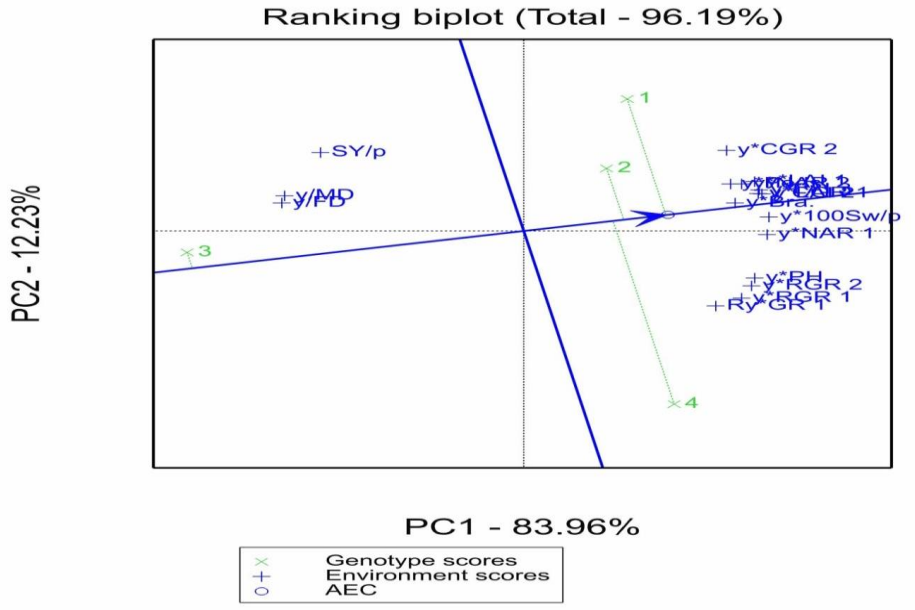

Fig. 2. Ranking view of the genotype by yield*trait (GYT) biplot to highlight studied genotypes

CONCLUSION

In this study, four soybean genotypes were used and planted at three different dates in two locations to investigate the effect of different planting dates on crop traits and yield components, as well as some physiological traits. The results showed significant differences between each of the studied factors. The first planting date (May first) was found to be the best for crop traits and components. The first (Giza 22) and second (H_1L_3) genotypes recorded the highest values for physiological traits and yield respectively. The GGE model was also used to perform GY*T analysis to determine the best genetic structures and the most influential traits in the crop trait and it showed that the first genotype (Giza 22) is the best performing genotypes but it is less stable than second genotypes (H_1L_3).

REFERENCE

Adhikari, B. M., A. Bajracharya, and A. K. Shrestha (2016). Comparison of nutritional properties of Stinging nettle (*Urtica dioica*) flour with wheat and barley flours**.** Food Science & Nutrition 4(1): 119–124.

Bartlett M. S. (1937). Properties of sufficiency and statistical tests. Proceedings of the Royal Statistical Society, Series a 160: 268-282.

Borowska, M. and J. Prusinski (2021). Effect of soybean cultivars sowing dates on seed yield and its correlation with yield parameters. Plant Soil Environ. 67, 360–366.

Economic Affairs Sector (2022). Ministry of Agricultural, Egypt, Annual Report.

Calviño, P.A., V.O. Sadras and F.H. Andrade (2003). Development, growth and yield of late-sown soybean in the southern Pampas. Eur. J. Agron., 19(2): 265-275. https://doi.org/10.1016/ /S1161-0301(02)00050-3.

Divito G.A., H. Echeverría, F.H. Andrade and V.O. Sadras (2016). Soybean shows an attenuated nitrogen dilution curve irrespective of maturity group and sowing date. Field Crop. Res., 186: 1-9. https://doi.org/10.1016/j.fcr.2015.11.004

Ebrahimi, L. (2023). 'Genotype by yield*trait' (GYT) biplot approach to evaluate resistance of soybean cultivars to Helicoverpa armigera Hübner under natural infestation conditions. Phytoparasitica 51, 909–918. https://doi.org/10.1007/s12600-023-01078-7

Fabiano, C., J. L., Alexander and E. L. Laura (2024). Soybean planting date and seeding rate effect on germinability and vigor of harvested seed. Crop Science. 64:903–913.

Fordonski, G., A. Okorski, D. Olszewski, J. abrowska and A. Pszczółkowska (2023). The Effect of Sowing Date on the Growth and Yield of Soybeans Cultivated in North-Eastern Poland. Agriculture, P. 1-18. https://doi.org/ 10.3390.

GENSTAT (2009). GenStat for Windows (21th Edition) Introduction. VSN International, Hemel Hempstead, UK. www.vsni.co.uk.

Gomez, K. A. and A. A. Gomez (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons.Inc. New York, USA.

Ibrahim, H.M. (2009). Effect of sowing dates on yield and quality of some soybean cultivars. J. Agric. Sci. Mansoura Univ. 34 (5): 4741 - 4752.

Ibrahim, Manar (2012a). Performance of some promising lines of soybean under different sowing dates. Ph.D. Thesis, Fac. Of Agric. Mansoura Univ. Egypt.

Ibrahim, S. E. (2012b). Agronomic studies on irrigated soybeans in central Sudan. II. Effect of sowing date on grain yield and yield components. Int. J. Agri Sci., 2(9): 766-773.

Jarecki, W. and D. Bobrecka-Jamro (2021). Effect of sowing date on the yield and seed quality of soybean (*Glycine max* (L.) Merr.). J. Elem. 26(1): 7-18.

Kundu, P. K., T. S., Roy, Md. S. H. Khan, K. Parvin, and H. E. M. Khairul Mazed (2016). Effect of Sowing Date on Yield and Seed Quality of Soybean. JAERI, 9(4): 1-7.

Li, M., Y. Liu, C. Wang, X. Yang, D. Li, X. Zhang, C. Xu, Y. Zhang, W. Li and L. Zhao (2020) Identification of Traits Contributing to High and Stable Yields in Different Soybean Varieties Across Three Chinese Latitudes. Front. Plant Sci. 10:1642. doi: 10.3389/fpls.2019.01642

Mohamed, M. S. A. and Faiza M. Morsi (2005). Evaluation of Some Soybean Genotypes in the New Reclaimed Lands of East Owinat. J. Agric. Sci. Mansoura Univ., 30 (1): 79 – 89.

Mohod, N.B., A.K. Verma, A.N. Paslawar, N. Seema, , G.K., Shrivastava, A.S. Magar, and S.P. Patil (2023). Evaluation of different sowing dates and spacing on soybean varieties for seed production during rabi season. The Pharma Innovation Journal 12(8): 1000-1003.

Moustafa, azhar (2011). Effect of sowing dates and growth regulators on seed yield and quality of some soybean cultivars. Ph.D. Thesis, Fac. of Agric. Kafrelsheikh Univ. Egypt.

Mourtzinis, S., J.E. Specht and S.P. Conley (2019). Defining optimal soybean sowing dates across the US. Sci. Rep., 9(2800): 1-7. https://doi.org/10.1038/s41598-019-38971-3.

Nico, M., D. J. Miralles and A. G. Kantolic (2019). Natural post-flowering photoperiod and photoperiod sensitivity: Roles in yield-determining processes in soybean. Field Crop. Res., 231: 141-152. https://doi.org/10.1016/j.fcr.2018.10.019.

Nwofia, G. E., R. E. Edugbo and E. U. Mbah (2016). Interaction of genotype × sowing date on yield and associated traits of soybean [*Glycine max* (L.) Merrill] over two cropping seasons in a humid agro-ecological zone of south-eastern Nigeria. J. Agric. Sci., 11(3): 164-177. http://dx.doi. org/10.4038/jas.v11i3.8170

Oh-E, I., R. Uwagoh, S. Jyo, T. Kurahashi, K. Saitoh, and T. Kuroda (2007). Effect of rising temperature on flowering, pod set, dry-matter production and seed yield in soybean. Japan Journal of Crop Science, 76(3), 433–444.

Radford, P.J. (1967). Growth analysis formulae, their use and abuses. Crop Sci. 7(3): 171-175.

Rahman, L. and M.S. Haque (1978). Cultivars of soybean in Bangladesh prospects and btheir chemical composition. Proc. Soybean Discussion Forum, Bangladesh Coordinated Soybean Res. Proj. 23 November, 1978. BARC. 1978;9.

Safina, S. A., H. Abdel-Lattif, M. M. Soliman and E. H. Esraa (2025). Influence of sowing dates on yield and its components on performance of new genotypes of soybean (Glycine max L.) in Middle and North Egypt. Egypt. J. Agron. Vol. 47, No. 3, pp: 481 – 497.

Setiyono, T.D., A. Weiss, J.E. Specht, A.M. Bastidas, K.G. Cassman and A. Dobermann (2007). Understanding and modeling the effect of temperature and daylength on soybean phenology under high-yield conditions. Field Crops Res., 100(2-3): 257-271. https://doi.org/10.1016/ /j.fcr.2006.07.011

Serafin-Andrzejewska, M., W. Helios, A. Jama-Rodze, M. Kozak, A. Kotecki, L. Kuchar (2021), Effect of Sowing Date on Soybean Development in South-Western Poland. Agricultur 1-11, 413. https://doi.org/10.3390/ agriculture 11050413

Serafin-Andrzejewska, M., W. Helios, M. Białkowska, A. Koteck and M. Kozak (2024). Sowing Date as a Factor Affecting Soybean Yield—A Case Study in Poland. Agriculture 1- 14, 970. https://doi.org/10.3390/ agriculture14070970.

Shaun, C., C. Shawn, L. Chad, L. Laura, L. Mark, K. Hans, K. Jonathan, K. Carrie, N. Seth, N. Emerson, P. Michael, R. Jeremy, S. Manindepal, and V. Rachel (2025). The Soybean growth cycle: Important risks, management and misconceptions. Article, Science for Success. https://soybeanscienceforsuccess.org/2025/05/07/the-soybean-growth-cycle-important-risks-management-and-misconceptions/

Soliman, M.M., E.M. Rabie and S.B. Ragheb (2007). Response of Soybean Yield to Late Sowing Dates. Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo, 15(1), 51-59.

Tunçtürk, R., M. Tunçtürk, and E. Oral (2021). Effect of Rhizobacterium (PGPR) Applications on Some Physiological Characteristics of Soybean (*Glycine max* L.) Grown under Drought Stress Conditions. COMU Journal of Agriculture Faculty 9(2), 359-368. https://doi.org/10.33202/comuagri.881226.

Watson, D.J. (1952). The physiological basis of variation in yield. Adv. Agron. 4: 101-145.

Yagoub, S. O. and M. A. H. Hamad (2013). Effect of Sowing Date on Two Genotypes of Soybean (*Glycine max*. Merrill.) Grown under Semi-desert Region. Universal Journal of Agricultural Research 1(3): 59-64.

Yan, W. and J. Fregeau (2018). Genotype by yield*trait GYT biplot: a novel approach for genotype selection based on multiple traits. Scientific Reports 8:8242/ DOI:10.1038/s41598-018-26688-8.

Yoon, C. Y., S. Kim, , J. Cho, and S.Kim (2021). Modeling the Impacts of Climate Change on Yields of Various Korean Soybean Sprout Cultivars. Agronomy 11(8), 1590. https://doi.org/10.3390/agronomy11081590.

أداء بعض التراكيب الوراثية من فول الصويا تحت مواعيد زراعة مختلفة

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أجريت الدراسة الحالية في موقعين، وهما محطتي بحوث سخا وملوي الزراعية، خلال موسمين متتاليين (٢٠٢٢ و٢٠٢٣)، لتقييم أربعة تراكيب وراثية من فول الصويا هي: جيزة ٢٢ وH_1L_3 وH_4L_4 وجيزه ١١١ في ثلاثة مواعيد زراعة مختلفة وهي (الأول من مايو ومنتصف مايو والأول من يونيو). وتم إستخدام تحليل GGE لتحديد أفضل التراكيب الوراثية لبعض الصفات الفسيولوجية والمحصول ومكوناته. ولتحديد أفضل بنية وراثية وأهم الصفات وأكثرها تأثيراً في المحصول، أجري أيضًا تحليل GYT باستخدام نموذج GGE. وكشفت النتائج عن وجود اختلافات معنوية بين العوامل المختلفة تحت الدراسة. وأظهرت النتائج أن الميعاد الأمثل للزراعة (الأول من مايو). وسجل التركيبان الوراثيان الأول والثاني (جيزة ٢٢، H_1L_3) على التوالي أعلى قيم بالنسبة للصفات الفسيولوجية وكذلك صفات المحصول.

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