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MISR 10: NEWLY RELEASED HIGH‹YIELDING SOYBEAN CULTIVAR AND TOLERANT TO COTTON LEAF WORM INFESTATION

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ABSTRACT

The new soybean cultivar Misr 10 has been developed by Food Legumes Research Department and was released for high yield potential under natural infestation with cotton leaf worm. Crossing and evaluation of generations were carried out from 2005 to 2011 to produce parental genotypes with high productivity. Twenty six field trials have consisted of two preliminary yield trials, four promising yield trials, eight advanced yield trials, six on‹farm trials, two cotton leaf worm trials, and four Value of Cultivation and Used (VCU) trials at 14 locations included eight Agricultural Research Stations (Sakha, Nubaria, Etai El‹Baroud, Gemmiza, Mallawi, Sids, Shandweel, and the New Valley) and six governorates (El‹Behira, El‹Menofia, El‹Sharkia, Beni Sweif, El‹Menya, and Assuit) from 2012 to 2021 to release Misr 10 cultivar. For each trial, genotypes were distributed in randomized complete blocks design in each location and replicated thrice. Across all seasons, an average of seed yield per fad of each trial and insect assemblages on soybean leaves trial were statistically analyzed as a split split plot design in randomized complete blocks arrangement replicated thrice. Seasonal effects were assigned to the main plots, locations were allocated to the sub‹plots, and genotypes were distributed in the sub sub‹plots. The results showed that seed yield of genotypes were not affected significantly by seasonal effects or their interactions in the combined data for all

trials. In the preliminary yield trials, Sakha location gave an increase in seed yield per fad by 10.62% compared to Etai El‹Baroud location. With respect to advanced yield trials, Sakha, Nubaria, Etai El‹Baroud, Gemmiza, Mallawi, Sids, and Shandweel locations gave an increase in seed yields per fad by 47.33, 47.25, 37.81, 36.75, 33.63, 17.55, and 2.87%, respectively, compared to New Valley location. In regard to on‹farm trials, El‹Behira, El‹Menofia, El‹Sharkia, Beni Sweif, and El‹Menya locations gave an increase in seed yields per fad by 24.18, 20.50, 16.15, 11.13, and 5.75%, respectively, compared to Assiut location. With regard to VCU trials, Sakha, Etai El‹Baroud, and Mallawi locations gave an increase in seed yields per fad by 10.12, 10.55, and 4.49%, respectively, compared to Sids location. Misr 10 gave a significant increase in seed yield per fad by 41.83% in preliminary yield trials, 23.03% in promising yield trials, 23.75% in advanced yield trials, 20.90% in on‹farm trials, and 21.99% in VCU trials compared to Giza 111. The interaction between locations and genotypes did not affect significantly Misr 10, Giza 111, and Crawford for all trials. Misr 10 was more tolerant to cotton leaf worm infestation by 22.40% than Giza 111. No significant correlation was detected between the seed yield of Misr 10 and infestation with cotton leaf worm at the Sakha location (r=0.177) or Etai El‹Baroud location (r=0.333). It can be recommended planting of Misr 10 on the commercial scale, with an increase in seed yield by 0.296 t/ fad (the combined data of on‹farm trials) and a high tolerance to cotton leafworm infestation compared to the commercial cultivar Giza 111.

Key words: ***Soybean genotypes, Misr 10, Seed yield, Cotton leaf worm, Phenotypic simple correlation.***

INTRODUCTION

In Egypt, soybean [*Glycine max* (L.) Merrill] is one of the essential oil crops due to its local consumption in several food and feed industries. Unfortunately, soybean area reached about 88000 fad, with productivity of seeds/fad of about 1.298 ton (Bulletin of Statistical Cost Production and Net Return, 2022). According to USDA (2022), Egypt’s largest supplier of soybeans was the USA, with about 2.788 ton/ha in 2020/21. However, it was expected that Egypt will import more soybeans in 2022‹23 (World Grain, 2023). As the demand for soybean seed increases, the main goal was to increase soybean yield potential with high tolerance to cotton leaf worm (*Spodoptera littoralis* 'Boisd.') infestation in the farmers’ fields. Cotton leaf worm can attack soybean plants throughout their growing season which represents a dangerous problem for the final yield (Lutfallah *et al* 1998 and Kandil *et al* 2003). Soybean breeders in the Egyptian National Food Legumes Research Program (ENFLRP) identified and selected parents which are not only genetically diverse but also have desirable traits since several years ago; and released many soybean cultivars such as Giza 21, Giza 22, Giza 35, Giza 82, Giza 83, and Giza 111. These cultivars were characterized by high‹yielding ability (ranging from 1 to 1.30 ton per fad). Also, Giza 21, Giza 22, Giza 35, Giza 83, and Giza 111 can tolerate cotton leafworm infestation with an acceptable level (Serag *et al* 2019). Thus, soybean breeders usually make most of the research in the germplasm enhancement area. However, there is a negative relationship between the variety's tolerance to cotton leaf worm infestation and yield capacity (Alakhder *et al* 2015). Additionally, excessive use of cotton leafworm insecticides with an unsuitable technique at higher concentrations than recommended can lead to insect tolerance and resurgence. Hence, the Food Legumes Research Department (FLRD) ‹ Field Crops Research Institute (FCRI) decided to produce a new cultivar tolerant to cotton leaf worm with productivity exceeding 1.30 tons per fad under conditions of natural infestation. Usually, hybridization in soybean can represent an effective breeding method (cross‹breeding) for producing high‹yielding varieties with other desirable characteristics from the available genetic variation (Gai *et al* 2015). Desirable contrasting parents in soybean breeding programs can form genetic and phenotypic variation for selecting recombinant progeny which exceeds the parents. The improvement in soybean yield, quality, and tolerance to pests and diseases can be genetically stable through the number of generations from the crossing of selected parents to lines in soybean for a longer period than those resulting from different methods of genetic engineering. It is known that as the number of genotypes and environments increases, the interactions become complex. Thus, FLRD introduced genotype N92‹8231 a long time ago and it was tested at different research stations. These results were confirmed by Morsi and Fateh (2016), who found that the N92‹8231 genotype exceeded two tons per fad, surpassing all Egyptian commercial cultivars. Meanwhile, the soybean cultivar Giza 111 had high yield potential under Egyptian conditions. In this context, Waly (2021) and Abdel‹Wahab and Naroz (2023) showed that Giza 111 cultivar can tolerate infestation with cotton leafworm. Hence, this cultivar can reach its productive capacity of 1.30 tons per fad under field infestation with this pest, given that tolerance or endurance is inversely related to the productive capacity of any cultivar. So, the objective of this study was to produce a new cultivar with high yield potential under natural infestation with cotton leaf worm.

MATERIALS AND METHODS

Screening of the parental genotypes and achieving different crosses (line x line, cultivar x cultivar, and line x cultivar) were carried out in Sakha Agricultural Research Station ‹ Kafr El‹Sheikh Governorate to produce promising soybean genotypes as F_1 seeds in the 2005 summer season. Importantly, soybean cultivar Misr 10 was developed by crossing soybean genotype N92‹8231 (IV) (high yielding potential) with Giza 111 (IV) (tolerant to cotton leaf worm infestation). Thereafter, F_1 seeds of these genotypes were sown to obtain F_2 seeds in the 2006 season. Accordingly, these trials continued to obtain F_6 seeds in the 2011 season. Twenty six field trials were carried out at fourteen locations in Egypt during ten summer seasons (2012 to 2021) for developing high‹yielding soybean cultivars tolerant to cotton leaf worm infestation. Two soybean check cultivars (Giza 111, tolerant to cotton leaf worm, and Crawford, susceptible to cotton leaf worm according to the recommendation of FLRD, ARC, Egypt) were used in this study. The genotypes were tested for seed yield evaluation through several locations for seventeen years (Table 1).

Two preliminary yield trials, four promising yield trials, eight advanced yield trials, six on‹farm trials, two cotton leaf worm trials, and four VCU trials were carried out at 14 locations including eight Agricultural Research Stations (Sakha, Nubaria, Etai El‹Baroud, Gemmiza, Mallawi, Sids, Shandweel, and the New Valley) and six governorates (El‹Behira, El‹Menofia, El‹Sharkia, Beni Sweif, El‹Menya, and Assuit) during ten summer seasons from 2012 to 2021 to release Misr 10.

With respect to insect assemblages, ten soybean plants were randomly collected from each plot and examined to record the population density of cotton leaf worm according to Mengel *et al* (1991). Five plants from each replication and nine leaves (upper, middle and lower) from each plant (Ul Haq *et al* 2003) were selected from Sakha and Etai El‹Baroud Agricultural Research Stations to at 50 days from sowing to estimate rating levels of % consumed leaf area by feeding larvae of cotton leaf worm under field and laboratory conditions according to Mengel *et al* (1991), as shown in Table 2.

Table 1. Different trials, seasons, locations, plot area and design.

Trial	Season	Location	Plot area	Design
Crossing program evaluation	2005 to 2011	Sakha	Three ridges (4.0 m long x 0.7 m wide=8.4 m^2)	Randomized complete blocks design in three replicates
Preliminary yield trial	2012 and 2013	Sakha and Etai El‹Baroud		
Promising yield trial	2014 and 2015	Sakha, Etai El‹Baroud, Mallawi, and Sids	Four ridges (4.0 m long x 0.7 m wide=11.2 m^2)	
Advanced yield trial	2016 to 2018	Sakha, Nubaria, Etai El‹Baroud, Gemmiza, Mallawi, Sids, Shandweel, and New Valley	Six ridges (4.0 m long x 0.7 m wide = 16.8 m^2)	
On‹farm trial	2018 to 2020	El‹Behira, El‹Menfia, El‹Sharkia, Beni Sweif, El‹Menya, and Assuit		
Cotton leaf worm trial	2020 and 2021	Sakha and Etai El‹Baroud	Three ridges (4.0 m long x 0.7 m wide=8.4 m^2)	
VCU trial	2020 and 2021	Sakha, Etai El‹Baroud, Mallawi, and Sids		

Table 2. Percentages of rating levels of leaf area consumed by leaf feeding larvae of cotton leaf worm. Mengel *et al* (1991).

Scale	Rating levels of leaf area consumed (%)		Relative susceptibility
	Value	Phenotype	
1	1 – 10%		Resistant
2	11 – 30%		Moderate Resistant (Intermediate)
3	> 30%		Susceptible

All trials were sown in the last third of May. Seeds were seeded as 20 plants per meter in one row of the ridge. All other agricultural practices were carried out as recommended without using pesticide treatments. Furrow irrigation was the irrigation system in all tested locations. In all tested seasons, seed yield/plot (kg) was measured as the total seed weight of all plants in the plot and seed yield/fad (t) was calculated by converting plot yield to fad. Data were statistically analyzed and means were compared using the LSD test ($P < 0.05$) according to Gomez and Gomez (1984). Phenotypic simple correlation coefficients were calculated for the combined data across the two seasons (2020 and 2021) for seed yield per fad and the population density of cotton leaf worm by MSTAT‹C computer program (1988).

Overall seasons, an average of seed yield per fad of each trial and insect assemblages on soybean leaves trial were statistically analyzed as split split plot design in randomized complete blocks arrangement in three replicates, seasonal effects were assigned in the main plots, locations were allocated in the sub‹plots, and genotypes were distributed in the sub sub‹plots.

RESULTS AND DISCUSSION

Seasonal effects and their interactions

Seed yield of genotypes were not affected significantly by seasonal effects or their interactions in the combined data for all trials (Tables 3 – 9). Seasonal effect × location interaction was not significant meaning the absence of genetic variability for yield stability across different locations among genotypes being tested under Egyptian conditions. Also, the consistent response was observed between seasonal effect and genotype for seed yield per fad, indicating that genotypes could be selected for this area with limited evaluations. Finally, the consistent response was observed among seasonal effect, location, and genotype for seed yield per fad, indicating genotype yield was not responding to location during different seasons. These results indicate that there was high experimental precision, providing reliability for selecting superior genotypes under different locations in Egypt.

I. Preliminary yield trials

Forty Egyptian genotypes (H_1L_1, H_1L_3, H_1L_{44}, H_1L_{48}, H_1L_{52}, H_3L_4, H_3L_{110}, H_3L_{122}, H_7L_{127}, H_7L_{134}, H_7L_{145}, H_7L_{157}, H_7L_{160}, H_7L_{206}, H_7L_{207}, H_7L_{210}, H_9L_{214}, H_9L_{415}, $H_{10}L_{228}$, $H_{10}L_{250}$, $H_{10}L_{253}$, $H_{10}L_{272}$, $H_{10}L_{274}$, Misr 10, $H_{10}L_{292}$, $H_{10}L_{294}$, $H_{10}L_{301}$, $H_{11}L_{223}$, $H_{11}L_{321}$, $H_{11}L_{340}$, $H_{11}L_{342}$, $H_{11}L_{344}$, $H_{11}L_{376}$, $H_{11}L_{379}$, $H_{11}L_{384}$, $H_{19}L_{96}$, $H_{29}L_{115}$, H_{160}, H_{163}, H_{164}), some of them being have greater yield than 2 t per fad, along with Giza 111 and Crawford were planted in Sakha and Etai El‹Baroud Agricultural Research Stations as preliminary yield trials during the summer seasons of 2012 and 2013.

Location effect

The location had a significant effect on seed yield of genotypes in the combined data across the two seasons (Table 3). Sakha location had the highest seed yield per fad than those grown under Etai El‹Baroud location. Sakha location gave an increase in seed yield per fad by 10.62% compared to Etai El‹Baroud location. Higher seed yields in Sakha location are probably due to long‹term joint soybean breeding efforts.

Genotypes

Although phenotypic variation for seed yield among the genotypes can decrease during the breeding program, effective selection for this trait may be used as a complement to the phenotypic selection, especially over a long period of years. The mean performance of all tested genotypes for seed yield per fad in the combined data across the two seasons is presented in Table (3).

Table 3. Average seed yield (ton/fad.) for some genotypes in preliminary yield trials as affected by seasonal effects, locations, genotypes and their interactions, combined data across the two seasons (2012 and 2013).

Genotypes	First season			Second season			Combined		Average of genotypes
	L_1	L_2	Mean	L_1	L_2	Mean	L_1	L_2	
H_1L_1	2.016	2.033	2.025	1.883	1.983	1.933	1.950	2.008	1.979 a‹c
H_1L_3	2.125	1.966	2.045	1.983	2.033	2.008	2.054	2.000	2.027 a
H_1L_{44}	1.350	1.066	1.208	1.133	1.100	1.116	1.241	1.083	1.162 h‹n
H_1L_{48}	1.100	0.950	1.025	0.966	0.950	0.958	1.033	0.950	0.991 m‹p
H_1L_{52}	1.350	1.133	1.241	1.133	1.116	1.125	1.241	1.125	1.183 g‹n
H_3L_4	2.066	1.866	1.966	1.950	1.933	1.941	2.008	1.900	1.954 a‹c
H_3L_{110}	2.108	1.916	2.012	1.900	1.850	1.875	2.004	1.883	1.943 a‹d
H_3L_{122}	1.375	0.750	1.062	1.033	0.933	0.983	1.204	0.841	1.022 l‹p
H_7L_{127}	1.300	0.966	1.133	1.233	1.166	1.200	1.266	1.066	1.166 g‹n
H_7L_{134}	1.200	0.933	1.066	1.100	0.966	1.033	1.150	0.950	1.050 j‹o
H_7L_{145}	1.150	0.900	1.025	0.983	0.900	0.941	1.066	0.900	0.983 n‹p
H_7L_{157}	1.666	1.250	1.458	1.583	1.450	1.516	1.625	1.350	1.487 e
H_7L_{160}	1.816	1.583	1.700	1.816	1.733	1.775	1.816	1.658	1.737 d
H_7L_{206}	1.525	1.233	1.379	1.500	1.466	1.483	1.512	1.350	1.431 ef
H_7L_{207}	1.433	1.050	1.241	1.383	1.166	1.275	1.408	1.108	1.258 f‹j
H_7L_{210}	0.925	0.866	0.895	0.833	0.833	0.833	0.879	0.850	0.864 op
H_9L_{214}	1.325	0.933	1.129	1.166	1.083	1.125	1.245	1.008	1.127 i‹n
H_9L_{415}	1.150	0.933	1.041	0.983	0.933	0.958	1.066	0.933	1.000 m‹p
$H_{10}L_{228}$	2.106	2.066	2.086	1.950	2.050	2.000	2.028	2.058	2.043 a
$H_{10}L_{250}$	2.050	1.916	1.983	1.866	1.900	1.883	1.958	1.908	1.933 a‹d
$H_{10}L_{253}$	0.975	0.750	0.862	0.800	0.766	0.783	0.887	0.758	0.822 p

Table 3. Cont.

Genotypes	First season			Second season			Combined		Average of genotypes
	L_1	L_2	Mean	L_1	L_2	Mean	L_1	L_2	
$H_{10}L_{272}$	1.956	1.950	1.953	1.866	1.983	1.925	1.911	1.966	1.939 a‹d
$H_{10}L_{274}$	1.275	0.733	1.004	1.016	0.900	0.958	1.145	0.816	0.981 n‹p
Misr 10	1.923	2.066	1.995	2.050	2.016	2.033	1.986	2.041	2.014 ab
$H_{10}L_{292}$	1.450	1.066	1.258	1.366	1.183	1.275	1.408	1.125	1.266 f‹i
$H_{10}L_{294}$	1.425	1.233	1.329	1.366	1.366	1.366	1.395	1.300	1.347 e‹h
$H_{10}L_{301}$	2.016	1.883	1.950	2.100	1.950	2.025	2.058	1.916	1.987 a‹c
$H_{11}L_{223}$	1.500	0.900	1.200	1.333	1.166	1.250	1.416	1.033	1.225 f‹l
$H_{11}L_{321}$	1.450	1.200	1.325	1.450	1.416	1.433	1.450	1.308	1.379 e‹g
$H_{11}L_{340}$	1.483	0.900	1.191	1.333	1.083	1.208	1.408	0.991	1.200 g‹m
$H_{11}L_{342}$	1.908	1.933	1.920	2.100	1.916	2.008	2.004	1.925	1.964 a‹c
$H_{11}L_{344}$	1.500	1.116	1.308	1.433	1.283	1.358	1.466	1.200	1.333 e‹i
$H_{11}L_{376}$	1.525	1.200	1.362	1.383	1.400	1.391	1.454	1.300	1.377 e‹h
$H_{11}L_{379}$	1.075	0.916	0.995	0.950	0.950	0.950	1.012	0.933	0.972 n‹p
$H_{11}L_{384}$	1.950	1.866	1.908	1.916	1.933	1.925	1.933	1.900	1.916 a‹d
$H_{19}L_{96}$	1.853	1.533	1.693	1.850	1.683	1.766	1.851	1.608	1.730 d
$H_{29}L_{115}$	1.550	1.216	1.383	1.300	1.450	1.375	1.425	1.333	1.379 e‹g
H_{160}	2.008	2.050	2.029	1.966	2.066	2.016	1.987	2.058	2.022 a
H_{163}	1.900	1.666	1.783	1.850	1.783	1.816	1.875	1.725	1.800 b‹d
H_{164}	1.883	1.616	1.750	1.866	1.766	1.816	1.875	1.691	1.783 cd
Giza 111	1.550	1.233	1.391	1.466	1.433	1.450	1.508	1.333	1.420 ef
Crawford	1.175	0.900	1.037	0.966	0.933	0.950	1.070	0.916	0.993 m‹p
Average of locations	1.582	1.339	1.460	1.479	1.428	1.453	1.530	1.383	1.456
L.S.D. 0.05 Season (S)									ns
L.S.D. 0.05 Location (L)									0.033
L.S.D. 0.05 Genotypes (G)									0.214
L.S.D. 0.05 S x L									ns
L.S.D. 0.05 S x G									ns
L.S.D. 0.05 L x G									0.359
L.S.D. 0.05 S x L x G									ns

L_1: Sakha, L_2: Etai El‹Baroud, Different letters in the same column indicate a significant difference at $p \leq 0.05$ according to Duncan's multiple range tests. ns: No‹significant

Genotypes $H_{10}L_{228}$, H_1L_3, H_{160}, Misr 10, $H_{10}L_{301}$, H_1L_1, $H_{11}L_{342}$, H_3L_4, H_3L_{110}, $H_{10}L_{272}$, $H_{10}L_{250}$, and $H_{11}L_{384}$ had higher seed yields per fad than the others. Seed yields of genotypes $H_{10}L_{228}$, H_1L_3, H_{160}, Misr 10, $H_{10}L_{301}$, H_1L_1, $H_{11}L_{342}$, H_3L_4, H_3L_{110}, $H_{10}L_{272}$, $H_{10}L_{250}$, and $H_{11}L_{384}$ recorded 2.043, 2.027, 2.022, 2.014, 1.987, 1.979, 1.964, 1.954, 1.943, 1.939, 1.933, and 1.916 t/fad, respectively. Genotypes $H_{10}L_{228}$, H_1L_3, H_{160}, Misr 10, $H_{10}L_{301}$, H_1L_1, $H_{11}L_{342}$, H_3L_4, H_3L_{110}, $H_{10}L_{272}$, $H_{10}L_{250}$, and $H_{11}L_{384}$ gave an increase in seed yield by 43.87, 42.74, 42.39, 41.83, 39.92, 39.36, 38.30, 37.60, 36.83, 36.54, 36.12, and 34.92%, respectively, compared with Giza 111. Meanwhile, these values reached 105.74, 104.12, 103.62, 102.81, 100.10, 99.29, 97.78, 96.77, 95.66, 95.26, 94.66, and 92.95%, compared to Crawford, respectively.

Conversely, genotypes Crawford, $H_{11}L_{379}$, $H_{10}L_{274}$, $H_{10}L_{253}$, H_9L_{415}, H_7L_{210}, H_7L_{145}, H_3L_{122}, and H_1L_{48} had lower seed yields per fad than the others. These results are probably due to soybean cultivar Misr 10 having a high regeneration capacity for its growth and development in comparison with other genotypes. These results are in the same context as those obtained by Hassan *et al*(2002) who showed that Giza 22 cultivar surpassed all tested cultivars in yield attributes.

The interaction between genotype and location

The quantitatively inherited traits as a genotype's yield performance often vary from one location to another leading to a significant genotype x location interaction. The interaction between genotype and the location was significant for seed yield per fad in the combined data across the two seasons (Table 3).

Seed yields of genotypes H_3L_{122}, $H_{11}L_{223}$, and $H_{11}L_{340}$ were differed significantly by the location. Meanwhile, genotypes H_1L_1, H_1L_3, H_1L_{44}, H_1L_{48}, H_1L_{52}, H_3L_4, H_3L_{110}, H_7L_{127}, H_7L_{134}, H_7L_{145}, H_7L_{157}, H_7L_{160}, H_7L_{206}, H_7L_{207}, H_7L_{210}, H_9L_{214}, H_9L_{415}, $H_{10}L_{228}$, $H_{10}L_{250}$, $H_{10}L_{253}$, $H_{10}L_{272}$, $H_{10}L_{274}$, Misr 10, $H_{10}L_{292}$, $H_{10}L_{294}$, $H_{10}L_{301}$, $H_{11}L_{321}$, $H_{11}L_{342}$, $H_{11}L_{344}$, $H_{11}L_{376}$, $H_{11}L_{379}$, $H_{11}L_{384}$, $H_{19}L_{96}$, $H_{29}L_{115}$, H_{160}, H_{163}, H_{164}, Giza 111, and Crawford were not affected. These results can be attributed to the yield potential among these genotypes that differed when they are exposed to unfavorable environmental effects. So, it may be possible that the yields of H_1L_1, H_1L_3,

H_1L_{44}, H_1L_{48}, H_1L_{52}, H_3L_4, H_3L_{110}, H_7L_{127}, H_7L_{134}, H_7L_{145}, H_7L_{157}, H_7L_{160}, H_7L_{206}, H_7L_{207}, H_7L_{210}, H_9L_{214}, H_9L_{415}, $H_{10}L_{228}$, $H_{10}L_{250}$, $H_{10}L_{253}$, $H_{10}L_{272}$, $H_{10}L_{274}$, Misr 10, $H_{10}L_{292}$, $H_{10}L_{294}$, $H_{10}L_{301}$, $H_{11}L_{321}$, $H_{11}L_{342}$, $H_{11}L_{344}$, $H_{11}L_{376}$, $H_{11}L_{379}$, $H_{11}L_{384}$, $H_{19}L_{96}$, $H_{29}L_{115}$, H_{160}, H_{163}, H_{164}, Giza 111, and Crawford were not affected (92.85% of the tested genotypes) and have a consistently high yield performance in different environments (Fig. 1).

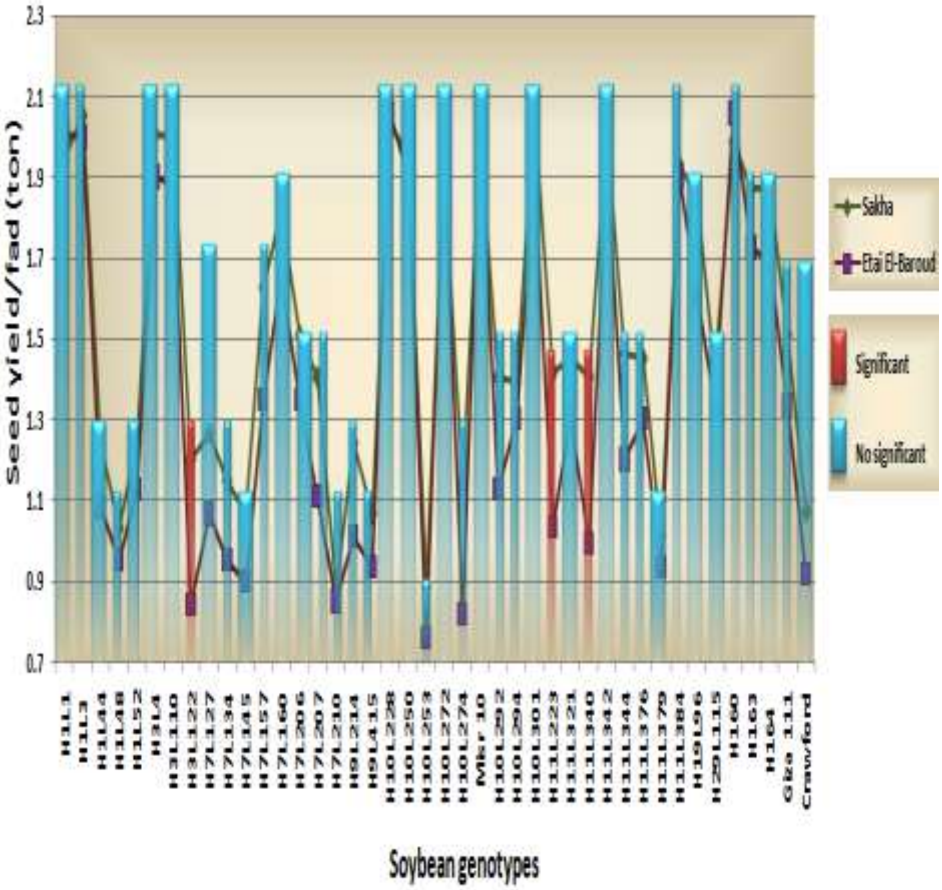

Fig. 1. The interaction between genotype and location in preliminary yield trials.

Accordingly, the use of mean seed yield across environments as an indicator of genotype performance is debatable (Ablett *et al* 1994). These results show that the genotypes H_3L_{122}, $H_{11}L_{223}$, and $H_{11}L_{340}$ responded differently to location for seed yield per fad.

II. Promising yield trials

Eighteen genotypes (H_1L_1, H_1L_3, H_3L_4, H_3L_{110}, H_7L_{157}, H_7L_{160}, $H_{10}L_{228}$, $H_{10}L_{250}$, $H_{10}L_{272}$, Misr 10, $H_{10}L_{301}$, $H_{11}L_{342}$, $H_{11}L_{384}$, $H_{29}L_{115}$, H_{160}, H_{163}, H_{164}, and $H_{19}L_{96}$) along with Giza 111 and Crawford were planted in Sakha, Etai El‹Baroud, Mallawi, and Sids Agricultural Research Stations during the summer seasons of 2014 and 2015.

Location effect

The location had a significant effect on the seed yield of genotypes in the combined data across the two seasons (Table 4). Sakha location had the highest seed yield per fad, followed by Etai El‹Baroud and Mallawi locations. Sakha, Etai El‹Baroud, and Mallawi location gave increase in seed yields by 30.78, 19.61, and 6.51%, respectively, compared to Sids location. Conversely, Sids location gave the lowest seed yield per fad. These results can be attributed to the differences in environmental conditions that surrounded soybean seedlings' growth and development between North and Middle Egypt. Moreover, the infestation of the leaf cotton leaf worm can be an important constraint to soybean productivity in a location.

Genotypes

The mean performance of all tested genotypes for seed yield per fad in the combined data across the two seasons is presented in Table (4). Genotypes Misr 10, H_3L_4, $H_{10}L_{228}$, $H_{10}L_{272}$, $H_{10}L_{301}$, $H_{11}L_{342}$, H_{163}, $H_{10}L_{250}$, H_1L_1, and H_1L_3 had higher seed yields per fad than the others. Seed yields of genotypes Misr 10, H_3L_4, $H_{10}L_{228}$, $H_{10}L_{272}$, $H_{10}L_{301}$, $H_{11}L_{342}$, H_{163}, $H_{10}L_{250}$, H_1L_1, H_1L_3 recorded 1.816, 1.713, 1.710, 1.707, 1.689, 1.687, 1.676, 1.647, 1.646, and 1.634 t/fad, respectively. Genotypes Misr 10, H_3L_4, $H_{10}L_{228}$, $H_{10}L_{272}$, $H_{10}L_{301}$, $H_{11}L_{342}$, H_{163}, $H_{10}L_{250}$, H_1L_1, and H_1L_3 gave an increase in seed yield by 23.03, 16.05, 15.85, 15.65, 14.43, 14.29, 13.55, 11.58, 11.51, and 10.70%, respectively, compared with Giza 111. Meanwhile, these values reached 48.12, 39.72, 39.47, 39.23, 37.76, 37.60, 36.70, 34.33, 34.25, and 33.27% compared with Crawford, respectively.

Table 4. Average seed yield (ton/fad.) for some genotypes in promising yield trials as affected by seasonal effects, locations, genotypes and their interactions, combined data across the two seasons (2014 and 2015).

Genotypes	First season					Second season					Combined				Average of genotypes
	L1	L2	L3	L4	Mean	L1	L2	L3	L4	Mean	L1	L2	L3	L4	
H_1L_1	2.110	1.818	1.388	1.358	1.668	2.043	1.638	1.583	1.233	1.624	2.076	1.728	1.485	1.295	1.646 a‹c
H_1L_3	1.925	1.988	1.177	1.592	1.670	1.883	1.773	1.263	1.478	1.599	1.904	1.880	1.220	1.535	1.634 a‹c
H_3L_4	1.946	1.891	1.681	1.475	1.748	1.866	1.741	1.733	1.376	1.679	1.906	1.816	1.707	1.425	1.713 ab
H_3L_{110}	1.614	1.555	1.522	1.589	1.570	1.777	1.474	1.650	1.403	1.576	1.695	1.514	1.586	1.496	1.573 bc
H_7L_{157}	1.560	1.828	1.289	1.666	1.585	1.422	1.681	1.440	1.544	1.521	1.491	1.754	1.364	1.605	1.553 bc
H_7L_{160}	1.955	1.478	1.722	1.583	1.684	1.722	1.373	1.837	1.366	1.574	1.838	1.425	1.779	1.474	1.629 bc
$H_{10}L_{228}$	2.178	2.029	1.441	1.267	1.728	2.066	1.964	1.537	1.205	1.693	2.122	1.996	1.489	1.236	1.710 ab
$H_{10}L_{250}$	2.001	1.798	1.510	1.308	1.654	1.932	1.607	1.643	1.377	1.639	1.966	1.702	1.576	1.342	1.647 a‹c
$H_{10}L_{272}$	2.136	2.123	1.389	1.342	1.747	1.898	1.912	1.400	1.462	1.668	2.017	2.017	1.394	1.402	1.707 ab
Misr 10	2.046	2.038	1.676	1.675	1.858	1.830	1.948	1.833	1.488	1.774	1.938	1.993	1.754	1.581	1.816 a
$H_{10}L_{301}$	2.005	1.901	1.264	1.708	1.719	1.957	1.820	1.310	1.553	1.660	1.981	1.860	1.287	1.630	1.689 ab
$H_{11}L_{342}$	1.920	1.672	1.622	1.667	1.720	1.802	1.582	1.733	1.499	1.654	1.861	1.627	1.677	1.583	1.687 ab
$H_{11}L_{384}$	1.856	1.779	1.401	1.442	1.619	1.719	1.635	1.457	1.583	1.598	1.787	1.707	1.429	1.512	1.609 bc
$H_{29}L_{115}$	1.466	1.374	1.162	1.277	1.319	1.299	1.189	1.288	1.164	1.235	1.382	1.281	1.225	1.220	1.277 d
H_{160}	1.929	1.675	1.420	1.433	1.614	1.793	1.455	1.550	1.278	1.519	1.861	1.565	1.485	1.355	1.566 bc
H_{163}	1.988	1.717	1.655	1.439	1.699	1.811	1.599	1.818	1.384	1.653	1.899	1.658	1.736	1.411	1.676 ab
H_{164}	2.060	1.516	1.504	1.125	1.551	1.974	1.436	1.633	1.033	1.519	2.017	1.476	1.568	1.079	1.535 bc
$H_{19}L_{96}$	1.766	1.772	1.447	1.303	1.572	1.854	1.554	1.553	1.860	1.536	1.810	1.663	1.500	1.244	1.554 bc
Giza 111	1.644	1.642	1.270	1.417	1.493	1.482	1.546	1.423	1.386	1.459	1.563	1.594	1.346	1.401	1.476 c
Crawford	1.473	1.249	1.188	1.167	1.269	1.397	1.105	1.143	1.088	1.183	1.435	1.177	1.165	1.127	1.226 d
Average of locations	1.878	1.742	1.436	1.441	1.624	1.776	1.601	1.541	1.354	1.568	1.827	1.671	1.488	1.397	1.596

L.S.D. 0.05 Season (S)	ns
L.S.D. 0.05 Location (L)	0.101
L.S.D. 0.05 Genotypes (G)	0.184
L.S.D. 0.05 S x L	ns
L.S.D. 0.05 S x G	ns
L.S.D. 0.05 L x G	0.417
L.S.D. 0.05 S x L x G	ns

L_1: Sakha, L_2: Etai El‹Baroud, L_3: Mallawi, L_4: Sids, Different letters indicate a significant difference at $p \leq 0.05$ according to Duncan's multiple range tests. ns: No‹significant.

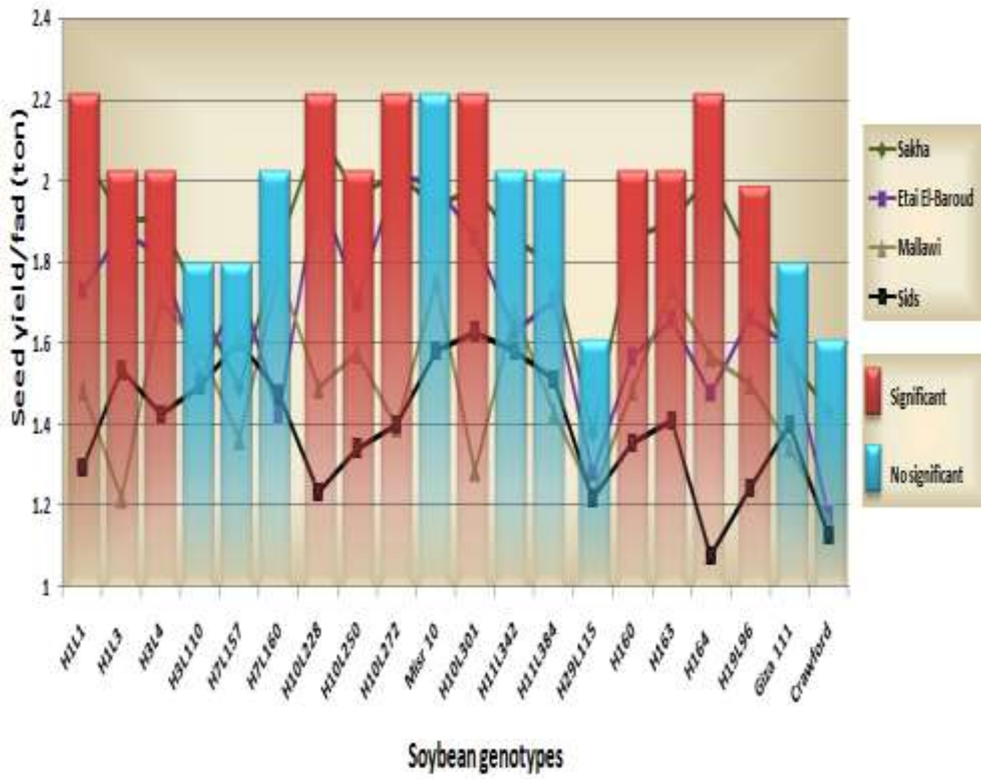

Fig. 2. The interaction between genotype and location in promising yield trials.

Location effect

These results reveal that Misr 10, $H_{10}L_{228}$, H_3L_4, $H_{10}L_{272}$, $H_{10}L_{301}$, and $H_{11}L_{342}$ have higher yield potential probably due to the suitable parental genotypes selection. Conversely, genotypes Crawford and $H_{29}L_{115}$ had lower seed yields per fad than the others. F_1 lines of soybean can give higher seed yield than that of their extraordinary parents by about 20% (Palmer *et al* 2001). Particularly, the low‹yielding ability of $H_{29}L_{115}$ was previously reported by Morsy *et al* (2015). With respect to the Crawford variety, it was more susceptible to cotton leaf worm infestation than other genotypes as reported by Abdel‹Wahab and Naroz (2023).

The interaction between genotype and location

The interaction between genotype and the location was significant for seed yield per fad in the combined data across the two seasons (Table 4). Seed yields of genotypes H_1L_1, H_1L_3, H_3L_4, $H_{10}L_{228}$, $H_{10}L_{250}$, $H_{10}L_{272}$, $H_{10}L_{301}$, $H_{19}L_{96}$, H_{160}, H_{163}, and H_{164} were differed significantly by the location. Meanwhile, genotypes H_3L_{110}, H_7L_{157}, H_7L_{160}, Misr 10, $H_{11}L_{342}$, $H_{11}L_{384}$, $H_{29}L_{115}$, Giza 111, and Crawford were not affected. These results can be attributed to the yield potential among these genotypes are differed when they are exposed to unfavorable environmental effects. So, it may be possible that the yields of H_3L_{110}, H_7L_{157}, H_7L_{160}, Misr 10, $H_{11}L_{342}$, $H_{11}L_{384}$, $H_{29}L_{115}$, Giza 111, and Crawford have a consistently high yield performance in different environments (Fig. 2). These results show that the genotypes H_1L_1, H_1L_3, H_3L_4, $H_{10}L_{228}$, $H_{10}L_{250}$, $H_{10}L_{272}$, $H_{10}L_{301}$, $H_{19}L_{96}$, H_{160}, H_{163}, and H_{164} responded differently to location for seed yield per fad. Fig. 2 shows the interaction between genotype and location in promising yield trials.

III. Advanced yield trials

Fourteen genotypes (H_1L_1, H_1L_3, H_3L_4, H_3L_{110}, H_7L_{160}, $H_{10}L_{228}$, $H_{10}L_{250}$, $H_{10}L_{272}$, Misr 10, $H_{10}L_{301}$, $H_{11}L_{342}$, $H_{11}L_{384}$, H_{160}, and H_{163}) along with Giza 111 and Crawford were planted in Sakha, Nubaria, Etai El‹Baroud, Gemmiza, Mallawi, Sids, Shandweel, and New Valley Agricultural Research Stations during the summer seasons of 2016, 2017, and 2018.The location had a significant effect on seed yield of genotypes in the combined data across the three seasons (Table 5). Sakha and Nubaria locations were superior for seed yield per fad, followed by Etai El‹Baroud, Gemmiza, and Mallawi locations, then Sids, Shandweel and New Valley locations. Sakha, Nubaria, Etai El‹Baroud, Gemmiza, Mallawi, Sids, and Shandweel locations gave increase in seed yields per fad by 47.33, 47.25, 37.81, 36.75, 33.63, 17.55, and 2.87%, respectively, compared to New Valley location. These results may be due to the location having more effects on the expression of this trait, and it can be useful in soybean screening programs. Climatic and edaphic conditions may vary among locations from one year to another and this confirmed the importance of the environmental conditions throughout this study.

Genotypes

The mean performance of all tested genotypes for seed yield per fad in the combined data across the three seasons is presented in Table (5). Genotypes Misr 10 and $H_{10}L_{228}$ had higher seed yield per fad than the others. Seed yields of genotypes Misr 10 and $H_{10}L_{228}$ recorded 1.761 and 1.696 t/fad, respectively. Genotypes Misr 10 and $H_{10}L_{228}$ gave an increase in seed yield by 23.75 and 19.18%, respectively, compared with Giza 111. Meanwhile, these values reached 54.74 and 49.03% compared with Crawford, respectively. Genotypes H_3L_4, $H_{10}L_{272}$, $H_{11}L_{342}$, and H_1L_3 came in the second rank. Conversely, Crawford had lower seed yields per fad than the others. These results are probably due to the differences in the genetic makeup of all genotypes. This reveals the importance of the proper selection of a genotype during advanced seed yield trials to make this genotype more profitable for farmers. These results are in the same context as those obtained by Abd El‹Mohsen *et al*(2013) who showed that Giza 111 gave the highest seed yield per unit area compared with the other cultivars. Also, Ragheb *et al*(2013) showed that DR101 has differed in some agronomic traits than Holladay and Toano.

The interaction between genotype and location

The interaction between genotype and the location was significant for seed yield per fad in the combined data across the three seasons (Table 5). Seed yields of genotypes H_1L_1, H_1L_3, H_3L_4, H_3L_{110}, H_7L_{160}, $H_{10}L_{228}$, $H_{10}L_{250}$, $H_{10}L_{272}$, $H_{10}L_{301}$, $H_{11}L_{384}$, and H_{163} were differed significantly by the location.

Meanwhile, genotypes Misr 10, $H_{11}L_{342}$, H_{160}, Giza 111, and Crawford were not affected. These results reveal that the genotypes responded differently to location for seed yield per fad. This shows that the genetic makeup of Misr 10 may lead to more flexibility in its performance to tolerate adverse environmental conditions than other genotypes. In the same context, Noureldin *et al*(2002) revealed that the seed yields of some genotypes have differed under the conditions of Middle Egypt and West Delta. These results agreed with Morsy *et al*(2015) who revealed that L_{273}, L_{163}, H_3L_4, H_4L_{24}, and DR 101 were adapted to high‹yielding environments. Fig. 3 shows the interaction between genotype and location in advanced yield trials.

Table 5. Average seed yield (ton/fad.) for some genotypes in advanced yield trials as affected by seasonal effects, locations, genotypes and their interactions, data are combined across the three seasons 2016, 2017 and 2018.

Genotypes	First season								
	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	Mean
H_1L_1	1.945	1.761	1.125	1.516	1.933	1.088	0.895	0.850	1.389
H_1L_3	2.150	1.846	1.475	1.891	2.033	1.420	1.269	1.205	1.661
H_3L_4	1.933	2.046	1.675	2.038	2.133	1.629	1.455	1.394	1.787
H_3L_{110}	1.739	1.629	1.433	1.675	1.850	1.385	1.188	1.145	1.505
H_7L_{160}	1.848	1.937	1.358	1.818	1.883	1.303	1.185	1.135	1.558
$H_{10}L_{228}$	2.050	2.036	1.342	2.123	1.700	1.302	1.195	1.077	1.603
$H_{10}L_{250}$	2.070	2.078	1.267	2.029	1.837	1.225	1.076	1.032	1.576
$H_{10}L_{272}$	1.846	1.978	1.592	1.988	1.563	1.510	1.377	1.230	1.635
Misr 10	1.847	1.834	1.308	1.864	1.843	1.668	1.689	1.420	1.684
$H_{10}L_{301}$	1.826	1.756	1.442	1.845	1.757	1.405	1.243	1.186	1.557
$H_{11}L_{342}$	2.067	2.192	1.667	1.672	2.065	1.635	1.432	1.375	1.763
$H_{11}L_{384}$	1.595	2.150	1.708	1.901	1.610	1.675	1.420	1.377	1.679
H_{160}	1.535	1.655	1.583	1.478	2.137	1.535	1.345	1.310	1.572
H_{163}	1.698	1.644	1.417	1.642	1.723	1.365	1.200	1.165	1.481
Giza 111	1.803	1.618	1.503	1.285	1.496	1.468	1.235	1.200	1.451
Crawford	1.303	1.373	1.167	1.249	1.443	1.120	0.880	0.830	1.170
Average of	1.828	1.845	1.441	1.751	1.812	1.420	1.255	1.183	1.567
Genotypes	Second season								
	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	Mean
H_1L_1	1.887	1.979	2.145	1.540	1.272	1.582	1.204	1.350	1.619
H_1L_3	2.227	1.703	1.983	1.627	1.703	1.333	1.483	1.267	1.665
H_3L_4	2.031	1.775	1.996	1.523	1.392	1.548	1.616	1.185	1.633
H_3L_{110}	1.882	1.859	1.734	1.557	1.512	1.618	1.340	1.135	1.579
H_7L_{160}	1.577	1.645	1.760	1.787	1.684	1.321	1.016	1.575	1.545
$H_{10}L_{228}$	2.057	2.111	2.088	1.910	1.723	1.637	1.466	1.695	1.835
$H_{10}L_{250}$	1.890	1.804	1.928	1.437	1.616	1.407	1.188	1.260	1.566
$H_{10}L_{272}$	2.135	1.921	1.657	1.913	1.694	1.617	1.530	1.747	1.776
Misr 10	1.896	2.049	1.801	1.776	1.783	1.839	1.317	1.325	1.723
$H_{10}L_{301}$	1.746	1.661	1.816	1.867	1.124	1.654	1.143	1.235	1.530
$H_{11}L_{342}$	1.824	1.543	1.916	1.573	1.752	1.500	1.255	1.268	1.578
$H_{11}L_{384}$	1.568	1.677	1.692	1.443	1.419	1.561	0.935	1.020	1.414
H_{160}	1.764	1.617	1.639	2.013	1.534	1.417	1.177	0.997	1.519
H_{163}	1.900	1.815	1.618	1.590	1.569	1.338	1.122	0.910	1.482
Giza 111	1.655	1.524	1.307	1.573	1.526	1.364	1.190	1.096	1.404
Crawford	1.358	1.234	1.233	1.243	1.341	0.900	0.788	0.785	1.110
Average of	1.837	1.744	1.769	1.648	1.540	1.477	1.235	1.240	1.561

L_1: Sakha, L_2: Nubaria, L_3: Etai El‹Baroud, L_4: Gemmiza, L_5: Mallawi, L_6: Sids, L_7: Shandweel, L_8: New Valley.

Table 5. Cont.

Genotypes	Third season									Combined								Average of genotypes
	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	Mean	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	
H_1L_1	1.736	1.916	2.223	1.500	1.442	1.302	1.428	1.477	1.628	1.856	1.885	1.831	1.518	1.549	1.324	1.175	1.225	1.545 $_{fg}$
H_1L_3	1.678	1.967	2.129	1.603	1.367	1.225	1.276	1.232	1.559	2.018	1.838	1.862	1.707	1.701	1.326	1.342	1.234	1.628 $_{b-e}$
H_3L_4	1.846	1.933	1.991	1.833	1.575	1.420	1.269	1.205	1.634	1.936	1.918	1.887	1.798	1.700	1.532	1.446	1.261	1.685 $_{b}$
H_3L_{110}	1.750	1.714	1.772	1.833	1.767	1.635	1.432	1.375	1.659	1.790	1.734	1.646	1.688	1.709	1.546	1.320	1.218	1.581 $_{d-f}$
H_7L_{160}	1.761	1.761	1.616	1.733	1.225	1.088	0.895	0.850	1.366	1.728	1.781	1.578	1.779	1.597	1.237	1.032	1.186	1.490 $_{g-i}$
$H_{10}L_{228}$	1.978	1.966	2.088	1.363	1.692	1.510	1.377	1.230	1.650	2.028	2.037	1.839	1.798	1.705	1.483	1.346	1.334	1.696 $_{ab}$
$H_{10}L_{250}$	1.701	1.748	1.898	1.743	1.408	1.268	1.289	1.320	1.546	1.887	1.876	1.697	1.736	1.620	1.300	1.184	1.204	1.563 $_{ef}$
$H_{10}L_{272}$	1.937	1.846	1.918	1.683	1.458	1.303	1.185	1.135	1.558	1.972	1.915	1.722	1.861	1.571	1.476	1.364	1.370	1.656 $_{bc}$
Misr 10	1.846	2.070	2.138	1.933	1.875	1.732	1.688	1.727	1.876	1.863	1.984	1.749	1.858	1.833	1.746	1.565	1.490	1.761 $_{a}$
$H_{10}L_{301}$	1.916	1.945	2.001	1.410	1.808	1.675	1.420	1.377	1.694	1.829	1.787	1.753	1.707	1.563	1.578	1.268	1.266	1.594 $_{c-f}$
$H_{11}L_{342}$	1.655	1.635	1.578	1.937	1.683	1.535	1.345	1.310	1.584	1.848	1.790	1.720	1.727	1.833	1.556	1.344	1.317	1.642 $_{b-d}$
$H_{11}L_{384}$	1.756	1.826	1.879	1.557	1.542	1.405	1.243	1.186	1.549	1.639	1.884	1.759	1.633	1.523	1.547	1.199	1.194	1.547 $_{fg}$
H_{160}	1.629	1.739	1.775	1.650	1.533	1.385	1.188	1.145	1.505	1.642	1.670	1.665	1.713	1.734	1.445	1.236	1.150	1.532 $_{f-h}$
H_{163}	1.485	1.803	1.385	1.296	1.603	1.468	1.235	1.200	1.434	1.694	1.754	1.473	1.509	1.631	1.390	1.185	1.091	1.466 $_{hi}$
Giza 111	1.544	1.564	1.642	1.423	1.417	1.365	1.200	1.165	1.415	1.667	1.569	1.484	1.427	1.479	1.399	1.208	1.153	1.423 $_{i}$
Crawford	1.373	1.303	1.249	1.143	1.167	1.120	0.880	0.830	1.133	1.344	1.303	1.216	1.211	1.317	1.046	0.849	0.815	1.138 $_{j}$
Average of locations	1.724	1.796	1.830	1.602	1.535	1.402	1.271	1.235	1.549	1.796	1.795	1.680	1.667	1.629	1.433	1.254	1.219	1.559

L.S.D. 0.05 Season (S)	ns
L.S.D. 0.05 Location (L)	0.054
L.S.D. 0.05 Genotypes (G)	0.071
L.S.D. 0.05 S x L	ns
L.S.D. 0.05 S x G	ns
L.S.D. 0.05 L x G	0.533
L.S.D. 0.05 S x L x G	ns

L_1: Sakha, L_2: Nubaria, L_3: Etai El‹Baroud, L_4: Gemmiza, L_5: Mallawi, L_6: Sids, L_7: Shandweel, L_8: New Valley, Different letters indicate a significant difference at $p \leq 0.05$ according to Duncan's multiple tests.

ns: No‹significant.

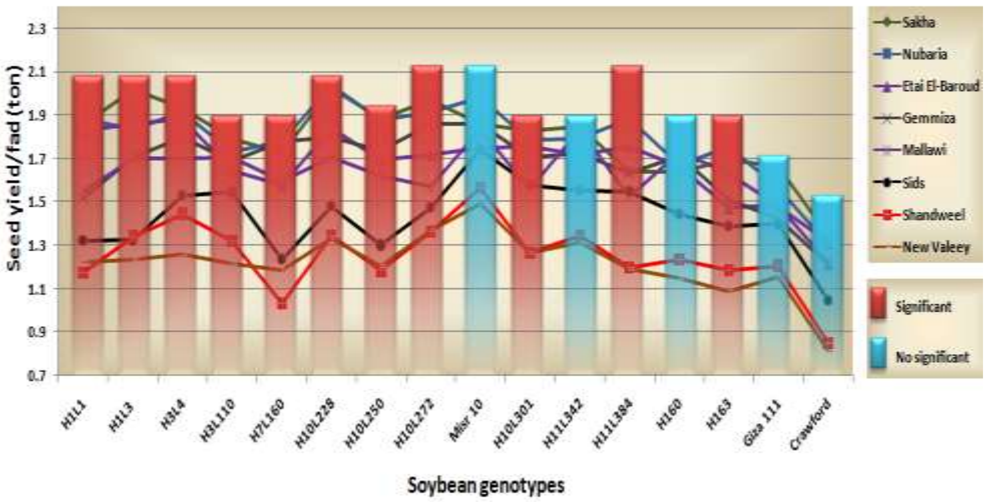

Fig. 3. The interaction between genotype and location in advanced yield trials.

IV. On‹farm trials

Five genotypes (H_3L_4, $H_{10}L_{228}$, $H_{10}L_{272}$, Misr 10, and $H_{11}L_{342}$) along with Giza 111 and Crawford were planted in six locations (El‹Behira, El‹Menofia, El‹Sharkia, Beni Sweif, El‹Menya, and Assuit) during the summer seasons of 2018, 2019 and 2020.

Location effect

The location had a significant effect on seed yield of genotypes in the combined data across the three seasons (Table 6). El‹Behira and El‹Menofia locations were superior for seed yield per fad, followed by El‹Sharkia and Beni Sweif locations, then El‹Menya location. El‹Behira, El‹Menofia, El‹Sharkia, Beni Sweif, and El‹Menya locations gave increase in seed yields per fad by 24.18, 20.50, 16.15, 11.13, and 5.75%, respectively, compared to Assiut location. Assuit location came in the last rank for seed yield per fad. These results may be attributed to the differences in climatic and edaphic conditions from one location to another that led to such results.

Table 6. Average seed yield (ton/fad.) for some genotypes in on‹farm trials as affected by seasonal effects, locations, genotypes and their interactions, combined data across the three seasons 2018, 2019 and 2020.

Genotypes	First season							Second season						
	L_1	L_2	L_3	L_4	L_5	L_6	Mean	L_1	L_2	L_3	L_4	L_5	L_6	Mean
H_3L_4	1.820	1.680	1.640	1.640	1.550	1.410	1.623	1.730	1.680	1.670	1.500	1.550	1.390	1.586
$H_{10}L_{228}$	1.870	1.800	1.780	1.680	1.480	1.450	1.676	1.800	1.825	1.680	1.650	1.600	1.400	1.659
$H_{10}L_{272}$	1.790	1.690	1.590	1.530	1.460	1.360	1.570	1.730	1.660	1.570	1.450	1.350	1.460	1.536
Misr 10	1.800	1.870	1.750	1.650	1.560	1.550	1.696	1.770	1.870	1.680	1.720	1.650	1.650	1.723
$H_{11}L_{342}$	1.890	1.730	1.540	1.550	1.490	1.350	1.591	1.830	1.560	1.600	1.400	1.400	1.450	1.540
Giza 111	1.540	1.350	1.450	1.350	1.300	1.250	1.373	1.450	1.620	1.500	1.450	1.450	1.300	1.461
Crawford	1.280	1.250	1.260	1.150	1.050	1.020	1.168	1.270	1.350	1.410	1.290	1.300	1.150	1.295
Average of locations	1.712	1.624	1.572	1.507	1.412	1.341	1.528	1.654	1.652	1.587	1.494	1.471	1.400	1.543

Genotypes	Third season							Combined						Average of genotypes
	L_1	L_2	L_3	L_4	L_5	L_6	Mean	L_1	L_2	L_3	L_4	L_5	L_6	
H_3L_4	1.800	1.720	1.720	1.610	1.450	1.350	1.608	1.783	1.693	1.676	1.583	1.516	1.383	1.606 c
$H_{10}L_{228}$	1.800	1.750	1.670	1.720	1.600	1.400	1.656	1.823	1.791	1.710	1.683	1.560	1.416	1.664 b
$H_{10}L_{272}$	1.760	1.660	1.620	1.570	1.400	1.430	1.573	1.760	1.670	1.593	1.516	1.403	1.416	1.560 d
Misr 10	1.860	1.810	1.700	1.710	1.680	1.550	1.718	1.810	1.850	1.710	1.693	1.630	1.583	1.712 a
$H_{11}L_{342}$	1.780	1.690	1.590	1.550	1.400	1.350	1.560	1.833	1.660	1.576	1.500	1.430	1.383	1.563 d
Giza 111	1.550	1.520	1.500	1.340	1.320	1.260	1.415	1.513	1.496	1.483	1.380	1.356	1.270	1.416 e
Crawford	1.250	1.240	1.170	1.150	1.090	0.950	1.141	1.266	1.280	1.280	1.196	1.146	1.040	1.201 f
Average of locations	1.685	1.627	1.567	1.521	1.420	1.327	1.524	1.684	1.634	1.575	1.507	1.434	1.356	1.532
L.S.D. 0.05 Season (S)														ns
L.S.D. 0.05 Location (L)														0.031
L.S.D. 0.05 Genotypes (G)														0.037
L.S.D. 0.05 S x L														ns
L.S.D. 0.05 S x G														ns
L.S.D. 0.05 L x G														0.273
L.S.D. 0.05 S x L x G														ns

L_1: El‹Behira, L_2: El‹Menofia, L_3: El‹Sharkia, L_4: Beni Sweif, L_5: El‹Menya, L_6: Assuit, Different letters indicate a significant difference at $p \leq 0.05$ according to Duncan’s multiple range tests.

ns: No‹significant.

Genotypes

The mean performance of all tested genotypes for seed yield per fad in the combined data across the three seasons is presented in Table (6). Soybean cultivar Misr 10 was superior for seed yield per fad. Seed yield of cultivar Misr 10 recorded 1.712 t/fad. Soybean cultivar Misr 10 gave an increase in seed yield by 20.90%, compared with Giza 111. Meanwhile, this value reached 42.54% compared to Crawford. Genotype

$H_{10}L_{228}$ came in the second rank for seed yield per fad. Conversely, Crawford had lower seed yields per fad than the others. It is likely that the genetic makeup of all genotypes controls their growth and development habits indicating differences in their productivity per unit area. These results show Misr 10 and $H_{10}L_{228}$ can be used as parents in crosses in a breeding program.

The interaction between genotype and location

The interaction between genotype and the location was significant for seed yield per fad in the combined data across the three seasons (Table 6). Seed yields of genotypes H_3L_4, $H_{10}L_{228}$, $H_{10}L_{272}$, and $H_{11}L_{342}$ were differed significantly by the location. Meanwhile, genotypes Misr 10, Giza 111, and Crawford were not affected. These results can be attributed to Misr 10 and Giza 111 having more positive adaptation to locations reflected by their vegetative and reproductive duration than the other genotypes, meanwhile, the susceptibility of Crawford to cotton leaf worm infestation did not vary from one location to another. These results indicate that each of these two factors acts independently on seed yield per fad for Misr 10, Giza 111, and Crawford. Fig. 4 shows the interaction between genotype and location in on‹farm trials.

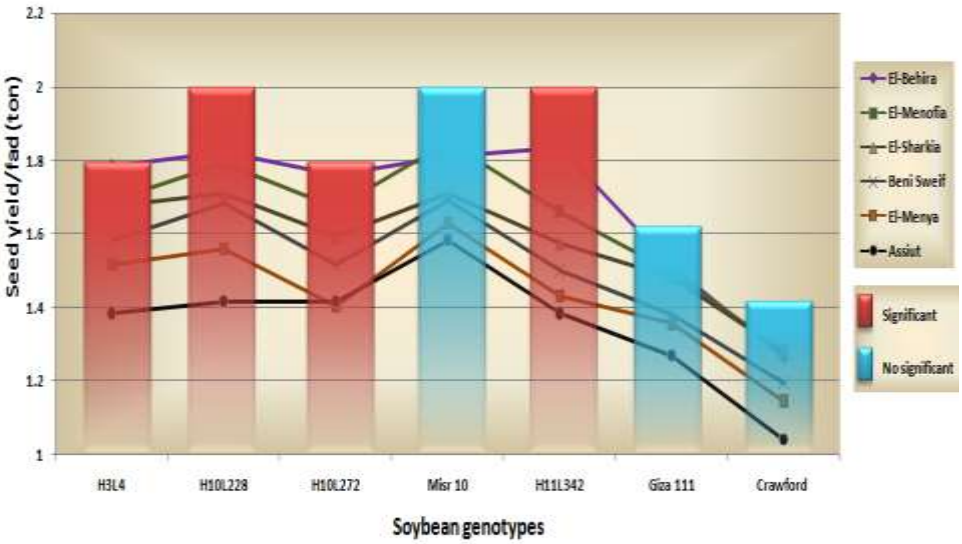

Fig. 4. The interaction between genotype and location in on‹farm trials.

V. Cotton leaf worm trials

Five genotypes (H_3L_4, $H_{10}L_{228}$, $H_{10}L_{272}$, Misr 10, and $H_{11}L_{342}$) along with Giza 22, Giza 83, Giza 111, and Crawford were planted in Sakha and Etai El‹Baroud Agricultural Research Stations during the summer seasons of 2020 and 2021.

A. Field Evaluation

No significant difference in respect of insect assemblages on leaves of the studied genotypes among the locations in the combined data across the two seasons is presented in Table (7). This shows that the entomological environment in Sakha location does not differ from that in the other location.

Genotypes

The mean performance of all tested genotypes for insect assemblages on leaves of the studied genotypes in the combined data across the two seasons is presented in Table (7). Genotypes H_3L_4, $H_{11}L_{342}$, Misr 10, $H_{10}L_{272}$, Giza 111 and $H_{10}L_{228}$ recorded lower insect assemblages on the leaves than the others.

Table 7. Insect assemblages on leaves of the studied genotypes at 50 days from sowing combined data across the two seasons 2020 and 2021.

Genotypes	First season			Second season			Combined		Average of genotypes
	L_1	L_2	Mean	L_1	L_2	Mean	L_1	L_2	
H_3L_4	2.330	1.660	1.995	1.660	1.730	1.695	1.995	1.695	1.845 d
$H_{10}L_{228}$	3.230	3.330	3.280	3.660	3.830	3.745	3.445	3.580	3.512 b‹d
$H_{10}L_{272}$	3.430	2.660	3.045	3.330	3.330	3.330	3.380	2.995	3.187 cd
Misr 10	3.830	2.830	3.330	1.660	1.630	1.645	2.745	2.230	2.487 cd
$H_{11}L_{342}$	2.930	1.830	2.380	1.330	1.660	1.495	2.130	1.745	1.937 d
Giza 22	5.160	4.330	4.745	3.830	3.623	3.726	4.495	3.976	4.235 bc
Giza 83	5.830	4.660	5.245	4.830	4.660	4.745	5.330	4.660	4.995 b
Giza 111	3.330	2.660	2.995	3.330	3.500	3.415	3.330	3.080	3.205 cd
Crawford	8.330	7.660	7.995	7.330	7.460	7.395	7.830	7.560	7.695 a
Average of locations	4.266	3.513	3.890	3.440	3.491	3.465	3.853	3.502	3.677
L.S.D. 0.05 Season (S)									ns
L.S.D. 0.05 Location (L)									ns
L.S.D. 0.05 Genotypes (G)									1.773
L.S.D. 0.05 S x L									ns
L.S.D. 0.05 S x G									ns
L.S.D. 0.05 L x G									ns
L.S.D. 0.05 S x L x G									ns

L_1: Sakha, L_2: Etai El‹Baroud, Different letters indicate a significant difference at $p \leq 0.05$ according to Duncan's multiple range tests.
ns: No‹significant.

Meanwhile, the converse was true for Crawford, Giza 22 and Giza 83. Insect assemblages on the leaves of Misr 10 recorded 2.487 with the decrease of 41.27, 50.21, 22.40 and 67.68%, compared with Giza 22, Giza 83, Giza 111, and Crawford, respectively. These results may be due to soybean cultivar Misr 10 had mechanical and/or chemical defenses that affected negatively cotton leaf worm growth and development. These results are in accordance with those observed by Lutfallah *et al*(1998) and Abdel‹Wahab and Naroz (2023).

The interaction between genotype and location

No significant differences were observed between genotype and location for insect assemblages on leaves of the studied genotypes in the combined data across the two seasons (Table 7).

B. Artificial feeding

Location effect

No significant difference in respect of artificial feeding on leaves of the studied genotypes among the locations in the combined data across the two seasons is presented in Table (8). This shows that the entomological environment in Sakha location does not differ from that in the other location.

Genotypes

The effects of infestation of cotton leafworm on leaves of the studied soybean genotypes under laboratory conditions are presented in Table 8. Leaves of soybean genotypes H_3L_4, $H_{10}L_{228}$, $H_{10}L_{272}$, Misr 10, and $H_{11}L_{342}$ caused lower cotton leaf worm infestation (1, 10%), while higher infestation (more than 30%) was observed for Crawford. The other soybean genotypes Giza 22, Giza 83, and Giza 111 had moderate response. In other words, soybean genotypes H_3L_4, $H_{10}L_{228}$, $H_{10}L_{272}$, Misr 10, and $H_{11}L_{342}$ were resistant (R) to infestation with cotton leaf worm. Meanwhile, Giza 22 and Giza 111 were moderate resistant (MR), and Giza 83 was moderately susceptible (MS) to infestation with cotton leafworm. Conversely, Crawford was susceptible (S) to infestation with cotton leafworm.

The interaction between genotype and location

No significant differences were observed between genotype and location for artificial feeding on leaves of the studied genotypes in the combined data across the two seasons (Table 8).

VI. VCU trials

Five genotypes (H_3L_4, $H_{10}L_{228}$, $H_{10}L_{272}$, Misr 10, and $H_{11}L_{342}$) along with Giza 22, Giza 83, Giza 111, and Crawford were planted in Sakha, Etai El‹Baroud, Mallawi, and Sids Agricultural Research Stations during the summer seasons of 2020 and 2021.

Table 8. Rating levels of consumed leaflets area of the studied soybean genotypes and their categories (cat.) for resistance of cotton leaf worm under laboratory conditions at 50 days from sowing.

Genotypes	First season						Second season						Combined				Average of genotypes	cat.
	L_1	cat.	L_2	Cat.	Mean	cat.	L_1	cat.	L_2	cat.	Mean	cat.	L_1	cat.	L_2	cat.		
H_3L_4	5.5	R	4.8	R	5.2	R	6.2	R	5.5	R	5.85	R	5.85	R	5.18	R	5.51 $_d$	R
$H_{10}L_{228}$	6.8	R	6.1	R	6.5	R	7.3	R	8.9	R	8.10	R	7.07	R	7.49	R	7.28 $_d$	R
$H_{10}L_{272}$	7.9	R	7.4	R	7.6	R	9.3	R	7.4	R	8.37	R	8.59	R	7.40	R	7.99 $_d$	R
Misr 10	4.2	R	5.6	R	4.9	R	6.5	R	6.9	R	6.72	R	5.37	R	6.24	R	5.80 $_d$	R
$H_{11}L_{342}$	6.3	R	5.6	R	6.0	R	9.0	R	6.7	R	7.80	R	7.60	R	6.14	R	6.87 $_d$	R
Giza 22	16.6	MR	18.3	MR	17.5	MR	22.2	MR	20.0	MR	21.08	MR	19.41	MR	19.14	MR	19.27 $_c$	MR
Giza 83	24.7	MS	23.1	MS	23.9	MS	24.6	MS	23.2	MS	23.90	MS	24.62	MS	23.18	MS	23.90 $_b$	MS
Giza 111	14.9	MR	16.3	MR	15.6	MR	16.7	MR	15.3	MR	16.00	MR	15.78	MR	15.82	MR	15.80 $_c$	MR
Crawford	62.1	S	60.4	S	61.3	S	59.6	S	61.6	S	60.59	S	60.86	S	60.98	S	60.92 $_a$	S
Average of locations	16.55		16.40		16.47		17.92		17.27		17.60		17.24		16.84		17.04	
L.S.D. 0.05 Season (S)																	ns	
L.S.D. 0.05 Location (L)																	ns	
L.S.D. 0.05 Genotypes (G)																	4.22	
L.S.D. 0.05 S x L																	ns	
L.S.D. 0.05 S x G																	ns	
L.S.D. 0.05 L x G																	ns	
L.S.D. 0.05 S x L x G																	ns	

L_1: Sakha, L_2: Etai El‹Baroud, Different letters in the same column indicate a significant difference at $p \leq 0.05$ according to Duncan's multiple range tests.
ns: No‹significant.
R = Resistant, MR = Moderate Resistant, S = Susceptible.

Location effect

The location had a significant effect on seed yield of genotypes in the combined data across the two seasons (Table 9). Sakha and Etai El‹Baroud locations were superior for seed yield per fad, followed by Mallawi location. Sakha, Etai El‹Baroud, and Mallawi locations gave increase in seed yields per fad by 10.12, 10.55, and 4.49%, respectively, compared to Sids location. Sids location came in the last rank for seed yield per fad. These results may be attributed to the differences in ecological adaptability from one location to another that led to such results.

Table 9. Average seed yield (ton/fad.) for some genotypes in VCU trials as affected by seasonal effects, locations, genotypes and their interactions in the combined data across the two seasons 2020 and 2021.

Genotypes	First season					Second season					Combined				Average of genotypes
	L_1	L_2	L_3	L_4	Mean	L_1	L_2	L_3	L_4	Mean	L_1	L_2	L_3	L_4	
H_3L_4	1.860	1.830	1.550	1.670	1.727	1.450	1.570	1.500	1.450	1.492	1.655	1.700	1.525	1.560	1.610 a‹c
$H_{10}L_{228}$	1.630	1.900	1.600	1.480	1.652	1.920	1.680	1.550	1.550	1.675	1.775	1.790	1.575	1.515	1.663 ab
$H_{10}L_{272}$	1.550	1.830	1.600	1.390	1.592	1.880	1.470	1.450	1.470	1.567	1.715	1.650	1.525	1.430	1.580 b‹d
Misr 10	1.816	1.803	1.883	1.570	1.768	1.810	1.706	1.753	1.686	1.739	1.813	1.755	1.818	1.628	1.753 a
$H_{11}L_{342}$	1.400	1.930	1.450	1.330	1.527	1.880	1.600	1.550	1.350	1.595	1.640	1.765	1.500	1.340	1.561 b‹d
Giza 22	1.350	1.550	1.450	1.350	1.425	1.440	1.450	1.350	1.350	1.397	1.395	1.500	1.400	1.350	1.411 de
Giza 83	1.300	1.250	1.350	1.250	1.287	1.300	1.250	1.250	1.300	1.275	1.300	1.250	1.300	1.275	1.281 ef
Giza 111	1.450	1.583	1.450	1.450	1.483	1.470	1.350	1.350	1.400	1.392	1.460	1.466	1.400	1.425	1.437 c‹e
Crawford	1.150	1.000	1.250	1.100	1.125	1.150	1.150	1.050	1.100	1.112	1.150	1.075	1.150	1.100	1.118 f
Average of locations	1.500	1.630	1.509	1.398	1.509	1.588	1.469	1.422	1.406	1.471	1.544	1.550	1.465	1.402	1.490

L.S.D. 0.05 Season (S)	ns
L.S.D. 0.05 Location (L)	0.079
L.S.D. 0.05 Genotypes (G)	0.172
L.S.D. 0.05 S x L	ns
L.S.D. 0.05 S x G	ns
L.S.D. 0.05 L x G	0.282
L.S.D. 0.05 S x L x G	ns

L_1: Sakha, L_2: Etai El‹Baroud, L_3: Mallawi, L_4: Sids, Different letters indicate a significant difference at $p \leq 0.05$ according to Duncan's multiple range tests. ns: No‹significant.

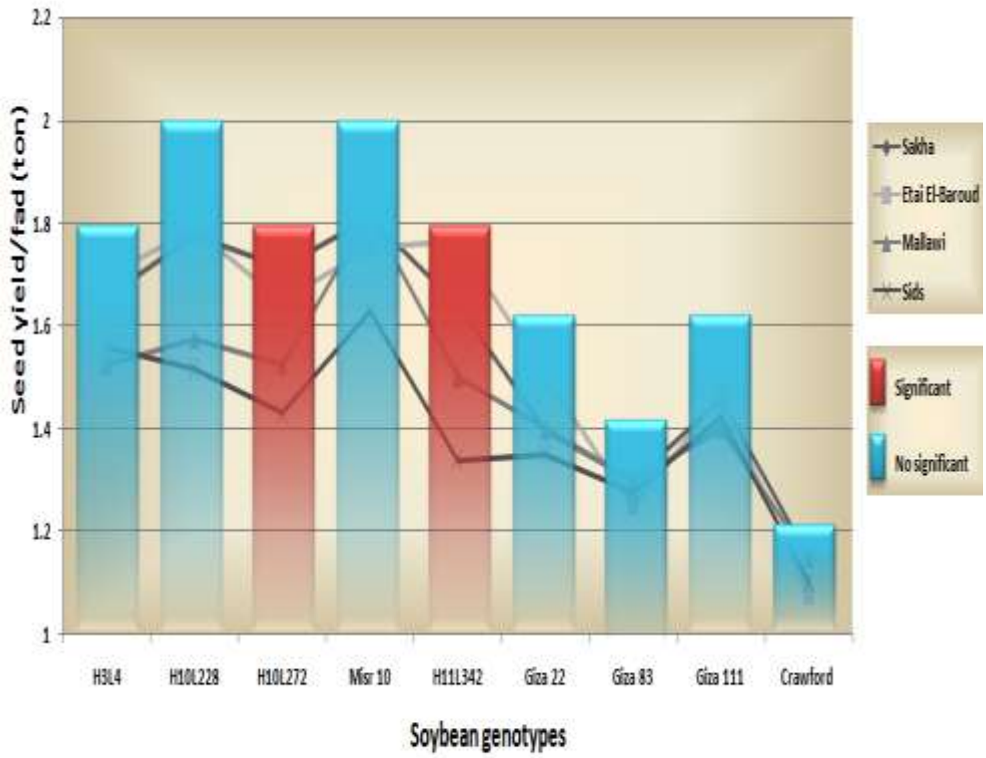

Fig. 5. The interaction between genotype and location in VCU trials.

Genotypes

The mean performance of all tested genotypes for seed yield per fad in the combined data across the two seasons is presented in Table (9). Genotypes Misr 10, $H_{10}L_{228}$, and H_3L_4 were superior for seed yield per fad. Seed yield of genotypes Misr 10, $H_{10}L_{228}$, and H_3L_4 recorded 1.753, 1.663 and 1.610 t/fad, respectively. Soybean cultivar Misr 10 gave an increase in seed yield by 24.23, 36.84, 21.99, and 56.79%, compared to Giza 22, Giza 83, Giza 111, and Crawford, respectively. Meanwhile, $H_{10}L_{228}$ gave an increase in seed yield by 17.85, 29.82, 15.72, and 48.74%, compared to Giza 22, Giza 83, Giza 111, and Crawford, respectively. Finally, H_3L_4 gave an increase in seed yield by 14.10, 25.68, 12.03, and 44.00%, compared with Giza 22, Giza 83, Giza 111, and Crawford, respectively. Conversely, Crawford and Giza 83 had lower seed yield per fad than the others. It seems that a genotype growth and development and in turn its productivity was regulated by its genetic makeup. These results show that Misr 10 and $H_{10}L_{228}$ can be used as parents in a breeding program.

The interaction between genotype and location

The effect of the location was significant on the seed yield in the combined data across the two seasons (Table 9). Seed yields of genotypes $H_{10}L_{272}$ and $H_{11}L_{342}$ were affected by the location. Meanwhile, seed yields of genotypes H_3L_4, $H_{10}L_{228}$, Misr 10, Giza 22, Giza 83, Giza 111, and Crawford were not affected.

These results can be attributed to differences among the genotypes in their adaptation to locations reflected by the vegetative and reproductive duration which translated to economic yield. These results indicate that each of these two factors acts independently on seed yield per fad for H_3L_4, $H_{10}L_{228}$, Misr 10, Giza 22, Giza 83, Giza 111, and Crawford. Fig. 5 shows the interaction between genotype and location in VCU trials.

VII. Phenotypic simple correlation coefficients between genotype and cotton leafworm infestation under field conditions at Sakha and Etai El‹Baroud locations

The results in Table (10) reveal that seed yield of H_3L_4 was not correlated significantly with infestation with cotton leaf worm at Sakha location (r = 0.429) or Etai El‹Baroud location (r = 0.227). No significant correlation was detected between seed yield of $H_{10}L_{228}$ and infestation with cotton leaf worm at Sakha location (r = ‹0.139) or Etai El‹Baroud location (r = ‹0.373). there was no significant correlation between seed yield of $H_{10}L_{272}$ and infestation with cotton leaf worm at Sakha location (r = 0.583) or Etai El‹Baroud location (r = 0.409), Also, no significant correlation was detected between seed yield of Misr 10 and infestation with cotton leaf worm at Sakha location (r = 0.177) or Etai El‹Baroud location (r = 0.333). Moreover, seed yield of $H_{11}L_{342}$ was not correlated significantly with infestation with cotton leaf worm at Sakha location (r = 0.379) or Etai El‹Baroud location (r = 0.457).

Table 10. Phenotypic simple correlation coefficients between genotypes and cotton leafworm infestation under field conditions at Sakha and Etai El‹Baroud locations, data are combined across the two seasons 2020 and 2021.

Genotypes	Simple correlation coefficient (r)	
	Sakha	Etai El‹Baroud
H_3L_4	0.429	0.227
$H_{10}L_{228}$	‹0.139	‹0.373
$H_{10}L_{272}$	0.583	0.409
Misr 10	0.177	0.333
$H_{11}L_{342}$	0.379	0.457
Giza 22	‹0.357	‹0.403
Giza 83	‹0.667	‹0.727*
Giza 111	0.615	0.477
Crawford	‹0.897**	‹0.925**

*** and ** indicate significance at 0.05 and 0.01 probability levels, respectively.**

In the same trend, no significant correlation was detected between seed yield of Giza 22 and infestation with cotton leaf worm at Sakha location (r = ‹0.357) or Etai El‹Baroud location (r=‹0.403). Seed yield of Giza 83 was not correlated significantly with infestation with cotton leaf worm at Sakha location (r = ‹0.667), but seed yield of this cultivar was correlated negatively with cotton leaf worm infestation at Etai El‹Baroud location (r = ‹0.727*). Moreover, no significant correlation was detected between seed yield of Giza 111 and infestation with cotton leaf worm at Sakha location (r = 0.615) or Etai El‹Baroud location (r = 0.477). Finally, there were a high negative significant correlation between seed yield of Crawford and cotton leaf worm infestation at Sakha location (r = ‹0.897**) or Etai El‹Baroud location (r = ‹0.925**). This shows that soybean cultivar Misr 10 was tolerant to infestation with cotton leaf worm under field conditions. Conversely, Giza 83 and Crawford were moderate susceptible and susceptible, respectively, to infestation with cotton leaf worm under field conditions of the two locations, respectively. These results are in harmony with Abdel‹Wahab and Naroz (2023) that found that no significant correlation was detected between the weight of larvae survival of cotton leaf worm and seed yield/ha (r = −0.189).

CONCLUSION

According to VCU trials, the promising cultivar Misr 10 exceeded the check cultivar Giza 111 by 0.316 t/fad (21.99%) in the combined data across the two seasons (2020 and 2021) among all the tested genotypes, and it should be recommended for Egyptian farmers.

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مصر ١٠: صنف جديد مبشر من فول الصويا عالى المحصول ومتحمل الإصابة بدودة ورق القطن

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شملت هذه الدراسة إستنباط صنف جديد من فول الصويا هو مصر ١٠ بقسم بحوث المحاصيل المحاصيل البقولية وهو من الأصناف المبشرة عالية المحصول والمقاوم للإصابة بدودة ورق القطن. تم إجراء التهجين وتقييم الأجيال الإنعزالية من ٢٠٠٥ حتى ٢٠١١م لإنتاج التراكيب الوراثية الأبوية ذات القدرة الإنتاجية العالية. تم تنفيذ ستة وعشرون تجربة حقلية (تجربتان تمهيديتان، أربعة تجارب مصغرة، ثمانية تجارب مبشرة، ستة تجارب تأكيدية، تجربتان لتقييم المقاومة لدودة ورق القطن، أربعة تجارب لتسجيل وإعتماد الصنف) فى أربعة عشر موقعا تتضمن ثمانية محطات بحثية (سخا، نوبارية، إيتاى البارود، جميزة، ملوى، سدس، شندويل، الوادى الجديد) وستة محافظات (البحيرة، المنوفية، الشرقية، بنى سويف، المنيا، أسيوط) من ٢٠١٢ حتى ٢٠٢١م لإنتاج صنف مصر ١٠. تم توزيع التراكيب الوراثية لفول الصويا في تصميم القطاعات الكاملة العشوائية لكل موقع فى ثلاث مكررات. بالنظر بالنظر إلى مواسم الدراسة، تم تحليل متوسط محصول البذور للفدان لكل تجربة وكذلك متوسط التجمعات الحشرية على أوراق فول الصويا إحصائيا من خلال تصميم القطع المنشقة مرتين فى ثلاث مكررات. تم وضع التأثيرات الموسمية في القطع الرئيسية ، وتخصيص المواقع في القطع الفرعية، وتوزيع التراكيب الوراثية لفول الصويا في القطع تحت الفرعية. أظهرت النتائج أن محصول بذور فول الصويا لم يتأثر معنويا بالتأثيرات الموسمية أو تفاعلاتها في التحليل التجميعى لكل التجارب. بالنظر إلى التجارب الأولية، أعطى موقع سخا زيادة في محصول البذور بنسبة ١٠,٦٢٪ مقارنة بموقع إيتاي البارود. بينما في التجارب المصغرة، أعطت مواقع سخا وإيتاى البارود وملوي زيادة في محصول البذور بنسبة ٣٠,٧٨ و١٩,٦١ و٦,٥١٪، على الترتيب، مقارنة بموقع سدس. فيما يتعلق بالتجارب المبشرة ، أعطت مواقع سخا والنوبارية وإيتاى البارود والجميزة وملوي وسدس وشندويل زيادة في محصول البذور بنسبة ٤٧,٣٣ ٤٧,٣٣ و٤٧,٢٥ و٣٧,٨١ و٣٦,٧٥ و٣٣,٦٣ و١٧,٥٥ و٢,٨٧٪، على الترتيب، مقارنة بموقع الوادي الجديد. فيما يتعلق بالتجارب التأكيدية، أعطت مواقع البحيرة والمنوفية والشرقية وبني سويف والمنيا زيادة في إنتاجية البذور بنسبة ٢٤,١٨ و٢٠,٥٠ و١٦,١٥ و١١,١٣ و٥,٧٥٪، على الترتيب، مقارنة بموقع أسيوط. فيما يتعلق بتجارب تسجيل الصنف وإعتماده، أعطت مواقع سخا وإيتاي البارود وملوي زيادة في محصول البذور بنسبة ١٠,١٢ و١٠,٥٥ و٤,٤٩٪، على الترتيب، مقارنة بموقع سدس. أعطى صنف فول الصويا مصر ١٠ زيادة في محصول بذور الفدان بنسبة ٤١,٨٣٪ في التجارب التجارب التمهيدية، ٢٣,٠٣٪ في التجارب المصغرة ، ٢٣,٧٥٪ في التجارب المبشرة، ٢٠,٩٠٪ في

التجارب التأكيدية، ٢١,٩٩٪ في تجارب تسجيل الصنف وإعتماده، مقارنة بصنف جيزة ١١١. لم يؤثر التفاعل بين المواقع والتراكيب الوراثية لفول الصويا على أصناف فول الصويا مصر ١٠، جيزة ١١١، كراوفورد لكل التجارب. بالنظر إلى تجارب تقييم المقاومة للإصابة بدودة ورق القطن، وجد أن صنف فول فول الصويا مصر ١٠ كان أكثر مقاومة للإصابة بدودة ورق القطن بنسبة ٢٢,٤٠٪ مقارنة بصنف جيزة جيزة ١١١ . لم يوجد إرتباط معنوي بين محصول بذور صنف فول الصويا مصر ١٠ والإصابة بدودة ورق ورق القطن في موقع سخا (معامل الإرتباط = ٠,١٧٧) أو موقع إيتاى البارود (معامل الإرتباط = ٠,٣٣٣). يمكن التوصية بزراعة مصر ١٠ على النطاق التجارى مع زيادة في محصول بذور الفدان بنسبة ٠,٢٩٦ طن / فدان (التحليل التجميعى للتجارب التأكيدية) ومقاومة عالية للإصابة بدودة ورق القطن مقارنة بالصنف التجاري جيزة ١١١.