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Agronomic evaluation of some faba bean genotypes under natural infection with foliar diseases

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Abstract

The current experiment was conducted at the Experimental Farm of Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt for two seasons: 2022/2023 and 2023/2024. The studied faba bean genotypes were four commercial cultivars (Giza-40, Giza-716, Sakha-1, and Sakha-4) and four promising lines (L-1, L-2, L-3, and L-4). The 8 genotypes were evaluated to the reaction of natural infection with chocolate spot and rust disease. Sakha-4 and Sakha-1 performed better in terms of seed yield due to their good genetic traits, under scoring their potential for higher productivity of faba beans. L-1 and L-2, on the other hand, showed encouraging results in terms of high seed yield per hectare, and less infection with foliar disease. These two promising lines are good candidates for high yield and resistance to foliar diseases, which makes them a feasible choice for those who are looking for increasing faba bean productivity. Plant height, pod number per plant, seed yield per plant, and seed output per hectare all improved in faba bean genotypes, L-1, L-2, L-3, and L-4 due to their resistance to foliar diseases. These traits also improved the overall growth. On the other hand, vulnerability of Giza-40 to foliar diseases had a major effect on the components of yield and seed production. This study revealed that Shakh-1, Shakh-4, L-1 and L-2 are more productive due to their enhanced resistance to foliar diseases. Because L-1 and L-2 are resistant to chocolate spot and rust, they show potential in foliar disease breeding programs. Thus, they are strong contenders to improve crop productivity and quality.

Keywords: Faba bean, chocolate spot, rust, seed yield, seed quality.

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1. Introduction

Faba bean (*Vicia faba* L.) is a significant food crop that is utilized in both human and livestock diets worldwide. It produces seeds with high contents of protein (Elsheikh *et al*., 1999), and fixes the air nitrogen into the roots of the plant, consequently it enriches the soils with nitrogen to be exploited in the following crops (Sherif *et al*., 2017). In 2023, the total planted area of faba beans, in Egypt, was only 47,000 ha, with an average seed yield of 3.42 tons/ha (Anonymous, 2023), most of area is located in northern Egypt. Faba bean crop faces some biotic challenges, from which are plant diseases that negatively affect the performance of different genotypes (Tantawy *et al*., 2022). Chocolate spot *(Botrytis fabae*) flourishes in northern Egypt because of suitable cool weather, reducing faba bean yield by approximately 60% (Ahmed, 2015; Harrison, 2007; Mostafa *et al*., 2021). Another significant disease that affects faba beans globally and causes losses of around 70% is faba bean rust disease; *Uromyces viciae-fabae* Pers. (Morsy, 2012). Disease resistant plants is the major component of IPM, to avoid environmental pollution by pesticides, and thus, planting resistant cultivars can help manage these diseases (Waly *et al*., 2019). According to Mohamed and El-Bakery (2020), Santamora, Giza-843, Sakha-3, and Sakha-4 have greater yields since they are resistant to both diseases. These cultivars have shown promising results in field trials, demonstrating their effectiveness in reducing the negative impact of diseases on crop production. In addition, high seed quality is a main target to faba bean breeders. In their study, Soliman *et al*. (2023) found that Nubaria (1) had the lowest levels of crude protein, total carbohydrates, and total tannins, whereas L-6 and L-7 breeding lines outperformed all evaluated genotypes in terms of resistance to chocolate spot and rust diseases. Therefore, the current study was carried out to evaluate the reaction of some faba bean genotypes to chocolate spot and rust diseases. In addition, the yield, yield traits, protein and carbohydrate contents of these genotypes were assessed.

2. Materials and methods

The current experiment was conducted at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt during 2022/2023 and 2023/2024 seasons. The studied genotypes were four commercial cultivars (Giza-40, Giza-716, Sakha-1, and Sakha-4) and four promising lines (L-1, L-2, L-3, and L-4). The promising lines were selected from F_5 generation for their superiority of resistance to foliar diseases compared with the check cultivars. The eight genotypes were evaluated under natural infection with foliar diseases to enhance seed yield and seed quality (Table 1).

Table (1): Pedigree of tested faba bean genotypes.

Genotype	Pedigree
Giza-40	Selection from Rebaya-40
Giza-716	416/842/83 × 03/453/83
Sakha-1	Giza-716 × 620/283/85
Sakha-4	Sakha-1 × Giza-3
L-1	Giza-843 × 37M/ILB43628
L-2	Nubaria-3 × Sakha-1
L-3	Nubaria-3 × Giza-7
L-4	Nubaria-3 × Nubaria-2

Rice was the preceding crop, and one hectare received 357 kg of calcium superphosphate (15.5% P_2O_5) mixed with soil during preparation. The tested genotypes were arranged in a RCBD, with three replications. Each plot consisted of three ridges, each 0.60 m wide and 3.0 m long, covering an area of 5.4 m^2. The seeds of faba beans were sown on November 5th in 2022 season and November 9th in 2023 season. Two plants were planted in each hill, separated by 25 cm, in a single row. In addition, furrow irrigation was used, and all recommended agricultural practices were implemented.

2.1 The collected data

2.1.1 Foliar diseases assessment

Using a 1–9 grading scale, the incidence of chocolate spot and rust on randomly chosen plant genotypes was evaluated twice; 65 and 85 days following planting (Bernier, 1993).

2.1.2 Yield and yield components

Plant height, number of branches and pods/plant, and seed yield per plant (g), were determined in 10 plants at harvest. Based on the experimental plot, seed yield/plot (kg) was calculated and adjusted to t/ha.

2.1.3 Quality of faba bean seeds

At Seed Technology Research Department, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt, quality tests of faba bean seeds were conducted. Fifty grams of faba bean seeds were air dried, milled into a fine powder, dried at 70°C until constant weight, and kept in brown glass vials. According to A.O.A.C. (2000), the MicroKjeldahl apparatus was used to determine the total N of faba bean seeds, which was multiplied by 6.25 to determine the crude protein level (Sadasivam and Manickam, 1997). In accordance with DuBois *et al*. (1956), the percentage of carbohydrates in seeds was assessed.

2.2 Statistical analysis

The L.S.D. test was used to compare means at 5% level (Gomez and Gomez, 1984). MSTATC was used to do an ANOVA on the measured variables (Freed, 1991).

3. Results and discussions

3.1 Susceptibility of faba beans to foliar disease infection

3.1.1 Chocolate spot disease

Faba bean genotypes differed significantly in chocolate spot disease infection at 65 and 85 days after planting (Table 2). Sixty-five days after planting in 2022/2023 season, the highest infected genotypes were Giza-40 (3.17), Giza-716 (3.06), and L-4 (2.84). The remaining genotypes proved to be less infected, ranging between 2.51 and 2.73. In 2023/2024 season, the highest infected genotypes were Giza-40 (3.40) and Giza-716 (3.28). Eighty-five days after planting in 2022/2023 season, the highest infected genotypes were Giza-40 (4.84) and L-4 (3.62). The remaining genotypes proved to be less infected, ranging between 2.84 and 3.40. In 2023/2024 season, the highest infected genotypes were Giza-40 (5.28), L-3 (4.51) and L-4 (4.51). Thus, Giza-40 exhibited sensitivity to chocolate spot disease, but Sakha-1 and Sakha-4 showed resistance, which is similar to results of Mohamed and El-Bakery (2020), and Mostafa *et al*. (2021).

Table (2): Reaction of studied faba bean genotypes to infection with chocolate spot at 65 and 85 days after planting in 2022/2023 and 2023/2024 seasons.

Genotype	2022/2023		2023/2024	
	65 days	85 days	65 days	85 days
Giza-40	3.17	4.84	3.40	5.28
Giza-716	3.06	3.40	3.28	4.40
Sakha-1	2.73	2.84	2.73	4.06
Sakha-4	2.51	3.40	2.51	3.62
L-1	2.62	3.17	2.73	3.40
L-2	2.62	3.40	2.51	4.40
L-3	2.73	3.28	2.84	4.51
L-4	2.84	3.62	2.73	4.51
LSD 5%	0.50	0.64	0.58	1.13

3.1.2 Rust disease

The genotypes of faba beans showed significant differences in rust disease infection at 65 and 85 days after planting (Table 3). Sixty-five days after planting in 2022/2023 season, the highest infected genotypes were Giza-40 (3.06), Giza-716 (2.51). The remaining genotypes proved to be less infected, ranging between 2.06 and 2.20. Eighty-five days after planting in 2022/2023 season, the highest infected genotypes were Giza-40 (4.95), Sakha-1 (3.51), and L-3 (3.51). The remaining genotypes proved to be less infected, ranging between 3.06 and 3.28. In 2023/2024 season, the highest infected genotypes were Giza-40 (6.62) and L-3 (4.40).

Table (3): Reaction of studied faba bean genotypes to infection with rust at 65 and 85days after planting.

Genotype	2022/2023		2023/2024	
	65 days	85 days	65 days	85 days
Giza-40	3.06	4.95	2.95	6.62
Giza-716	2.51	3.06	3.40	4.28
Sakha-1	2.17	3.51	2.62	4.06
Sakha-4	2.06	3.28	2.06	3.73
L-1	2.06	3.28	2.40	3.84
L-2	2.17	3.28	2.40	4.21
L-3	2.06	3.51	2.40	4.40
L-4	2.20	3.06	2.40	4.28
LSD 5%	0.36	0.68	0.23	1.01

3.2 Seed yield and yield components

Significant differences in yield and yield components were found among genotypes (Tables 4 and 5). In 2022/2023 season, the tallest plants were those of L-2, Giza-40, L-1, and L-3 with 124.84, 121.51, 118.51, and 118.51 cm, respectively (Table 4). The shortest plants were those of Sakha-4 (107.06 cm) and Giza-716 (117.06 cm). In 2023/2024 season, Table 5 shows that the tallest plants were those of L-2 (119.84 cm) and Giza-40 (110.95 cm), while the shortest plants were those of Sakha-1 (100.95 cm) and L-1 (103.17 cm). The highest numbers of branches per plant were those of Sakha-4 (3.84 and 4.17) and Sakha-1 (3.69 and 3.95) in 2022/2023 and 2023/2024 seasons, respectively. The lowest number of branches per plant was those of Giza-40 (3.29 and 3.41) in 2022/2023 and 2023/2024 seasons, respectively.

Table (4): Yield and yield components of studied faba bean genotypes under natural foliar diseases infection in 2022/2023 season.

Genotype	Plant height (cm)	Branches (No./plant)	Pods (No./plant)	Seed yield (g/plant)	Seed yield (t/ha)
Giza-40	121.51	3.29	11.82	29.29	3.31
Giza-716	117.06	3.56	15.16	36.63	4.71
Sakha-1	114.84	3.69	17.47	39.51	5.23
Sakha-4	107.06	3.84	17.10	40.89	5.25
L-1	118.51	3.42	17.00	38.89	4.99
L-2	124.84	3.52	16.62	39.00	4.98
L-3	118.51	3.62	15.15	35.13	4.47
L-4	117.40	3.62	15.44	35.68	4.58
LSD 5%	8.32	Ns	1.12	4.02	0.30

The highest numbers of pods per plant were those of Sakha-1 (17.47 and 17.15) and Sakha-4 (17.10 and 19.68) in 2022/2023 and 2023/2024 seasons, respectively. The lowest number of pods per plant was those of Giza-40 (11.82 and 12.65) in 2022/2023 and 2023/2024 seasons, respectively. Regarding seed yield per plant, Sakha-4, Sakha-1, L-2 and L-1 had higher values (40.89, 39.51, 39.00 and 38.89 g, respectively) in 2022/2023 season; meanwhile Sakha-4 had higher value

(44.11, g) in the 2023/2024 season. Regarding seed yield per hectare, Sakha-4, Sakha-1, L1 and L-2 had higher values (5.25, 5.23, 4.99 and 4.98 t, respectively) in 2022 /2023 season; meanwhile Sakha-4 had higher value (5.00 t) in the 2023/2024 season.

Table (5): Yield and yield components of studied faba bean genotypes under natural foliar diseases infection in 2023/2024 season.

Genotype	Plant height (cm)	Branches (No./plant)	Pods (No./plant)	Seed yield (g/plant)	Seed yield (t/ha)
Giza-40	110.95	3.41	12.65	27.35	3.39
Giza-716	106.51	3.73	16.83	37.72	4.98
Sakha-1	100.95	3.95	17.15	36.73	4.87
Sakha-4	106.62	4.17	19.68	44.11	5.00
L-1	103.17	3.84	17.11	36.67	4.97
L-2	119.84	3.84	16.64	37.00	4.98
L-3	105.73	3.95	18.28	39.27	4.96
L-4	115.95	3.73	15.51	34.00	4.25
LSD 5%	6.34	Ns	0.22	1.26	0.17

These outcomes were ascribed to Sakha-1, Sakha-4, L-1 and L-2 resilience to foliar diseases (Tables 4 and 5), which allowed both genotypes to sustain high levels of yield throughout the year. Furthermore, Sakha-4 and Sakha-1 performance better due to their genetic traits, underscoring its potential for higher productivity in the production of faba beans. L-1 and L-2, on the other hand, showed encouraging yield productivity. Consequently, they show potential in foliar disease breeding programs, allowing a choice f0r whom looking for increasing crop productivity. These results may be explained by the fact that Sakha-4 has greater amounts of photosynthetic pigments than other cultivars. According to these findings, Sakha-4, Sakha-1, L-1 and L-2 were the best performers in terms of seed yield, continuously exhibiting more output than the other genotypes in both seasons. Tarek *et al.* (2020) found that Sakha-4 yielded about 15 – 24 % over Sakha-1 and Sakha-3. Additionally, G-6 had higher seed yield and yield components, according to Ghannam *et al*. (2024). Likewise, notable variations in plant attributes were noted by Abou-El-Seba *et al*. (2016). Plant height, pod number per plant, seed yield per plant, and seed output per hectare all improved in faba bean genotypes, L-1, L-2, L-3, and L-4 due to their resistance to foliar diseases compared to Giza-40 (Tables 4 and 5). These traits also improved the overall growth, vigor, and performance of the plant throughout the season by favorably influencing the accumulation of dry matter throughout growth and development. On the other hand, vulnerability of Giza-40 to foliar diseases had a major effect on the components of yield and seed production. According to Mohamed and El-Bakery (2020), the decreased yield was ascribed to susceptibility of Giza-40 to the disease.

3.3 Quality of faba bean seeds

In 2022/2023 season (Table 6), Sakha-1,

Sakha-4, Giza-716, and L-2 had higher seed protein content (24.45%, 23.52%, 23.68%, and 23.89%, respectively) compared to the remaining genotypes. Conversely, in 2023/2024 season, Sakha-1, Sakha-4, L-2, and L-3 had higher seed protein content (24.00, 23.69, 23.92, and 23.50%, respectively) than the other genotypes. In all seasons, Sakha-1, Sakha-4, and L-2 consistently displayed higher seed protein content, suggesting that they may need further breeding initiatives to enhance seed quality. In comparison to the other genotypes, Sakha-1 and L-2 showed greater seed carbohydrates 57.64− 54.61%. Likewise, in the second season, the percentage of seed carbohydrates was greater in Sakha-1, Sakha-4, Giza-716, L-1, and L-2 than in the others (54.78, 54.36, 53.60, 53.70, and 53.66%, respectively). For those looking for high carbohydrates, Sakha-1 and L-2 are potential options. When choosing the best genotypes for their particular requirements, these variations in seed quality should be considered. According to Attia*et al*. (2009), Sakha-1 produced higher-quality seed than Masr-3. In another study, Qabil *et al*. (2018) showed that Nubaria-1 was the most productive faba bean cultivar, but Sakha-4 had the highest protein and carbohydrate contents.

Table (6): Seed protein and carbohydrate contents of faba bean genotypes in 2022/2023 and 2023/2024 seasons.

Genotype	2022/2023 season		2023/2024 season	
	Seed protein content (%)	Seed carbohydrates content (%)	Seed protein content (%)	Seed carbohydrates content (%)
Giza-40	22.84	52.99	22.38	52.86
Giza-716	23.68	53.96	23.23	53.60
Sakha-1	24.45	57.64	24.00	54.78
Sakha-4	23.52	53.51	23.69	54.36
L-1	23.13	53.54	22.01	53.70
L-2	23.89	54.61	23.92	53.66
L-3	23.00	53.84	23.50	53.23
L-4	22.84	53.90	22.31	52.58
LSD 5%	1.03	0.87	0.81	0.78

4. Conclusion

This study identified faba bean genotypes Shakh-1, Shakh-4, L-1, and L-2 as the most productive, a result directly linked to their heightened resistance to foliar diseases. The specific resistance of L-1 and L-2 to major pathogens causing chocolate spot and rust highlights their significant potential as valuable genetic resources. Consequently, their integration into future breeding programs is strongly recommended to advance the development of high-yielding, disease-resistant faba bean cultivars.

References

A.O.A.C. (2000), *Official Methods of Analysis*, 17th Edition, The Association of Official Analytical Chemists, Gaithersburg, MD, USA.

Abou-El-Seba, S. E. A., Abou-Salama, A. M., El-Nagar, G. R. and El-Mohsen, M. A. (2016), "Physiological responses

for growth and yield of some faba bean varieties under different plant densities", *Assiut Journal of Agricultural Sciences*, Vol. 47 No. 6-1, pp. 18 – 33.

Ahmed, G. A. (2015), "Efficiency of some bio-inducers in induction of faba bean resistance to chocolate spot disease", *International Journal of Scientific & Engineering Research*, Vol. 6 No. 11, pp. 601–611.

Anonymous (2023), *Bulletin of Agricultural Statistics, Part (1), Winter Crops, 2022/2023*, Economic Affairs Sector, Ministry of Agriculture and Land Reclamation, Egypt.

Attia, A., Seadh, S., El-Emery, M. and El-Khairy, R. (2009), "Effect of planting dates and seed size on productivity and quality of some faba bean cultivars", *Journal of Plant Production*, Vol. 34 No. 12, pp. 11311–11325.

Bernier, C. C., Hanounik, S. B., Hussein, M. M. and Mohamed, H. A. (1993), *Field Manual of Common Faba Bean Diseases in the Nile Valley*, International Center for Agricultural Research in the Dry Areas (ICARDA), Allepo, USA.

DuBois, M., Gilles, K. A., Hamilton, J. K., Rebers, P. A. and Smith, F. (1956), "Colorimetric method for determination of sugars and related substances", *Analytical Chemistry*, Vol. 28, pp. 350–356.

Elsheikh, E. A. E., ElTinay, A. H. and Fadul, I. A. (1999), "Effect of nutritional status of faba bean on proximate composition, anti-nutritional factors and *in vitro* protein digestibility (IVPD)", *Food Chemistry*, Vol. 67, pp. 379 – 383.

Freed, R. D. (1991), *MSTATC Microcomputer Statistical Program*, Michigan State University East Lansing, USA.

Ghannam, H. A., Soliman, A. A., Mousa, M. I., Ibrahim, R. A. and El-Marsafawy, T. S. (2024), "Performance of some faba bean genotypes (*Vicia faba* L.) and its stability using GGE-biplot analysis", *Scientific Journal of Agricultural Sciences*, Vol. 6 No. 1, pp. 109–120.

Gomez, K. A. and Gomez, A. A. (1984), *Statistical Procedures for Agricultural Research*, John Willey and Sons, USA.

Harrison, G. (2007), "The biology of *Botrytis spp*. on *Vicia* beans and chocolate spot disease - A review", *Plant Pathology*, Vol. 37 No. 2, pp. 168–201.

Mohamed, M. Kh. A. and El-Bakery, A. (2020), "Evaluation of some faba bean genotypes under natural infection with chocolate spot and rust diseases", *Acta Scientific Agriculture*, Vol. 4, pp. 37–51.

Morsy, K. M. M. (2012), "Induced resistance in faba bean plants for controlling rust disease *Uromyces viciae-fabae* (Pers.) Schrot",

Egyptian Journal of Phytopathology, Vol. 40 No. 1, pp. 1–11.

Mostafa, S. M., Zaid, G. G. A. A. and Mohamed, A. M. (2021), "Effect of sowing date on chocolate spot and rust foliar diseases reaction, yield components and seed quality in faba bean (*Vicia faba*)", *Menoufia Journal of Plant Production*, Vol. 6, pp. 83–100.

Qabil, N., Helal, A. A. and Abd El-Khalek, R. Y. S. (2018), "Evaluation of some new and old faba bean cultivars (*Vicia faba* L.) for earliness, yield, yield attributes, and quality characters", *Zagazig Journal of Agricultural Research*, Vol. 45 No. 3, pp. 821–833.

Sadasivam, S. and Manickam, A. (1997), *Biochemical Methods*, 2nd Edition, New Age International (P) Ltd., Delhi, India, pp. 5–207.

Sherif, A. E. A., ElKhalawy, S. M. A. and Hegab, E. A. (2017), "Impact of nitrogen and cobalt rates on faba bean crop grown on clayey soil", *Journal of Soil Sciences and Agricultural Engineering*, Vol. 8 No. 9, pp. 459–465.

Soliman, A. A., Mousa, M. I., Mosalam, A. M., Ghareeb, Z. E., Ibrahim, S. D., Rehan, M., Yu, H. and He, Y. (2023), "The potential genetic effect for yield and foliar disease resistance in faba bean (*Vicia faba* L.) assessed via morphological and SCot markers", *Plants*, Vol. 12 No. 20, Article No. 3645.

Tantawy, A. A., Abdullah, S. Sh., Hefny, Y. A. M. and Ridwan A. R. M. (2022), "Performance of some faba bean genotypes for tolerance to the infestation of broomrape (*Orobanche crenata*) weed", *Journal of Sohag Agriscience*, Vol. 7 No. 2, pp. 138–153.

Tarek, S. M., Mohamed, M. Kh. A. and Abdel-Rahman, R. A. (2020), "Evaluation of some faba bean genotypes under three planting dates in Middel Egypt", *Alexandria Journal of Agricultural Sciences*, Vol. 65 No. 3, pp. 201–209.

Waly, F. E., Rashwa,n E. A., Abdel-Whab, G. M., Khafagy, I. F. and Arafa, H. M. (2019), "Evaluation of some faba bean cultivars yield under chemical control to common insect pests and fungal diseases under El-Beheira governorate environmental conditions", *Journal of Plant Production, Mansoura University*, Vol. 10 No. 2, pp. 107–116.