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Impact of the 2020 Mediterranean Storm 'Dragon Storm' on Chocolate Spot Disease, Growth, and Yield of Faba Bean in Egypt

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ABSTRACT

To study the Impact of the 2020 Mediterranean Storm 'Dragon Storm' on chocolate spot disease, growth, and yield of faba bean in Egypt, field experiment using faba bean cultivars namely Giza 843, Sakha 1 and Giza 40 was carried out during seasons 2019/2020 and 2020/2021 at Etay El-Baroud Agricultural Research Station Farm, El-Beheira Governorate. In the first season, the rain ranged between 1/3/2020 - 11/3/2020 from 0.00 to 0.38 mm day^{-1} but suddenly on 12/3/2020 heavy rain (26.3 mm day^{-1}), thunderstorms and floods were happened. Also the relative humidity recorded 82.08, 79.43 and 69.10% on 12/3, 13/3 and 14/3/2020. At the same time the maximum temperature decreased on 12/3 and 13/3/2020 to 20.16 and 21.80°C, respectively compared with 25.52°C on 11/3. After 5 days from the beginning the storm, the disease severity increased sharply but Giza 843 had the least value followed by Sakha 1 then Giza 40 with averages of 23.70, 28.89 and 43.70%, respectively and increased with increasing the periods. In contrast in the second season, the disease severity showed normal averages being 8.15, 8.12 and 10.62% with the previous cultivars, respectively. Using quadratic correlation, there were positive strong correlations between disease severity and rain (mm) and the relative humidity%. Giza 40 was the earliest in the flowering and maturing dates significantly followed by another two cultivars (Sakha 1 and Giza 40). Giza 843 cv. had the best value of plant height with an average of 94.33 cm and exceeded Sakha 1 and Giza 40 significantly in the number of branches/plant, number of pods/plant, seed yield/plant (g), seed yield/plot (Kg) and seed yield/feddan (ardab) with averages of 3.68, 17.97, 32.11, 4.26 and 16.55, respectively.

INTRODUCTION

Faba bean (*Vicia faba* L.) is considered to be one of the major leguminous crops all over the world due to its high nutritional value, carbohydrate-rich fraction for biofuel production, rich in microelements (Iron and Zinc), and protein content which make it suitable for human diet and animal feed (Atnafu and Keskse, 2020, Pszczółkowska *et al.*, 2020, and Maalouf *et al.*, 2021). Also, it fixes atmospheric nitrogen which reduces the contribution of fertilizers and as green manure (Ali *et al*., 2014 and Paul and Gupta, 2021). In addition, faba bean is used as a source of cash crop to farmers (Merga *et al*., 2019).

Due to several biotic and abiotic factors, faba bean productivity can be reduced and plants are often challenged by them which acting in combination (Chojak-Kózniewska *et al*., 2018). Chocolate spot and rust diseases consider the most important biotic factors reduced faba bean yield in the Mediterranean region (Hanounik and Bisri, 1991, Ahmed *et al*., 2010 and Pszczółkowska *et al*., 2020).

Kole *et al.* (2015) reported that climatic changes effect on agricultural productivity because of the instabilities in temperature, rain and other climatic factors. Plant breeders are requisite to increase efforts to improve different germplasm lines that can endure to climatic abnormalities (Bahl, 2015). Pszczółkowska *et al.* (2020) reported that temperature and rain effect on the improvement and yield of *Vicia faba* growth stages. Establishment of pathogens like the fungal diseases severity depend on numerous biotic and abiotic elements such as agricultural practices, cultivars, environmental conditions and seed health (El-Ammari, 2017, Podleśny *et al*., 2017 and Deneke, 2018). Also, Zayan (2019) and Burdon and Zhan (2020) reported that climate change influences the occurrence and severity of plant diseases. Wind and rain splash spread conidia over a very short distance in the absence of wind (Sache, 2000) to near plants and fields but when carried in moderate winds, can travel for a long distance (Fitt *et al*., 1989 and Nagarajan and Singh1990) where they repeat new infections and the wetness of the plant surface necessary for spore germination and infection (Alberta Pulse Growers, 2020). Plant immune responses can directly affect by climate change (Cheng *et al*., 2019, Saijo and Loo, 2020 and Castroverde and Dina, 2021) facilitate the appearance of new pathogen strains, which consecutively can collapse host-plant resistance

(Velasquez *et al*., 2018, and Cohen and Leach, 2020) and increase the spread of plant disease into new areas (Chaloner *et al*., 2021 and Singh *et al*., 2023). It indirectly influences plant–pathogen interactions by changing the biological processes of the plant host and/or pathogen (Desaint *et al*., 2021 and Trivedi *et al*., 2022). An unusually Mediterranean Storm 'Dragon Storm' that formed rapidly over Egypt on Thursday, 12 March, 2020 and the following days, bringing heavy rain, thunderstorms and floods to northern Egypt, Jordan, Syria, Lebanon, Palestine, Saudi Arabia and Iraq (NASA, 2020) caused damages on some buildings and farms. Therefore, this work aimed to evaluate the response of some faba bean cultivars pathologically and agronomically to the Mediterranean Storm "Dragon Storm" happened over Egypt on the 2019-2020 growing season.

MATERIAL AND METHODS

The present study was conducted at the experimental farm of Etay El-Baroud Agricultural Research Station, El-Beheira Governorate (Latitude: 30.89, Longitude: 30.63 and Attitude: 18) during the two successive seasons of 2019/2020 and 2020/2021 (Fig.1).

Field Experiment:

The field experiments were carried out in randomized complete block design (RCBD) with three replications where the three faba beans cultivars, Giza 843 and Sakha 1 (resistant) (Mohamed and El-Bakery, 2020 and Heiba *et al*., 2022**)** and Giza 40 (susceptible) (El-Komy, 2014) were used for this investigation. Each plot consisted of 5 ridges, 3 m long and 0.70 m apart. Seeds were planted in two sides of the ridge at 15 cm between hills with one seed per each. Seeds were sown in 15th and 16th of November 2019 and 2020, respectively.

Determination of chocolate spot disease severity under field conditions:

Chocolate spot disease severity was determined from 5th March to 9th April and every 12 days. Twenty randomly plants from each replicate were chosen and numbers of the necrotic lesions and the size of blighted area per leaf were calculated according to the scale 1-9 mentioned by Hanounik and Rebertson (1988)**.** Disease severity (DS) percentage was calculated according the equation:

DS (%) = [∑(n X v) /9N] X 100

n= Number of plants in every grade, v = Numerical grade, N= Total number of examined plants, 9 = Maximum disease grade.

Character Measurements:

1- Growth characters:

Days to 50% flowering and 90% to physiological maturity were recorded. Also, at harvesting time (after 155 days from sowing), ten plants from each replicate were randomized taken to measure plant height (cm), and number of branches/plant.

2 - Yield and its attributes:

Also, number of pods/plant, 100-seed weight (g), and seed weight/plant were estimated (g). Seeds in each plot were harvested and weighed then converted to seed yield (kg/plot) and seed yield/feddan (ardab).

Climate data of Etay El-Baroud, El-Beheira Governorate, Egypt:

These data were obtained from Central Laboratory for Agricultural Climate (CLAC) as: Rain: Precipitation (mm day $^{-1}$), Wind: Wind Speed (m/s) at 2 meters, RH: Relative Humidity % at 2 meters,Tdew: Dew/Frost Point (C°) at 2 meters, Tmax: Maximum Temperature (C°) at 2 meters, Tmin: Minimum Temperature (C°) at 2 meters, Srad, Solar Radiation (MJ/m^2/day), Tmean: Temperature Average (C°) at 2 meters.

Fig. 1: Location of Etay El-Baroud Agricultural Research Station, El-Beheira Governorate.

The daily climate parameters were recorded by automated agro-metrology station model (iMetos 2, made in Austria, EU) in El- Beheira Governorate, Etay El-Baroud experimental field sites (Latitude: 30.89, Longitude: 30.63, Altitude: 18). The early stages of the strong cyclonic abnormal phenomenon "Dragon storm" were published in satellite images by Korosec **(**2020) (Fig.2).

Statistical Analysis:

All data were statistical analyzed according to Gomez and Gomez (1984). Treatments were compared by L.S.D at 5% level of probability.

RESULTS

Agro-Meteorological data:

The climatic data were obtained from the Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center (ARC) and shown in Tables, 1, 2 and 3. The daily weather parameters were measured and recorded as means of the maximum, minimum and average temperature (°C), Dew Point (°C), relative humidity (%), rain (mm/day), wind (m/s), solar radiation (MJ/m^2/day), during the two consecutive season were recorded.

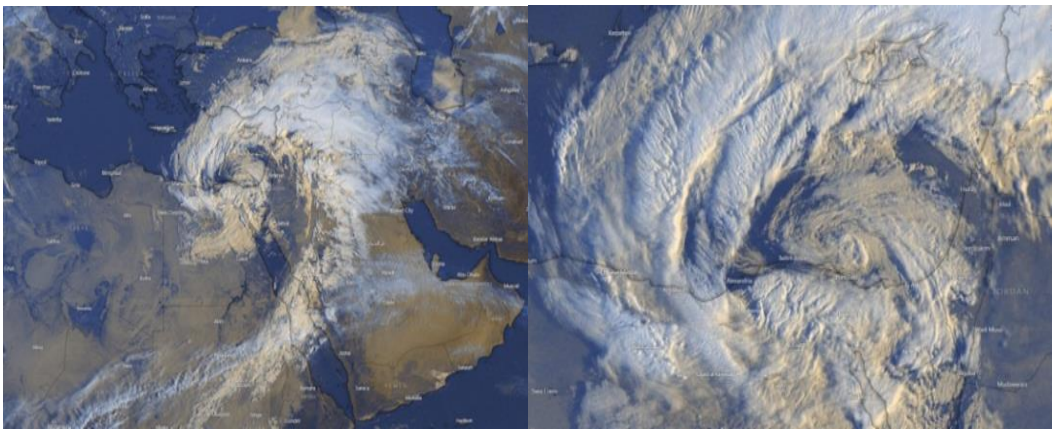
Metrological analysis:

Data presented in Tables 1 and 2 clear climate data of Etay El-Baroud, El- Beheira Governorate, Egypt at March 2020 and 2021, respectively. It can be noticed from Table (1) that data of the rain (mm day^{-1}), relative humidity (%), T-max (C°) and Srad (MJ/m^2) ranged between 0.00 - 0.38, 33.50 - 61.51, 21.81 - 28.30, and 17.67 - 20.63 from 1/3/2020 to 11/3/2020 but suddenly on 12/3 and 13/3/2020 heavy rain (26.3 and 8.93 mm day $^{-1}$), thunderstorms and floods were happened. Also the relative humidity increased to 82.08, 79.43 and 69.10 on 12/3, 13/3 and 14/3/2020, respectively. At the same time the maximum temperature in addition to solar radiation decreased (20.16, 21.81C° and 14.38 and 14.14.20 MJ/m^2/day, respectively). In contrast in the next season, data in Table (2) cleared that the values of the same parameters mentioned above were 0.0 - 3.8, 50.0 - 76.4, 17.3 - 32.0, and 15.6 - 22.9, respectively but rain (mm day^{-1}) and the relative humidity (%) increased to 26.7 and 74.6, respectively just only on 21/3/2021 and decreased to 0.0 and 63.4, respectively on the next day (22/3/2021).

Data in Table (3) exhibited that from 8/3 to 14/3/2020 the average values of rain (mm day $^{-1}$), RH(%), dew/frost point (°C), maximum and minimum temperatures (°C) increased with averages of 5.18, 64.80, 10.17, 24.99 and 11.49, respectively at the same time solar radiation (MJ/m^2/day) decreased to 18.58 compared to the same period of 2021. In that week the Dragon storm happened exactly at 12/3/2020 as mentioned above and the precipitation (mm day^{-1}) and the relative humidity (%) recorded 26.30 and 82.08, respectively.

Chocolate spot disease severity:

The three tested faba bean cultivars varied in its sensitivity to the infection with *Botrytis fabae* under natural infection (Table 4 and Figure 3). Disease severity was determined at 5/3, 17/3, 29/3 and 9/4. In the first season (2019/2020), the disease severity 5 days before the happening of Dragon storm had normal average values being 6.05, 5.44 and 7.17% for Giza 843, Sakha 1 and Giza 40, respectively. After 5 days from the beginning of the storm the disease severity increased sharply with the three cultivars but Giza 843 had the least value followed by Sakha 1 and Giza 40 with averages of 23.70, 28.89 and 43.70%, respectively.



A **B**

Fig. 2: Satellite images show the Mediterranean Storm "Dragon Storm" responsible for the storms from 12 to 15 March, 2020 (A) and closer view of the cyclone's core (B). Uploaded a work by Korosec (2020) from https://www.severe-weather.eu/recent-events/powerful-frontal-system-hits-egypt-mk/

Table 1: Climate data of Etay El-Baroud, El-Beheira Governorate, Egypt on March, 2020.

Date	Rain (mm day^{-1})	Wind (m/s)	RH (%)	Tdew (C°)	Tmax (C°)	Tmin (C°)	Tmean (C°)	Srad (MJ/m^2/day)
01/03/2020	0.00	2.97	55.69	6.05	21.81	10.30	14.78	18.84
02/03/2020	0.00	1.64	57.77	6.76	22.88	9.85	14.95	19.26
03/03/2020	0.01	2.55	60.45	7.70	24.99	7.01	15.24	19.55
04/03/2020	0.03	1.53	44.57	5.66	28.3	8.99	17.95	19.12
05/03/2020	0.00	2.88	33.50	2.12	27.41	10.94	18.62	19.30
06/03/2020	0.37	3.23	59.29	8.30	21.90	11.97	16.18	17.67
07/03/2020	0.00	1.48	55.59	7.91	25.46	10.39	16.79	19.85
08/03/2020	0.10	3.15	56.75	8.78	27.51	9.29	17.39	20.42
09/03/2020	0.08	3.87	47.36	7.32	31.03	11.11	18.76	20.58
10/03/2020	0.01	2.01	57.40	7.45	23.76	9.77	15.79	20.63
11/03/2020	0.38	3.94	61.51	9.25	25.52	10.32	16.59	19.40
12/03/2020	26.30	2.73	82.08	12.94	20.16	13.80	15.97	14.38
13/03/2020	8.93	4.33	79.43	12.81	21.80	12.14	16.34	14.20
14/03/2020	0.46	2.59	69.10	12.64	25.17	14.02	18.32	20.43
15/03/2020	0.01	1.55	54.45	9.43	27.45	10.32	18.75	21.20
16/03/2020	0.00	1.97	51.45	8.92	27.66	12.87	19.13	21.17
17/03/2020	0.31	5.05	60.87	7.59	20.03	11.62	15.01	14.85
18/03/2020	0.00	3.94	53.41	5.42	21.33	8.89	14.77	18.63
19/03/2020	0.00	4.35	56.20	5.02	19.52	9.44	13.54	20.85
20/03/2020	0.41	4.34	58.19	5.14	18.33	9.09	13.12	16.18
21/03/2020	0.01	2.51	56.74	4.93	19.69	8.89	13.29	21.50
22/03/2020	0.18	1.55	49.08	4.11	22.95	5.93	14.70	22.45
23/03/2020	0.00	3.14	41.01	5.10	29.23	10.80	18.69	21.88
24/03/2020	0.01	2.54	59.52	9.40	26.06	10.67	17.28	22.35
25/03/2020	0.07	2.01	65.59	10.12	23.91	9.84	16.50	21.71
26/03/2020	0.11	3.30	51.53	8.75	28.10	11.61	18.93	16.82
27/03/2020	0.06	3.34	59.30	11.02	27.28	11.83	19.06	22.71
28/03/2020	0.02	3.21	56.40	8.16	24.55	11.41	16.83	23.47
29/03/2020	0.00	3.02	40.00	4.15	27.85	9.23	18.04	23.34
30/03/2020	0.00	2.93	32.24	3.16	29.39	11.64	20.42	19.41
31/03/2020	0.03	5.07	40.64	6.55	27.40	14.30	20.44	23.51

Also it can be noticed that the disease severity increased with increasing periods up to 9/4/2020 with averages of 66.67, 69.63 and 77.11% for Giza 843, Sakha 1 and Giza 40, respectively. Generally the disease severity increased sharply from 6.22% on 5/3/2020 to 71.24% on 9/4/2020. In contrast, in the second season (2020/2021), the disease severity showed normal averages as 8.15, 8.12 and 10.62 with cvs. Giza 843, Sakha 1 and Giza 40, respectively and generally the disease severity increased from 5.14 to 11.17% between 5/3 and 9/4/2021. The results showed that in the second season (2020/2021) faba bean cv. Sakha1 had the least disease severity followed by Giza 843 and Giza 40 with averages of 8.12, 8.15 and 10.09%, respectively.

Correlation between chocolate spot disease severity% and rain (mm) and relative humidity (Rh%):

Data illustrated in Fig.4 show quadratic liner regression between chocolate spot disease severity % and each of accumulated rain (mm) and relative humidity (Rh%) during the two seasons;2019/2020 and 2020/2021. In the first season it is evident that significant positive correlation was found between disease severity %, rain and relative humidity (Rh%) with correlation coefficient of r = 0.79* and 0.71*, respectively. Also in the second season the association between disease severity%, accumulated rain and relative humidity (Rh%) were positive and significant with strong correlation coefficient of r = 0.99** and 0.97**, respectively.

Flowering and maturity date:

Data presented in Table (5) appear that Giza 40 was the earliest in the flowering date than Giza 843 and Sakha 1 with averages of 44.83, 49.83 and 51.17 days, respectively. The differences between this trait in seasons 2019/2020 and 2020/2021 were not significant. With regard to the interaction effect, Giza 40 x 1st season, Giza 40 x 2nd season and Giza 843 x 2nd season cleared the earliest flowering dates with averages of 44.67, 45.00 and 49.33 days,

respectively. In respect of maturity date, also Giza 40 was the earliest mature followed by Sakha 1 and Giza 843 with averages of 147.00, 148.67 and 152.00 days, respectively. The statistical analysis between them was significant. At the same time, the differences between the two seasons were not significant. With respect of the interaction, Giza 40 x 1st season had the earliest mature date followed by Giza 40 x 2nd season and Sakha 1 x 1st season with averages of 147.00, 148.00 and 148.67 but the differences were not significant.

Table 2. Climate data of Etay El-Baroud, El- Beheira Governorate, Egypt on March, 2021.

Date	Rain (mm day^{-1})	Wind (m/s)	RH (%)	Tdew (C°)	Tmax (C°)	Tmin (C°)	Tmean (C°)	Srad (MJ/m^2/day)
01/03/2021	0.0	3.0	67.4	8.8	21.6	10.5	15.3	19.6
02/03/2021	0. 1	3.6	64.4	7.0	20.1	9.3	14.1	19.0
03/03/2021	2.8	3.9	64.6	6.5	17.3	10.7	13.2	15.6
04/03/2021	0.4	3.3	67.7	8.1	20.3	10.4	14.6	18.9
05/03/2021	0.0	2.0	71.4	8.3	22.6	8.6	14.5	22.4
06/03/20211	0.2	2.0	71.7	8.3	23.2	7.6	14.4	22.9
07/03/2021	0.2	2.3	70.6	8.2	23.2	8.8	14.8	22.1
08/03/2021	0.8	1.8	70.1	9.0	24.0	10.3	15.8	22.4
09/03/2021	0.6	2.8	62.2	7.5	27.7	8.5	17.1	20.3
10/03/2021	2.5	3.9	50.0	5.8	32.0	12.8	20.0	21.9
11/03/2021	3.8	3.9	76.4	12.8	24.3	14.3	17.6	19.4
12/03/2021	0.0	4.9	59.1	6.8	20.8	11.0	15.3	21.6
13/03/2021	0.0	2.4	65.8	7.4	21.1	10.2	14.3	22.0
14/03/2021	0.0	2.2	68.4	9.1	23.6	10.2	15.7	16.4
15/03/2021	0.0	2.1	73.4	10.8	23.2	10.5	16.3	19.7
16/03/2021	0.0	2.6	69.7	9.7	22.4	11.4	15.9	21.9
17/03/2021	0.7	3.4	64.7	7.5	22.8	8.5	15.4	24.0
18/03/2021	3.2	2.6	69.2	8.9	22.2	10.7	15.3	21.2
19/03/2021	9.1	1.8	62.5	7.8	23.4	11.1	16.0	22.5
20/03/2021	0.1	2.6	64.0	10.4	27.1	11.4	18.5	22.4
21/03/2021	26.7	2.2	74.6	14.4	26.3	12.8	19.7	12.2
22/03/2021	0.0	2.2	63.4	14.1	27.7	17.9	21.7	13.5
23/03/2021	0.0	4,4	64.9	11.7	23.1	12.6	18.8	15.5
24/03/2021	1.2	5.0	68.9	8.3	18.6	11.0	14.3	20.8
25/03/2021	2.4	3.0	73.5	8.5	17.1	10.6	13.4	22.6
26/03/2021	0.6	3.6	66.4	6.0	17.3	8.4	12.5	19.2
27/03/2021	2.1	3.4	60.8	5.3	19.0	7.3	13.2	21.4
28/03/2021	6.2	2.9	66.6	7.9	19.1	11.7	14.5	17.4
29/03/2021	2.5	3.0	66.4	7.6	20.0	10.5	14.3	20.3
30/03/2021	6.1	3.1	69.4	9.0	21.5	11.3	15.4	22.8
31/03/2021	18.4	2.9	72.3	8.2	18.8	9.5	13.6	18.8

Table 3: The averages of the climate data recorded weekly for March of Etay El- Baroud, El- Beheira Governorate in 2019/2020 and 2020/2021 seasons.

Parameter	Rain	RH	T/dew	T-max	T-min	Srad
Season / Date			2019/2020			
1/3 – 7/3/2020	0.06	52.41	6.34	24.69	9.92	19.08
8/3 – 14/3/2020	5.18	64.80	10.17	24.99	11.49	18.58
15/3 – 21/3/2020	0.11	55.90	6.64	22.00	10.16	19.20
22/3 – 28/3/2020	0.06	54.63	8.09	26.01	10.30	21.63
Season / Date			2020/2021			
1/3 – 7/3/2021	0.52	58.07	7.89	21.19	9.41	20.07
8/3 – 14/3/2021	1.10	64.57	8.34	24.79	11.04	20.57
15/3 – 21/3/2021	5.69	68.30	9.93	23.91	10.91	20.56
22/3 – 28/3/2021	1.79	66.36	8.83	20.27	11.36	18.63

Table 4: Effect of the Mediterranean storm "Dragon Storm" on chocolate spot disease severity % on faba bean cvs. Giza 843, Sakha 1 and Giza 40 during two successive seasons; 2019/2020 and 2020/2021.

Parameter / Factor		Chocolate spot disease severity % 2019/2020	2020/2021
Cultivar (C)			
Giza 843		36.98	8.15
Sakha 1		39.04	8.12
Giza 40		47.07	10.62
Date (D)			
5/3		6.22	5.14
17/3		32.10	7.96
29/3		54.57	9.88
9/4		71.24	11.17
Interaction (C x D)			
Giza 843	5/3	6.05	6.03
	17/3	23.70	6.91
	29/3	51.48	9.14
	9/4	66.67	10.25
Sakha 1	5/3	5.44	5.93
	17/3	28.89	7.41
	29/3	52.22	9.13
	9/4	69.63	10.00
Giza 40	5/3	7.16	6.18
	17/3	43.70	9.57
	29/3	60.00	11.36
	9/4	77.11	13.27
L.S.D 0.05	C	1.93	0.63
	D	2.23	0.72
	C xD	3.93	1.252

Growth characters and seed yield:

Giza 843 had the tallest plants with an average of 94.33 cm and exceeded the another cultivars (Sakha 1 and Giza 40) in the number of branches/plant, number of pods/plant, seed yield/plant (g), seed yield/plot and seed yield/feddan (ardab) with averages of 3.68, 17.97, 32.11, 4.26 and 16.55, respectively (Table 6). The differences between the previous parameters were significant. The differences between the results of the two seasons were not significant except seed yield /plant (g), it may be due to the late increasing of the disease severity which happened (17/3/2020) after the pods setting and during maturity. With regard to the interaction, the differences between number of pods/plant, seed yield/plot and seed yield/feddan (ardab) were significant.

DISCUSSION

The Global Precipitation Measurement (GPM) detected the early stages of a strong cyclonic system that established over northern Africa on 12 March 2020 and the following days, causing heavy rain, thunderstorms, floods, and sandstorms, to northern Egypt, Jordan, Israel, Syria, Lebanon, State of Palestine and Iraq. In this respect, Zayan (2019), and Burdon and Zhan **(**2020**)** mentioned that climate changes effect on the severity of crop diseases. Papstylianou *et al.* **(**2021) mentioned that the yield stability of faba bean under various environmental conditions is an important parameter for a maintainable farming system, especially at the present time with the great variations of climatic factors from year to another. In the first season (2019/2020) data obtained after 5 days from the beginning of the Dragon storm where there were two days with a lot of rainfall, cleared sharply increase of the disease severity with the three cultivars but Giza 843 had the least value followed by Sakha 1 and Giza 40 with means of 23.70, 28.89 and 43.70%, respectively. This result is in close to that mentioned by Stoddard *et al*. (2010) and Karkanis *et al*. (2018) who reported that with temperatures of 15–22°C and RH >80%, chocolate spot disease cause severely damage on faba bean crops, which necrosis spreads quickly, defoliating and then killing the plant, during 2 days.

Fig. 2: Effect of Dragon storm on the severity of chocolate spot disease on some faba bean cultivars (Giza 843, Sakha 1 and Giza 40), season 2019/2020.

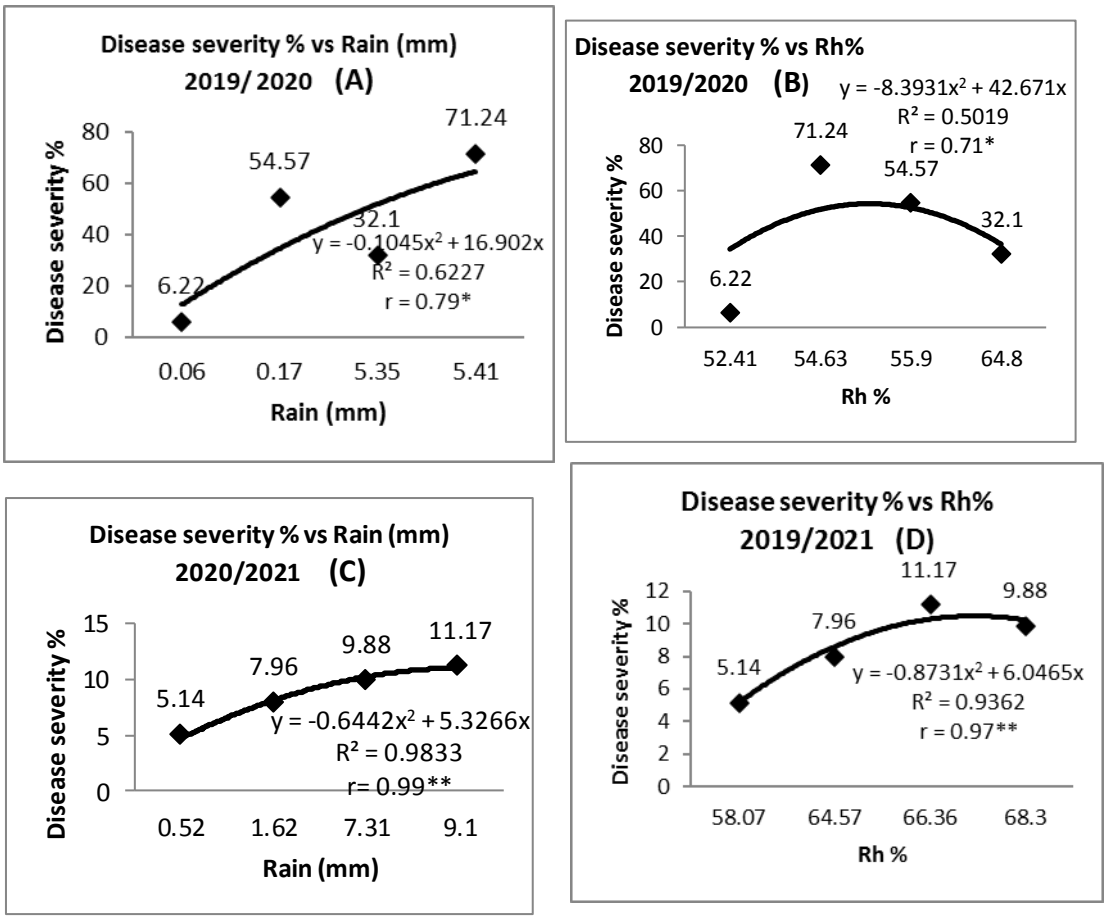


Fig. 4: Quadratic correlation between chocolate spot disease severity %, accumulated rain (mm) and relative humidity (Rh%) during two seasons; 2019/2020 (A and B) and 2020/2021 (C and D), respectively.

Table 5. Effect of the Mediterranean storm "Dragon storm" on days to flowering and maturity of faba bean cvs. Giza 843, Sakha 1 and Giza 40 during the two successive seasons, 2019/2020 and 2020/2021.

Parameter	Days to flowering	Days to maturity
Factor		
Cultivar (C)		
Giza 843	49.83	152.00
Sakha 1	51.17	148.67
Giza 40	44.83	147.00
Season (S)		
2019/2020	48.56	148.89
2020/2021	48.67	149.56
Interaction (C x S)		
Giza 843		
1st season	50.33	152.33
2nd season	49.33	151.67
Sakha 1		
1st season	50.67	148.67
2nd season	51.67	149.00
Giza 40		
1st season	44.67	147.00
2nd season	45.00	148.00

Table 6: Effect of the Mediterranean storm "Dragon storm" on yield and yield components of faba bean cvs, Giza 843, Sakha 1 and Giza 40 during two successive seasons, 2019/2020 and 2020/2021.

Parameter / Factor	Plant height (cm)	No.of branches /plant	No.of pods/ plant	100-seed weight (g)	Seed yield/plant (g)	Seed yield/ plot (kg)	Seed yield/ feddan (Ardab)
Cultivar (C)							
Giza 843	94.33	3.68	17.97	70.83	32.11	4.26	16.55
Sakha 1	89.83	2.97	10.17	73.17	19.27	3.14	12.20
Giza 40	80.96	2.27	9.92	64.24	17.71	2.81	10.91
Season (S)							
1st season	87.12	2.89	12.43	69.30	20.42	3.44	13.36
2nd season	89.63	3.06	12.94	69.54	25.63	3.36	13.08
Interaction	C x S						
Giza 843							
1st season	95.33	3.50	19.13	71.27	28.07	4.60	17.89
2nd season	93.33	3.87	16.80	70.43	36.14	3.91	15.21
Sakha 1							
1st season	88.00	3.00	8.75	73.41	17.00	3.07	11.90
2nd season	91.67	2.93	11.58	72.93	21.53	3.22	12.51
Giza 40							
1st season	78.05	2.16	9.41	63.22	16.20	2.65	10.30
2nd season	83.88	2.38	10.43	65.25	19.23	2.96	11.52
L.S.D 0.05							
C	4.73	0.49	1.70	1.36	3.07	0.35	1.33
S	N.S	N.S	N.S	N.S	2.51	N.S	N.S
C x S	N.S	N.S	2.40	1.92	N.S	0.49	1.87

Also, Pulse Breeding Australia (2013) and Alberta Pulse Growers (2020) mentioned that warm and humid are suitable conditions for spreading chocolate spot infection through four to five days, producing spores on infected tissue, repeating secondary infection and more spread of the disease happen. In this respect, Rosenzweig *et al*. (2000) reported that temperature, rain, RH, dew, solar radiation and wind speed play an important role in increase and survival of crop diseases. So, the influence of weather change on agriculture can be minimized by improving farming practices using varieties suitable to new climatic conditions (Lammerts van Bueren *et al*., 2018).

Exposure to solar radiation, spores creation, survival, spreading, germination, pathogenicity and virulence can be affected. UV radiation is the greatest damaging and mutagenic waveband of the solar spectrum and direct exposure to it for a few hours can destroy spores of most fungal species through altering molecular structures and activating the production of reactive oxygen species (ROS) that cause damage, reduce fungal viability, and incite cell death (Braga *et al*., 2001, Nascimento *et al*., 2010, and Braga *et al*., 2015).

Also, data showed that Giza 843 had the least disease severity value followed by Sakha 1 and Giza 40 with means of 23.70, 28.89 and 43.70%, respectively and this result in agreement with that mentioned by El-Komy (2014) who reported that the development of the chocolate spot disease symptoms increased slowly on resistant cultivar (Nubaria) but happened at a faster level on the susceptible cultivar (Giza 40). In this respect, Mohamed and El-Bakery, (2020) mentioned that faba bean genotypes Giza 843 and Sakha 1 showed high resistance to chocolate spot disease and the opposite was true for Giza 40.

The quadratic liner regression between chocolate spot disease severity % and each of rain (mm) and relative humidity(Rh%) during the two seasons;2019/2020 and 2020/2021 showed significant positive correlations. In the first season it is evident that significant positive correlations were found between disease severity %, rain and relative humidity (Rh%) with correlation coefficient of r = 0.79***** and 0.71*, respectively. Also in the second season the association between disease severity %, rain and relative humidity (Rh%) were positive and significant with strong correlation coefficient of r = 0.99** and 0.97**, respectively. These results are confluent with that mentioned by Dhaliwal *et al*. **(**2018**)** with brown spot severity in rice, Saharan and Saharan **(**2004**)** in alternaria leaf blight of cluster bean, and Pandit **(**2020**)** in anthracnose development of horse gram. Also**,** Stoddard *et al*. **(**2010**)**, Misgana **(**2017**)** and Berhan and Bekel **(**2021) reported that temperature (15-23°C), and RH (≥70%) strongly influenced growth and sporulation of *B. fabae* and infection and increase the chocolate spot disease in faba bean varieties. In this respect, Pszczolkowska *et al*.

(2020) exhibited correlations between weather conditions vs. biotic factors and revealed that the incidence of pathogenic, and toxin-producing fungi was affected by temperature and rain in the faba bean flowering stage and the maximum at the 4–5 leaves unfolded stage and at the end of flowering.

Data revealed that faba bean cv.Giza 40 was the earliest in the flowering and maturing dates significantly followed by another two cultivars (Sakha 1 and Giza 843). Also, Qabil *et al.* (2018) and Tarek *et al.* (2020) exhibited that the tested faba bean cultivars differed significantly in their days to first flower, days to 50% flowering and days to fruiting. The genotype genetic constitution and its reaction to climatic conditions play an important role in the differences among them in most traits and variations among cultivars (Abbas *et al*., 2010, Mohamed, 2012**,** Badr *et al.*, 2013**,** Abido and Seadh, 2014 and Mohamed and El-Bakery**,** 2020)**.**

In case of yield and its attributes, Giza 843 cv. had the tallest plants and exceeded Sakha 1 and Giza 40 significantly in the number of branches/plant, number of pods/plant, seed yield/plant (g), seed yield/plot (Kg) and seed yield/feddan (ardab). These results are in confirm with that mentioned by Abido and Seadh **(**2014**)** and Ibrahim (2016) who exhibited significant differences between the tested faba bean cultivars in vegetative and yield characters through their response to climatic conditions. Similar results were mentioned by Hamza and Khalifa (2017), Hussein *et al*. (2017) and Qabil *et al.*, (2018) who reported that the existence of suitable genetic differences in the used genetic material led to highly significant variations between the tested faba bean cultivars for yield and its characteristics during the tested seasons. Also, it can be noticed that the seed yield for the two seasons were not significant. Alberta Pulse Growers, (2020) interpreted this result by the timing of the infection starts, with early disease development in the season or during flowering, may cause more damage and yield losses and mid- to late-season infections may cause little or no yield loss. Also, Waly *et al.* (2019) mentioned that with low or moderate infection, the resistant genotypes may produce high yield but, the high infection led to decrease the yield in case of both resistant and susceptible genotypes. In this respect, Alharbi and Adhikari, (2020) pointed out that faba bean has a very poor flower: pod ratio, with a maximum 20% of flowers resulting in pods. Climate stresses cause damages to flowers and young pods; therefore, identical phenology of crops to the environment is important for minimizing injurious effects of unfavourable environmental conditions.

CONCLUSION

From this study, it can be concluded that, the Mediterranean storm "Dragon Storm" bringing heavy rain, wind and high of RH% more than 65% are the most suitable factors for increasing the severity of chocolate spot disease on faba bean through spreading the fungal conidia by wind and rain splash which causing new infections and the high RH% promotes spores germination on the plant surface. The timing of this abnormal phenomenon increases the serious of this disease on faba bean productivity if it happened at the beginning of the pod set stage.

Because of storms are natural phenomenon and had harmful effects on several crops when it happen at critical plant growth stages, generally it can be minimize its dangerous effects through the continuous crop breeding to produce crop varieties with desired characteristics, follow-up the agricultural meteorological data through the crop growth stages and using the recommended fungicides in suitable time.

REFERANCES

Abbas, Z., Sellami, Amri, F. M., and Kharrat, M. (**2010**). Effect of sowing date on *Orobanche foetida* infection and seed yield of resistant and susceptible faba bean cultivars. Acta Phytopathol. Et. entomol. Hungarica, **45(2)**: 267-275.

Abido, W.A.E., and Seadh, S.E. (**2014**). Rate of variations between field bean cultivars due to sowing dates and foliar spraying treatments. Sci. Inter. **2(1)**: 1-12.

Ahmed, S., Muhammad, Kumar, I. S., Malhotra, R. and Maalouf, F. (**2010**). Impact of climate change and variability on diseases of food legumes in the dry areas. Proceedings of an International Conference Food Security and Climate Change in Dry Areas: **1-4 February**, Amman, Jordan.

Alberta Pulse Growers (APG). (**2020**). Faba Bean – Foliar Diseases.

Alharbi, N. H. and Adhikari, K. N. (**2020**). Factors of yield determination in faba bean (*Vicia faba*). Crop & Pasture Science, **71**: 305–321.

Ali, A. A., Abd El-Hai, K. M., and Atwa, M. A. M. (**2014**). Management of chocolate spot disease of *Vicia faba* using nutritional elements. Asian J. Plant Pathol. **8(2)**:45–54.

Atnafu, D., and Keskse, D. (**2020**). Overview of epidemiology, biology and integrated management of chocolate spot (*Botrytis fabae*) of faba bean in Ethiopia. Agriculture, Forestry and Fisheries; **9(2)**: 22-27.

Bahl, P.N. (**2015**). Climate change and pulses: Approaches to combat its impact. Agric. Res., **4**, 103–108.

Badr, E.A., Asal, M.W., and Gehan, A. A. (**2013**). Effect of sowing dates and biofertilizer on growth attributes, yield and its components of two faba bean (*Vicia faba* L.) cultivars. World Appl.Sci.J.**28(4)**: 494-498.

Berhan, M., and Bekel, D. (**2021**). Impact of chocolate spot (*Botrytis fabae* SARD) on production of faba bean (*Vicia faba* L.) and its management of in Ethiopia: A review. Asian J. Adv. Res. **4(1)**: 1226-1236.

Braga, G. U. L., Rangel, D. E. N., Fernandes, E. K. K., and Flint, S. D. (**2015**). Molecular and physiological effects of environmental UV radiation on fungal conidia. Current Genetics. **61(3)**: DOI:10.1007/s00294-015-0483-0

Braga, G. U., Flint, S. D., Miller, C. D., Anderson, A. J., and Roberts, D. W. (**2001**). Variability in response to UV-B among species and strains of Metarhizium isolated from sites at latitudes from 61 N to 54 S. J. Invertebr. Pathol. **78**, 98–108. doi: 10.1006/jipa.2001.5048

Burdon, J. J., and Zhan, J. (**2020**). Climate change and disease in plant communities. PLoS Biol **18(11)**: e3000949. https://doi.org/10.1371/journal. pbio.3000949

Castroverde, C. D. M., and Dina, D. (**2021**). Temperature regulation of plant hormone signaling during stress and development. J. Exp. Bot. https://doi.org/10.1093/jxb/erab257.

Chaloner, T. M., Gurr, S. J., and Bebber, D. P. (**2021**). Plant pathogen infection risk tracks global crop yields under climate change. Nat. Clim. Change **11**, 710–715.

Cheng, Y. T., Zhang,L., and He, S. Y. (**2019**). Plant–microbe interactions facing environmental challenge. Cell Host Microbe, **26**, 183–192.

Chojak-Ko ´zniewska, J., Ku ´zniak, E. and, Zimny, J. (**2018**). The Effects of Combined Abiotic and Pathogen Stress in Plants: Insights From Salinity and Pseudomonas syringae pv lachrymans Interaction in Cucumber. Front. Plant Sci. **9**: 1691. doi: 10.3389/fpls.2018.01691

Cohen, S. P. ,and Leach, J. E. (**2020**). High temperature-induced plant disease susceptibility: more than the sum of its parts. Curr. Opin. Plant Biol. **56**, 235–241.

Deneke, S. (**2018**). Review on epidemiology and management of faba bean (*Vicia fabae*) chocolate spot (*Botrytis fabae*), root rot (*Fusarium solani*) and rust (*Uromyces vicia fabae*) in Ethiopia. Int. J. Sci. Res. Publ. **8**: 105–111.

Desaint, H., Aoun, N., Deslandes, L. , Vailleau, F. , Roux, F., and Berthom, R. (**2021**). Fight hard or die trying: when plants face pathogens under heat stress. N. Phytol. **229**, 712–734.

Dhaliwal, L.K., Sandhu, S.K., Kaur, S., and Singh, S. (**2018**). Effect of meteorological parameters on incidence of brown leaf spot in rice crop under different planting methods. J. Agrometeo. **20(1)**: 53-56.

El-Ammari, A.S. (**2017**). Plant fungal diseases of faba bean in Benghazi. ContROL, **1**: 1–5.

El-Komy, M. H. (**2014**). Comparative analysis of defense responses in chocolate spot-resistant and -susceptible faba bean (*Vicia faba*) cultivars following infection by the necro-trophic fungus *Botrytis fabae*. Plant Pathol. J. **30(4)**: 355-366.

Fitt, B. D. L., H. A. McCartney and P. J. Walklate (**1989**). The role of rain in dispersal of pathogen inoculum. Annu. Rev. Phytopathol. **27**, 241–270.

Gomez, K. A., and Gomez, A. A. (**1984**). Statistical procedures for Agricultural Research. 2nd ed., Wiley, New York.

Hamza, F.E.A., and Khalifa, G.E. (**2017**). The correlation and path coefficient analysis for yield and some yield components of faba bean (*Vicia faba* L.) genotypes in Northern Sudan. Nile J. Agric. Sci., **2 (1)**: 52-63.

Hanounik, S. B., and Bisri, M. (**1991**). Status of diseases of faba bean in the Mediterranean region and their control. In: Cubero JI and Saxena MC (Eds), Present status and future prospects of faba bean production and improvement in the Mediterranean countries. Zaragoza: CIHEAM. 59 -66.

Hanounik, S.B., and Robertson, L.D. (**1988**). New sources of resistance in *Vicia faba* to chocolate spot caused by *Botrytis fabae.* Plant Dis. **72:** 696-698.

Heiba, H. E., Mahgoub, E., Mahmoud, A., Ibrahim, M., and Mahdy, E. M. B. (**2022**). Genetic improvement of faba bean (*Vicia faba* L.) genotypes selected for resistance to chocolate spot disease. Agronomía Colombiana, **40(2):** 186-197.

Hussein, M., Embiale, A., Husen, A., Aref, I.M., and Iqbal, M. (**2017**). Salinity-induced modulation of plant growth and photosynthetic parameters in faba bean (*Vicia faba* L.) cultivars. Pak. J. Bot., **49 (3)**: 867-877.

Ibrahim, H. M. (**2016**). Performance of some faba bean (*Vicia Faba* L.) cultivars sown at different dates. Alex. Sci. Exch. J., **37(2)**:175-185.

Karkanis, A., Ntatsi, G., Lepse, L., Fernández, J.A., Vågen, I.M., Rewald, B., Alsiņa, I., Kronberga, A., Balliu, A., Olle, M., et al. (**2018**). Faba bean cultivation–revealing novel managing practices for more sustainable and competitive European cropping systems. Front Plant Sci. **9**: 1115.

Kole, C., Muthamilarasan, M., Henry, R., Edwards, D., Sharma, R., Abberton, M., Batley, J., Bentley, A., Blakeney, M., Bryant, J., *et al*. (**2015**). Application of genomics-assisted breeding for generation of climate resilient crops: Progress and prospects. Front. Plant Sci., **6**, 563.

Korosec, M. (**2020**). A powerful frontal system hits Egypt, storm leaves at least five fatalities and destructive flooding. https://www.severe-weather.eu/recent-events/powerful-frontal-system-hits-egypt-mk/

Lammerts van Bueren, E.T., Struik, P.C., van Eekeren, N., and Nuijten, E. (**2018**). Towards resilience through systems-based plant breeding. A review. Agron. Sustain. Dev., **38**, 42.

Maalouf, F., S. Ahmed and Z. Bishaw (**2021**). Faba bean. The beans and the peas. Chapter **6**, pages:105-131, Copyright © 2021 Elsevier Inc. https://doi.org/10.1016/B978-0-12-821450-3.00008-1

Merga, B., Egigu, M. C., and Wakgari, M. (**2019**). Reconsidering the economic and nutritional importance of faba bean in Ethiopian context. Cogent Food & Agriculture, **5**: 1683938https://doi.org/10.1080/23311932.2019.168393

Misgana, M. (**2017**). Integrated management of chocolate spot (*Botrytis fabae*) disease of faba bean (*Vicia faba* L.) in Ethiopia: A Review.Inter. J. Res. -Granthaalayah.; **5 (9)**: 195-205.

Mohamed, Marwa, Kh. A. (**2012**). Effect of sowing date and broomrape control on productivity of some faba bean (*Vicia faba* L.) cultivars. M. Sc. Thesis, Fac. Of Agric., Kafr-Elsheikh Univ., Egypt.

Mohamed, Marwa, K.h. A., and El-Bakery, A.M. (**2020**). Evaluation of some faba bean genotypes under natural infection with chocolate spot and rust diseases. Acta Sci. Agric. **4(8)**: 37-51.

Nagarajan, S. and D. V. Singh (**1990**). Long-distance dispersion of rust pathogens. Annu. Rev. Phytopathol. **28**: 139–153.

Nascimento, É., Da Silva, S. H., dos Reis Marques, E., Roberts, D. W., and Braga, G. U. (**2010**). Quantification of cyclobutane pyrimidine dimers induced by UVB radiation in conidia of the fungi *Aspergillus fumigatus*, *Aspergillus nidulans*, *Metarhizium acridum* and *Metarhizium robertsii*. Photochem. Photobiol. **86**, 1259–1266.

NASA (**2020**). The storm system, nicknamed the "Dragon Storm", responsible for severe flooding and the cause of 21 deaths in Egypt, March13.hhps://www.nnvl.noaa.gov/view/global data.html#TRUE

Papastylianou, P., Vlachostergios, D.N., Dordas, C., Tigka, E., Papakaloudis, P., Kargiotidou, A., Pratsinakis, E., Koskosidis, A., Pankou, C., Kousta, A., *et al*. (**2021**). Genotype X Environment Interaction Analysis of Faba Bean (*Vicia faba* L.) for Biomass and Seed Yield across Different Environments. *Sustainability*, ***13***, 2586. https://doi.org/10.3390/su13052586

Paul, S.K., and Gupta, D.R. (**2021**). Faba Bean (Vic ia faba L.), A Promising Grain Legume Crop of Bangladesh: A Review. Agricultural Reviews. DOI: 10.18805/ag.R−203.

Pandit, D. (**2020**). Effect of temperature, relative humidity, photoperiod on anthracnose of horse gram and role of weather parameters in development of disease in Himachal Pradesh. J. Global Biosci . **9 (7)**:7725-7734.

Podleśny, J., Podlesna, A. , and Nedzi, M. (**2017**). Occurrence of fungal diseases caused by fungi on faba bean (*Vicia faba* L. var. minor Harz.) plants in different regions of Poland. Progress in Plant Protection **57**: 190-195.

Pszczółkowska, A., Okorski, A., Fordonski, G., Kotecki, A., Kozak, M., and Dzienis, G. (**2020**). Effect of weather conditions on yield and health status of faba bean seeds in Poland. Agron. **10(1)**: 48. https://doi.org/10.3390/agronomy10010048

Pulse Breeding Australia (**2013**). Southern/Western faba and broad bean-best management practices training course. Module 6-Disease Management.

Qabil, Naglaa, Helal, A. A., and Abd El-Khalek, Rasha, Y.S. (**2018**). Evaluation of some new and old faba bean cultivars (*Vicia faba* L.) for earliness, yield, yield attributes and quality. Zagazig J. Agric. Res., **5 (3)**: 821-833.

Rosenzweig, C., Iglesias, A., Yang, Y. B., Epstein, P. R., and Chivian, E. (**2000**). Climate Change and U.S. Agriculture: The impacts of warming and extreme weather events on productivity, plant diseases and pests. Boston, MA, USA: Center for Health and the Global Environment, Harvard Medical School.

Sache, I., (**2000**). Short-distance dispersal of wheat rust spores. Agronomie, **20**: 757–767.

Saharan, M. S., and Saharan, G. S. (**2004**). Influence of weather factors on the incidence of *Alternaria* blight of cluster bean (*Cyamopsis tetragonoloba* (L.) Taub.) on varieties with different susceptibilities. Crop Protec. **23 (12)**: 1223-1227.

Saijo, Y., and Loo, E. P. (**2020**). Plant immunity in signal integration between biotic and abiotic stress responses. N. Phytol. **225**, 87–104.

Singh, B. K., Delgado-Baquerizo, M., Egidi, E., Guirado, E., Leach, Jan, E., Liu, H., and Trivedi, P. (**2023**). Climate change impacts on plant pathogens, food security and paths forward. nature reviews microbiology, https://doi.org/10.1038/s41579-023-00900-7

Stoddard, F. L., Nicholas, A. H., Rubiales, D., Thomas, J.,and Villegas- Fernández, A. M . (**2010**). Integrated pest management in faba bean. Field Crops Res. **115(3):** 308–318.

Tarek, S. M., Mohamed, Marwa, Kh. A,. and Rehab, A. M. A. (**2020**). Evaluation of some faba bean genotypes under three Pplanting dates in Middle Egypt. Alex. J. Agric. Sci. **65(3)**: 201–209.

Trivedi, P., Batista, B. D., Bazany, K. E., and Singh, B. K. (**2022**). Plant–microbiome interactions under a changing world: responses, consequences and perspectives. N. Phytol. **234**, 1951–1959.

Velasquez, A. C., Castroverde, C. D. M., and He, S. Y.(**2018**). Plant–pathogen warfare under changing climate conditions. Curr. Biol. **28**: 619–634.

Waly F. E., Rashwan, E. A. A., Abdel-Whab, Gehad, and Khafagy, Ii (**2019**). Evaluation of some faba bean cultivars yield under chemical control to common insect pests and fungal diseases under El-Beheira Governorate environmental conditions. J.Plant Prod., Mansoura Univ., **10.2**: 107-116.

Zayan, Sahar, A. (**2019**). Impact of Climate Change on Plant Diseases and IPM Strategies. Plant Diseases - Current Threats and Management Trends. Edited by Snježana Topolovec-Pintarić, DOI: 10.5772/intechopen.87055

الملخص العربى

تأثير عاصفة البحر المتوسط "عاصفة التنين" عام ٢٠٢٠ على شدة الإصابه بالتبقع الشيكولاتى ونمو وإنتاجية الفول البلدى فى مصر

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لدراسة تأثير عاصفة التنين المتكونه سريعا فوق مصر عام ٢٠٢٠ على شدة الإصابه بالتبقع الشيكولاتى ونمو وإنتاجية الفول البلدى خلال موسمى ٢٠١٩ /٢٠٢٠ و٢٠٢٠/٢٠٢١ تم إجراء هذه الدراسه بإستخدام ثلاثة أصناف من الفول البلدى وهم جيزه ٨٤٣، سخا ١، جيزه ٤٠ بمزرعة محطة البحوث الزراعيه بإيتاى البارود – محافظة البحيره٠ فى الموسم الأول تراوح معدل سقوط الأمطار فى الفتره من ٢٠٢٠/٣/١ حتى ٢٠٢٠/٣/١١ من ٠,٠٠ إلى ٠,٣٨ مم/يوم إلا أنه فجأة فى يوم ٢٠٢٠/٣/١٢ حدث هطول أمطار غزيره بمعدل ٢٦,٣ مم / يوم صاحبها عواصف رعديه٠ كما سجلت الرطوبه النسبيه إرتفاعا بنسب ٨٢,٠٨, ٧٩,٤٣, ٦٩,١٠ ٪ خلال أيام ٣/١٢, ٣/١٣, ٢٠٢٠/٣/١٤فى نفس الوقت إنخفضت درجة الحراره العظمى خلال اليومين ٣/١٢, ٢٠٢٠/٣/١٣ إلى ٢٠,١٦ , ٢١,٨٠ م° على التوالى٠ بعد ٥ أيام من بدء العاصفه إرتفعت شدة الإصابه بالتبقع الشيكولاتى إرتفاعا حادا على الأصناف الثلاثه ولكن كان الصنف جيزه ٨٤٣ الأقل إصابه يليه سخا ١ ثم جيزه ٤٠ بمتوسطات ٣٦,٩٨, ٣٩,٠٤, ٤٧,٠٧٪ على التوالى وتزايدت شدة الإصابه بزيادة الفترات٠ على العكس من ذلك ففى الموسم الثانى أظهرت شدة الإصابه متوسطات عاديه بقيم ٨.١٥, ٨,١٢, ١٠,٦٢٪ للأصناف السابقه على التوالى٠ اظهرت هذه الدراسه وجود معنويه قويه موجبه لمعامل الإرتباط بين شدة الإصابه بالتبقع الشيكولاتى لأصناف الفول البلدى محل الدراسه ومعدل

سقوط الأمطار والرطوبه النسبيه خلال موسمى الدراسه. خلال الموسمين أظهر الصنف جيزه ٤٠ تبكيرا فى التزهيروالنضج يليه الصنفين الآخرين (سخا ١و جيزه ٨٤٣)٠ كان الصنف جيزه ٨٤٣ الأكثر طولا بمتوسط ٩٤,٣٣ سم وتفوق على الصنفين الآخرين (سخا ١, جيزه ٤٠) فى عدد الفروع/نبات, عدد القرون/نبات, محصول البذور/نبات (جم), محصول البذور/قطعه (كجم), محصول البذور/فدان (أردب) بمتوسطات ٣,٦٨, ١٧,٩٧, ٣٢,١١, ٤,٢٦, ١٦,٥٥ على التوالى٠

الكلمات المفتاحيه: عاصفة التنين، مصر، التبقع الشيكولاتى، المحصول، الأمطار، الرطوبه النسبيه.