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Response of Some Faba Bean Cultivars to Organic, Bio and Mineral Fertilizers and Their Effect on Yield and Tolerance to the Stresses of Fungi and Insects

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Abstract: To determine the role of compost and rhizobia alone or combined with mineral fertilizers (NPK) on seed yield and yield components, leaf miner (*Liromiza congesta*) numbers, aphid (*Aphis gossypii*) numbers, chocolate spot disease severity caused by *Botrytis fabae* Sard and rust severity caused by *Uromyces vicia faba*, the three faba bean cultivars, Sakha 1, Giza 716 and Giza 40 were used under soil application of 100 % NPK, Compost, Rhizobia, 50% NPK+ Compost, 50% NPK+ Rhizobia, Compost + Rhizobia and 25% NPK+ Compost + Rhizobia and control treatment without fertilizers. For this purpose a field experiment was designed in a split plot design in the experimental farm of Itay EL-Baroud agricultural research station during 2016/2017 and 2017/2018 growing seasons. The results showed that, Sakha 1 cv. was the earliest among all tested cultivars, the same cultivar showed the lowest numbers of both leaf miner (L. congesta) and aphid (*A. gossypii*), the lowest percentage of rust severity and the highest polyphenol-oxidase activity in both seasons. Giza 40 cv. had the highest plant (cm), number of branches/plant and dry matter percentage in both seasons. Giza716 showed the highest 100-seed weight, seed yield/hectare, the lowest percentage of disease severity of chocolate spot and the highest peroxidase activity in both seasons. Fertilized faba bean plants with Compost + Rhizobia had the highest leaf area index in the 1st and 2nd seasons, while, 100% NPK treatment had the highest plant. Fertilized faba bean plants with 50% NPK+ Compost showed the highest number of branches /plant the highest number of pods/plant, the highest 100-seed weight, seed yield/hectare and the lowest rust infection in both seasons. The lowest disease severity of chocolate spot, number of leaf miner and the lowest number of adult aphids were peaked from faba bean plants fertilized with 25% NPK+ Compost + Rhizobiain both seasons. Generally, soil application with 50% NPK+ Compost could be recommended to increase faba bean seed yield and reduce aphid and leaf miner number as well as decrease chocolate spot and rust severity. Data clear that there were presented negative and highly significant coefficients between peroxidase and polyphenol-oxidase activities with rust and chocolate spot disease severity for seasons 2016/17 and 2017/19 and with combined season data.

Key words: Faba Bean · Compost · Rhizobia · NPK · Leaf Miner · Aphid · Chocolate Spot · Rust and Yield

INTRODUCTION

Faba bean is the most important legume crop all over the world, where faba bean dry seed contain about 20-36% protein so it is very useful for human and animal feeding. In Egypt, faba bean is the major winter leguminous crop and used as a source of protein and improving soil fertility by providing a substantial input of N2 fixation. The world total production of dry seeds were 4.82 million tons produced from 2.46 million hectares while, the Egyptian total production of dry seed were 139.303 thousand tons produced from 40.298 thousand hectares [1].

Faba bean play a great role in the Egyptian crop rotation, due to its fixation of atmospheric nitrogen, which enriches the soil with nitrogen and organic matter and improving water use efficiency of the cropping system [2].

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Faba bean is attacked by many insects and fungal diseases, it exposes to several pests such as Chocolate spot (*Botrytis fabae*), rust (*Uromyces vicia faba*), *Aphis craccivora* and *Liriomyza trifolii* [3]. Diseases classified as an important biotic stresses that reduce the faba bean production of dry seeds. Chocolate spot (*Botrytis fabae*) and rust (*Uromyces vicia faba*) are the most dangerous diseases that infected faba bean caused a large loss in seed yield. In the Middle East, the total losses of seed yield on susceptible faba bean genotypes due to chocolate spot disease reached about 60-80% [4] and 50-70% as a result of rust disease [5]. As for insects *A. gossypii* resulted in a large losses in faba bean seed yield by two way, the first way it reduce the yield by the direct feeding resulted in induce plant deformation and the second way it caused an indirect damage by transmission of viruses [6], also larvae of *Liriomyza trifolii* reduce the plant photosynthetic activity by eating the mesophyll caused a large damage of photosynthetic pigments in faba bean leaves [7]. The total yield of faba bean differed from genotype to another and this may to the wide diversity between genotypes where some genotypes had higher yield ability more than the others. In this respect Abbas *et al*. [8] found that Sakha 1 one cultivar expressed the highest mean values for some growth traits (plant height and number of branches/plant) compared with Giza716 and Giza 40 cultivars. While the same author indicated that, Giza 716 cv. gave the highest number of pods, seed weight /plant and seed yield/fed. The percentage increases for seed yield/fed. were (1, 3, 11 and 11%) over Sakha 1, Giza 40, Giza 3 and Sakha 2 cultivars, respectively in the second season only. The second reason may due to cultural practice such as soil fertility, quality of irrigated water and controlling of biotic and abiotic stresses these factors may improve by enhanced faba bean plants growth environment using some mineral, bio and organic material.

The use of chemical insecticides and fungicides in controlling pests caused air and water pollution make environmental hazards [9]. Moreover it has recently been reported that *B. fabae* and *B. cinerea* become more resistance to those chemical pesticides [10] as a result of the previous dangerous of chemical pesticides it is very important to search for new environmental friendly alternatives for the control of these pests. The environmental hazard caused by the excessive use of chemical pesticides or fertilizer, bio-fertilization become a great alternative in legume and non-legume crops to reduce this pad effect of chemical substances. Bio-fertilizers are products consisted of living cells of manykinds of microorganisms that have the ability to convert complex important elements from unavailable to available form through biological processes [11].

Compost recorded to be used as sources of useful microorganisms in controlling of insects and fungal diseases in plants by foliar spray or soil application [12, 13]. In addition microorganismsin the Compost are effective in enhancing the plant growth and defense against several pests by antibiosis, competition, mycoparasitism, cell wall degradation enzymes and induced systemic resistance.

Dileep-Kumar *et al.* [14] found that rhizobia stimulate plant growth mainly by increase root development, which, improved macro and micronutrients and water uptake in the early stages of plant growth. Moreover, Talaat and Abdallah [15] reported that, the plant host organisms may be affected by one or more mechanisms such as nitrogen fixation, production of plant growth promoting substances, phytohormons, enhancing nutrient uptake and organic acids. Rugheim and Abdelgani [16] suggested the use of, microbial fertilization with compatible effective strains to compensate the chemicals fertilizers, to decrease the expenses of chemical fertilizers and to protect the environment from pollution hazards.

With the observation to the previous studies the present work was aimed to determine the efficacy of Compost and rhizobium as safe alternatives to mineral fertilizers in increasing seed yield and its component of faba bean in addition to the role of these fertilizers in reduce chocolate spot and rust severity as well as aphid and leaf miners on faba bean under field conditions.

MATERIALS AND METHODS

Field experiments were carried out at Etay- El-Baroud Agric. Res. Station during the seasons 2016-2017 and 2017-2018 to study the response of faba bean cultivars (Sakha 1, Giza 716 and Giza 40). The rate of five different applications of fertilizers (organic, Bio and mineral) mentioned in Table (1). Seeds were sown in 1st and 2nd of November 2016 and 2017, respectively.

The field experiment was arranged in a spilt plot where the cultivars were laid out in the main plots and fertilization treatments were in the sub-plots. The plot area of 5 ridges, each ridge was three-meter long and 70 cm apart. Seeds were planted in two sides of the ridge at 15 cm spacing hills with one seed / hill. Seeds of faba bean cultivars were obtained from Field Crops Research Institute (ARC). The experimental soil was clay loam. Seed inoculation with rhizobium was done by using effective okadeen of *Rhizobium leguminosarum* provided from Dept, of Agric. Microbiol., Agric. Res. Center, Giza.

Table 1: The used fertilizers properties, rate, method and time of application

Fertilizer	Properties	Rate and time of application
100% NPK	NH_4NO_3(33.5% N)	50 kg/fed was add three weeks after seed sowing
	K_2O (48% K)	50 kg/fed was add month latter from the first dose.
	P_2O_5(15.5 %P)	150 kg was added as Single dose before sowing.
Compost	Compost	15 tons/fed. was added as single dose in the tillage
Rhizobia	*Rhizobium leguminosarum*	200g mixed with 50kg seeds before sowing.
50%NPK+ Compost	NH_4NO_3(33.5% N)	25 kg/fed was add three weeks after seed sowing.
	K_2O (48% K)	25 kg/fed was add month latter from the first dose.
	P_2O_5(15.5 %P)	75 kg was added as single dose before sowing.
	Compost	15 tons/fed was added as single dose in the tillage.
50%NPK+ Rhizobia	NH_4NO_3(33.5% N)	25 kg/fed was add three weeks after seed sowing.
	K_2O (48% K)	25 kg/fed was add month latter from the first dose.
	P_2O_5(15.5 %P)	75 kg was added as single dose before sowing.
	Rhizobium leguminosarum	200g mixed with 50kg seeds before sowing.
Compost + Rhizobia	Compost	15 tons/fed. was added as single dose in the tillage.
	Rhizobium leguminosarum	200g mixed with 50kg seeds before sowing.
25% NPK+ Compost + Rhizobia	NH_4NO_3(33.5% N)	12.5kg/fed was add three weeks after seed sowing.
	K_2O (48% K)	12.5kg/fed was add month latter from the first dose.
	P_2O_5(15.5 %P)	37.50 kg was added as single dose before sowing.
	Compost	15 tons/fed was added as single dose in the tillage.
	Rhizobium leguminosarum	200g mixed with 50kg seeds before sowing.
Control	Without any additions	

Table 2: Physiochemical properties of experimental soil in both seasons

	Seasons	
Properties	2016/2017	2017/2018
Particle size distribution		
Clay %	60.41	59.61
Slit %	32.5	31.8
Sand %	7.09	8.59
Texture	Clay	
$CaCO_3$ %	3.15	2.45
PH	7.70	7.75
E.C dS/m	1.93	1.88
Soluble cations (meq/L)		
Ca++	6.12	5.10
Mg++	3.54	2.61
K+	1.56	1.64
Na+	8.17	6.89
SAR	3.73	3.53
Soluble Anions (meq/L)		
Cl-	10.11	8.42
HCO_3^{-}	0.85	0.70
$SO_4^{=}$	8.43	7.02
Available nutrient mg/kg		
K+	74.11	68.34
P	2.66	2.34
N	41.78	40.09
OM%	0.68	0.54

Mechanical and chemical properties of the experimental soil sits in two seasons and Compost used in the experiment are shown in Table (2).

Data Recorded

Growth and Yield Measurements

Growth and Yield Traits: Ten plants from each plot were chosen randomly to measure the average plant height (cm), numbers of branches/plant, number of pods/plant, 100-seed weight (g) and seed yield/hectare (ton) which estimated as the total seed yield for each sub plot, then converted into tons /hectare.

Leaf Area Index and the Percentage of Dry Matter: After 105 days from sowing 5 guarded plants were chosen randomly from each plot and used to determined leaf area index according to the following formula as suggested by Watson [17] as follows:

$$\text{LAI}=\frac{\text{Total leaf area (cm}^2)}{\text{Unit land area occupied by land (cm}^2)}$$

The average fresh weight of the five plants were estimated and the same plants were artificially drayed to 10% water content (in oven at 70°C for 2 days) and the average dry weight was estimated to determine the percentage of dry matter as follows:

$$\text{Dry matter\%}=\frac{\text{Average dry weight}}{\text{Average fresh weight}}\times 100$$

Determination of Chocolate Spot Disease and Rust Severity (%): The disease severity of chocolate spot was visually estimated by at 15th January to 30th February and rust disease severity was recorded at 15th March to 30 April from sowing in two seasons under natural infection conditions. Twenty plants were randomly selected from each plot to determine the severity of both disease infection using a rate of 1-9 [18], where 1 = no disease symptoms and 9 = extensive lesions on leaves, stems and pods, severe defoliation, heavy sporulation, stem girdling, blackening and death of more than 80% of plants (highly susceptible). The disease severity % was assessed according to the following formula:

Disease severity % = Σ (n × v)/9 × N × 100

where:
n = number of plants in each grade.
v = numerical grade (disease grade).
9 = maximum disease grade.
N = total number of plants.

Determination of Peroxidase (PO) and Polyphenoloxidase (PPO) Activities: The sample of one g of leaves (after 90 days from sowing) was homogenized in 2 ml of 0.1 M sodium phosphate buffer (SPB) pH 6.5 at 4°C. The filtrate was centrifuged at 20, 000 rpm at 4°C for 15 min., the supernatant served as an enzyme extract for enzyme assay of polyphenoloxidase and peroxidase.

Peroxidase Activity: Peroxidase activity was assayed calorimetrically according to the method described by Amako *et al*. [19]. The increase in optical density at 430 nm against blank was continuously recorded every minute. Peroxidase enzyme activity was expressed as change in absorbance per min/g fresh leaves.

Polyphenol Oxidase (PPO) Activity: Polyphenol oxidase activity was estimated as described by Mayer and Harel[20] with some modifications. The polyphenol oxidase activity was expressed as change in absorbance at 495 nm against blank per min g-1 fresh leaves.

Number of Leaf Miner (*Liromizacongesta*) and Aphid (*Aphis gossypii*): Monitoring of *B. tabaci*and *A. gossypii,* numbers was conducted throughout the from three after sowing until the end of the fruiting stage in the six faba bean cultivars plots. Sampling was carried out at weekly interval early in the morning before the insect pests adults tend to be more active, Gameel [21]. Number of whitefly and aphid were assessed by leaf random sampling. For sampling, 30 leaves representing top, middle and bottom canopy were picked from each of the six faba bean cultivars were randomly selected per plot. Thus, in all 120 leaves replication-1 were observed at one time for each cultivar. Leaf samples were kept in separate paper bags properly labeled with plot number. The leaves were then brought to the laboratory on the same day where the adult insect pests were counted.

Statistical Analysis: All data were subjected to the analyses of variance (ANOVA) for split-plot design for each season individually followed by compared means with LSD at level probability5% according to Gomez and Gomez [22].

RESULTS AND DISCUSSION

Effect of Cultivars, Fertilizer Treatments and Their Interaction on Faba Bean Growth During 2016/17 and 2017/18 Seasons

Effect of Cultivars: Data in Table 3 indicate that Sakha 1 cv. was the earliest flowering and maturing cultivar among all tested cultivars. It showed the lowest number of days to flowering (41.63 and 43.71 days) and maturity (142.13 and 145.39 days) also, this cultivar showed the highest leaf area index (2.01 and 1.96) in both seasons, respectively. However, Giza 40 cv. had the highest plant (87.29 and 85.55cm), number of branches/plant (2.54 and 2.67) and the highest dry matter percentage with averages of 7.70 and 7.51% in both seasons, respectively.

The results indicated that Giza 40 surpassed both Sakha 1 and Giza 716 in plant height, number of branches/ plant and the percentage of dry matter. Eman *et al*. [23] reported that, the Egyptian faba bean cultivars varied significantly for growth, yield components and harvest index in both seasons during his study and in seed yield in the first season only and Sakha l gave the lowest value for growth traits in the two seasons. Incontrast Abbas *et al*. [8] found that Sakha 1 cultivar expressed the highest mean values for some growth traits (plant height and number of branches/plant) compared with Giza716 and Giza 40 cultivars.

Effect of Fertilizer Treatments: As for fertilizer treatments data in Table (3) showed that, the control treatment had the lowest number of days to flowering (40.22 and 42.23 days), maturity date (142.22 and 145.49 days) and the highest percentage of dry matter with averages of 10.06% and 9.81% in both seasons, respectively. The exceeded of control treatment in earliness did not differ significantly with the same values obtained by 50% NPK+Rhizobia.

Table 3: Means of earliness (Flowering -Maturity) and growth characters in faba bean cultivars as affected by cultivar, fertilizer treatments and their interactions during 2016/17 and 2017/18 seasons

Traits		Flowering dates (days)		Maturity dates (days)		Plant height (cm)	
Seasons		2016/17	2017/18	2016/17	2017/18	2016/17	2017/18
Factors							
1-Cultivar							
Sakha 1		41.63^{b}	43.71^{b}	142.13^{c}	145.39^{c}	77.50^{b}	75.95^{b}
Giza 40		47.63^{a}	50.01^{a}	149.88^{a}	153.32^{a}	87.29^{a}	85.55^{a}
Giza 716		42.42^{b}	44.54^{b}	145.38^{b}	148.72^{b}	84.38^{a}	82.69^{a}
LSD 5%		0.22	0.23	0.68	0.70	5.20	5.09
2-Fertilizer							
100 % NPK		46.44^{a}	48.77^{a}	147.78^{bc}	151.18^{bc}	102.7^{a}	100.72^{a}
Compost		42.00^{cd}	44.10^{cd}	142.67^{de}	145.95^{de}	61.67^{d}	60.43^{d}
Rhizobia		46.44^{a}	48.77^{a}	149.89^{a}	153.34^{a}	99.44^{ab}	97.46^{ab}
50%NPK+ Compost		46.56^{a}	48.88^{a}	148.67^{ab}	152.09^{ab}	97.22^{b}	95.28^{b}
50%NPK+ Rhizobia		41.56^{cd}	43.63^{cd}	144.11^{d}	147.43^{d}	68.33^{c}	66.97^{c}
Compost + Rhizobia		44.78^{ab}	47.02^{ab}	146.89^{c}	150.27^{c}	100.56^{ab}	98.54^{ab}
25% NPK+ Compost + Rhizobia		43.11^{bc}	45.27^{bc}	144.11^{d}	147.43^{d}	69.44^{c}	68.06^{c}
Control		40.22^{d}	42.23^{d}	142.22^{e}	145.49^{e}	65.00^{cd}	63.70^{cd}
LSD 5%		1.81	1.90	1.64	1.68	4.74	4.65
3-Interaction							
Sakha 1	100% NPK	42.33	44.45	144.67	147.99	91.67	89.83
	Compost	39.33	41.30	138.67	141.86	55.00	53.90
	Rhizobia	45.33	47.60	145.67	149.02	93.33	91.47
	50%NPK+ Compost	43.00	45.15	143.33	146.63	96.67	94.73
	50%NPK+ Rhizobia	39.67	41.65	140.00	143.22	61.67	60.43
	Compost + Rhizobia	44.33	46.55	144.33	147.65	90.00	88.20
	25% NPK+ Compost + Rhizobia	41.33	43.40	140.67	143.90	73.33	71.87
	Control	37.67	39.55	139.67	142.88	58.33	57.17
Giza 40	100% NPK	52.67	55.30	153.00	156.52	103.33	101.27
	Compost	45.67	47.95	150.67	154.13	63.33	62.07
	Rhizobia	49.67	52.15	154.33	157.88	100.00	98.00
	50%NPK+ Compost	50.67	53.20	152.00	155.50	98.33	96.37
	50%NPK+ Rhizobia	44.33	46.55	147.67	151.06	75.00	73.50
	Compost + Rhizobia	46.33	48.65	144.33	147.65	113.33	111.07
	25% NPK+ Compost + Rhizobia	48.67	51.10	150.33	153.79	71.67	70.23
	Control	43.00	45.15	146.67	150.04	73.33	71.87
Giza 716	100% NPK	44.33	46.55	145.67	149.02	113.33	111.07
	Compost	41.00	43.05	138.67	141.86	66.67	65.33
	Rhizobia	44.33	46.55	149.67	153.11	105.00	102.90
	50%NPK+ Compost	46.00	48.30	150.67	154.13	96.67	94.73
	50%NPK+ Rhizobia	40.67	42.70	144.67	147.99	68.33	66.97
	Compost + Rhizobia	43.67	45.85	152.00	155.50	98.33	96.37
	25% NPK+ Compost + Rhizobia	39.33	41.30	141.33	144.58	63.33	62.07
	Control	40.00	42.00	140.33	143.56	63.33	62.07
LSD 5%		2.61	2.74	2.37	2.43	6.86	6.72

Table 3: continued

Traits		No. of branches /plant		Leaf area index		Dry mater %	
Seasons		2016/17	2017/18	2016/17	2017/18	2016/17	2017/18
Factors							
1-Cultivar							
Sakha 1		2.12[b]	2.23[b]	2.01[a]	1.96[a]	5.72[b]	5.58[b]
Giza 40		2.54[a]	2.67[a]	1.92[b]	1.87[b]	7.70[a]	7.51[a]
Giza 716		2.26[ab]	2.38[ab]	1.71[c]	1.67[c]	5.62[b]	5.48[b]
LSD 5%		0.35	0.36	0.09	0.09	0.69	0.67
2-Fertilizer							
100% NPK		3.41[b]	3.59[b]	2.17[a]	2.11[a]	4.75[c]	4.63[c]
Compost		1.32[e]	1.38[e]	1.89[c]	1.85[c]	7.22[b]	7.04[b]
Rhizobia		1.90[d]	2.00[d]	1.82[c]	1.77[c]	4.21[c]	4.11[c]
50%NPK+ Compost		4.07[a]	4.28[a]	1.93[bc]	1.88[bc]	7.37[b]	7.19[b]
50%NPK+ Rhizobia		1.74[d]	1.83[d]	1.55[d]	1.51[d]	6.83[b]	6.65[b]
Compost + Rhizobia		3.11[c]	3.27[c]	2.18[a]	2.13[a]	3.79[c]	3.69[c]
25% NPK+ Compost + Rhizobia		1.82[d]	1.91[d]	2.07[ab]	2.02[ab]	6.56[b]	6.39[b]
Control		1.08[e]	1.14[e]	1.42[d]	1.39[d]	10.06[a]	9.81[a]
LSD 5%		0.29	0.31	0.16	0.16	1.20	1.17
3-Interactions							
Sakha 1	100% NPK	2.51	2.64	1.82	1.78	4.88	4.76
	Compost	0.75	0.79	2.06	2.00	4.42	4.31
	Rhizobia	1.69	1.77	1.95	1.90	3.63	3.54
	50%NPK+ Compost	4.28	4.48	2.31	2.25	6.46	6.30
	50%NPK+ Rhizobia	1.87	1.96	1.78	1.74	6.14	5.98
	Compost + Rhizobia	2.42	2.54	1.80	1.75	4.89	4.77
	25% NPK+ Compost + Rhizobia	2.35	2.47	2.29	2.23	8.51	8.29
	Control	1.11	1.17	2.11	2.05	6.85	6.68
Giza 40	100% NPK	3.87	4.06	2.78	2.71	4.53	4.41
	Compost	1.93	2.03	1.45	1.41	11.84	11.54
	Rhizobia	2.40	2.52	2.36	2.30	3.24	3.16
	50%NPK+ Compost	3.69	3.87	1.35	1.31	10.47	10.21
	50%NPK+ Rhizobia	1.91	2.01	1.32	1.28	9.41	9.18
	Compost + Rhizobia	3.64	3.83	2.47	2.40	2.61	2.54
	25% NPK+ Compost + Rhizobia	1.80	1.89	2.48	2.41	7.05	6.87
	Control	1.07	1.12	1.13	1.10	12.48	12.17
Giza 716	100% NPK	3.87	4.06	1.91	1.86	4.84	4.71
	Compost	1.27	1.33	2.17	2.12	5.41	5.27
	Rhizobia	1.62	1.70	1.13	1.11	5.78	5.63
	50%NPK+ Compost	4.27	4.48	2.14	2.09	5.18	5.05
	50%NPK+ Rhizobia	1.44	1.52	1.56	1.52	4.93	4.80
	Compost + Rhizobia	3.27	3.43	2.27	2.21	3.86	3.76
	25% NPK+ Compost + Rhizobia	1.31	1.38	1.45	1.41	4.12	4.02
	Control	1.07	1.12	1.04	1.01	10.84	10.57
LSD 5%		0.41	0.43	0.28	0.27	2.08	2.03

100% NPK treatment gave the highest plant (102.70 and 100.72 cm) followed by Compost + Rhizobia (100.56 and 98.54cm) in the two seasons, respectively. Also the data indicated that fertilized faba bean plants with Compost + Rhizobia gave the highest leaf area index with averages of 2.18 and 2.13 in the 1st and 2nd seasons, respectively but these values did not differ significantly with those obtained by NPK treatment. Finally, the highest number of branches /plant was given from faba bean plants that fertilized by 50%NPK+ Compost (4.07 and 4.28) in both seasons, respectively.

Effect of Cultivars × Fertilizer Treatments Interactions: Data in Table (3) revealed that the three faba bean cultivars showed different responses to all fertilizer treatments. The best responses for earliness (number of days to flowering and maturity) in both seasons were shown by Sakha 1 x control followed by Sakha 1 x Compost then Sakha 1 x 50%NPK+ Rhizobia. On contrast, the interactions of Giza 40 x NPK, Giza 40 x Rhizobia and Giza 40 x 50%NPK+ Compost were the latest among all tested parameter in both seasons. The tallest plants were obtained by Giza 716 x NPK and Giza 40 x Compost +

Rhizobia while the shortest plants were presented by Sakha 1 x Compost in the two seasons. The data also indicated that the interactions between Sakha 1 and Giza 716 with 50%NPK+ Compost showed the highest number of branches/plant in both seasons. Data in Table 3 showed that the highest leaf area index were obtained by Giza 40 x NPK followed by Giza 40 x 25% NPK+ Compost + Rhizobia in both seasons. Finally the highest dry matter % were presented by Giza 40 x control followed by Giza 40 x Compost in the two seasons.

In this study 100% NPK resulted in significant increase in faba bean growth traits. Several studies indicated the complementary efficiency of nitrogen, phosphorous and potassium. Phosphorous (P) plays important roles in nodulation and N fixation, photosynthesis and nutritional values of legume crops including faba bean [24]. Phosphorus application often results in increased yield and biomass of faba beans in soil with a low limited of phosphorous [25]. Potassium (K) is an essential nutrient which involved in plant metabolism by activating many enzymes and plays a great role in enhance water management of plants [26]. Availability of K to faba bean plants has a positive effect on N fixation [27] and significantly increases biomass and seed yield production [28]. Compost asorganic fertilizer is an environmental friendly fertilizer and safe alternative for the chemical fertilizers. Our findings showed that Compost + Rhizobia and 50%NPK+ Compost enhanced faba bean growth compared to the control treatment. This finding is in agreement with those mentioned by Mohamed and Gomaa [9] who reported that the bio-organic treatment consisted of 10 m^3Compost + *Rhizobium leguminosarum*+ Soil yeast *Candida tropicalis* increased plant height by 3.4% over the positive control. The bio-organic treatments of 5 m^3Compost + *Rhizobium* + *Candida* increased total fresh weight by 5.4 %. In addition, Hegazi and Algharib [30] recorded that the number of plant leaves, improved under 25% of mineral NPK + 75% of Compost tea (CT) as a soil drench also, Suganthi and Jayanandhan [31] mentioned that the seed soaking with Compost tea increased the number of leaves by 43% compared with control.

Effect of Cultivars, Fertilizer Treatments and Their Interaction on Faba Bean Yield and Yield Components Traitsduring 2016/17 and 2017/18 Seasons

Effect of Cultivar: Data in Table (4) showed that Giza 40 cv. had the highest number of pods/ plant (14.23 and 13.81)in both seasons, respectively. These percentages significantly exceeded the values obtained by Sakha1 cv. but did not differ significantly with those obtained by Giza716. Giza716 cv. showing the highest 100-seed weight (78.07 and 76.03g) and seed yield/hectare (3.41and 3.37 ton) in both seasons, respectively.

The results indicated that Giza 716 significantly exceeded Giza 40 and Sakha 1 in all yield and yield components traits, this finding was in harmony with those obtained by Talaat and Abdallah [15], concluded that the variations on faba bean yield may be attributed to differences in genetic constitution of the varieties which affects their response to environment. Also, Abbas *et al*. [8] who mentioned that Giza 716 cv. gave the highest number of pods, seed weight /plant and seed yield/fed. The percentage increases for seed yield/fed were (1, 3, 11 and 11%) over Sakha 1, Giza 40, Giza 3 and Sakha 2 cultivars, respectively in the second season only. Eman *et al*. [23]showed that, concerning number of seeds/plant, Giza 843 gave the highest values, whereas Giza 716 exhibited the lowest values in the two seasons. Regarding seed yield/ ha, Nubariah 3 gave the significantly highest value (2.54 t/ha) while Sakhal gave the lowest value (2.18 t/ ha) in the first season.

Effect of Fertilizer Treatments: As for data of fertilizer treatments in Table (4), it was found that faba bean plants fertilized with 50%NPK+ Compost attained the highest number of pods/plant (21.56 and 20.91), the heaviest 100-seed (75.17 and 73.19g), the highest seed yield/hectare (4.57 and 4.52 ton) in 1st and 2nd seasons, respectively. In all cases, 50%NPK+ Compost treatment did not differ significantly at Compost + Rhizobia except for seed yield/hectares in both seasons.

Effect of Cultivars × Fertilizer Treatments Interactions: Data in Table (4) indicatedwide different responses of the three faba bean cultivars to all fertilizer treatments for yield its yield components traits in both seasons of this study. The interaction of Giza716 x 50%NPK+ Compost showed desirable value for the number of pods/plant, the 100-seed weight, seed yield/ hectare in both seasons. Also, Giza40 x 50%NPK+ Compost showed excellent seed yield/ hectare in 1st and 2 nd seasons. These interactions significantly exceeded all other interactions in both seasons of the study.

In this study, the two treatments 50%NPK+ Compost andCompost + Rhizobia significantly exceeded all other treatments in addition to the control treatment in all yield and yield components traits in both seasons. In the same line, Mohamed and Gomaa [29] showed that when the bio fertilization of faba bean with the combined inoculum of *Rhizobium* and *Candida* accompanied with either 5 m^3 or 10 m^3 of Compost, pods number/plant, seeds number/pod

Table 4: Means of yield and its components infaba bean cultivarsas affected by cultivar, fertilizer treatments and their interactions during 2016/17 and 2017/18 seasons

Traits		No. of pods/ Plant		100-seed weight (g)		Seed yield /hectare (ton)	
Seasons		2016/17	2017/18	2016/17	2017/18	2016/17	2017/18
Factors							
1-Cultivar							
Sakha 1		9.65^{b}	9.36^{b}	72.29^{b}	70.41^{b}	2.98^{b}	2.94^{b}
Giza 40		14.23^{a}	13.81^{a}	62.39^{c}	60.81^{c}	2.91^{c}	2.87^{c}
Giza 716		14.18^{a}	13.75^{a}	78.07^{a}	76.03^{a}	3.41^{a}	3.37^{a}
LSD 5%		1.14	1.11	1.29	1.26	0.04	0.04
2-fertilizer							
100% NPK		16.00^{b}	15.52^{b}	71.53^{bc}	69.66^{bc}	3.09^{d}	3.05^{d}
Compost		7.04^{d}	6.83^{d}	70.57^{c}	68.90^{c}	2.75^{e}	2.71^{e}
Rhizobia		12.51^{c}	12.14^{c}	68.14^{d}	66.36^{d}	2.24^{g}	2.21^{g}
50%NPK+ Compost		21.56^{a}	20.91^{a}	75.17^{a}	73.19^{a}	4.57^{a}	4.52^{a}
50%NPK+ Rhizobia		7.64^{d}	7.42^{d}	68.20^{d}	66.43^{d}	2.40^{f}	2.37^{f}
Compost + Rhizobia		20.91^{a}	20.28^{a}	73.58^{ab}	71.65^{ab}	4.17^{b}	4.12^{b}
25% NPK+ Compost + Rhizobia		8.51^{d}	8.26^{d}	70.04^{cd}	68.23^{cd}	3.45^{c}	3.40^{c}
Control		7.31^{d}	7.09^{d}	70.08^{cd}	68.26^{cd}	2.15^{h}	2.12^{h}
LSD 5%		1.58	1.53	2.26	2.20	0.04	0.04
3-Interaction							
Sakha 1	100% NPK	9.53	9.25	75.50	73.55	3.31	3.27
	Compost	5.13	4.98	71.82	69.97	2.63	2.60
	Rhizobia	7.47	7.24	71.09	69.24	2.17	2.14
	50%NPK+ Compost	18.60	18.04	76.82	74.81	4.30	4.25
	50%NPK+ Rhizobia	7.60	7.37	68.26	66.49	2.06	2.04
	Compost + Rhizobia	13.93	13.52	74.29	72.36	4.10	4.05
	25% NPK+ Compost + Rhizobia	7.27	7.05	68.94	67.16	3.20	3.16
	Control	7.67	7.44	71.57	69.71	2.07	2.04
Giza 40	100% NPK	23.00	22.31	60.37	58.75	2.40	2.37
	Compost	7.08	7.57	62.96	61.79	2.75	2.72
	Rhizobia	13.33	12.93	58.55	57.01	2.07	2.05
	50%NPK+ Compost	17.87	17.33	67.12	65.37	4.67	4.61
	50%NPK+ Rhizobia	8.20	7.95	60.71	59.12	2.05	2.02
	Compost + Rhizobia	25.73	24.96	65.75	64.01	3.97	3.92
	25% NPK+ Compost + Rhizobia	10.80	10.48	61.57	59.98	3.37	3.33
	Control	7.13	6.92	62.07	60.46	1.99	1.97
Giza 716	100% NPK	15.47	15.00	78.72	76.66	3.55	3.51
	Compost	8.20	7.95	76.94	74.94	2.86	2.82
	Rhizobia	16.73	16.23	74.78	72.82	2.47	2.44
	50%NPK+ Compost	28.20	27.35	81.58	79.41	4.74	4.68
	50%NPK+ Rhizobia	7.13	6.92	75.64	73.69	3.09	3.05
	Compost + Rhizobia	23.07	22.37	80.71	78.58	4.45	4.40
	25% NPK+ Compost + Rhizobia	7.47	7.24	79.61	77.55	3.77	3.72
	Control	7.13	6.92	76.60	74.62	2.39	2.36
LSD 5%		2.29	2.22	3.26	3.18	0.06	0.06

and pod weight increased. Also, the inoculation of faba bean seed with active nitrogen fixing bacteria before sowing has a significant role for the increase of the seed yield [32]. Also, P fertilizer is essential for grain production in faba beans [33].

Effect of Cultivars, Fertilizer Treatments and Their Interaction on Chocolate Spot and Rust Diseases Severity % During 2016/17 and 2017/18 Seasons

Effect of Cultivars: Data in Table (5) showed that the lowest percentages of disease severity of chocolate spot were found in Giza 716 (8.98 and 8.14) followed by cv. Sakha 1. (9.04 and 9.51%) in both seasons, respectively. However, Sakha 1 cv. recorded the lowest percentage of disease severity of rust compared with all tested cultivars (15.75 and 15.63%) in both seasons, respectively. While, the data also showed that Giza 40 cv. had the highest values of the disease severity of chocolate spot and rustin both seasons.

Results indicated that Giza 716 and Sakha 1 seemed to be more resistant to chocolate spot and rust diseases than Giza 40 and this result is in the same trend mentioned byEl-Sayed *et al.* [34] observed that, the cvs. Giza 716 and Sakha 2 showed lower infection than the other tested cvs, except with Giza 40 which was highly susceptible. Field studies showed significant differences under the influence of chocolate spot disease. The area under the disease progress curve (AUDPC) was higher on Giza 40 followed by Sakha 1, Giza 3 Mohassen, Sakha 2 and Giza 716, respectively, with higher disease infection in the first season 2007/08 than 2008/09 season. Where, Abbas *et al.* [8] whoreported that Giza 716 cultivar followed by Sakha 1 were more resistance for infection with chocolate spot and rust diseases than Giza 40 and Giza 3. Also, Waly *et al.* [35] found that, Nubaria 1 cv. was the most resistant one to chocolate spot where it scored the lowest disease severity among all cultivars in both seasons followed by Misr 1 cv. in both seasons.

Effect of Fertilizer Treatments: The effect of fertilizer treatments on chocolate spot and rust diseases severity (DS) and consequently on the protection of faba bean plants of (Sakha 1, Giza 40 and Giza 716 cvs.) during the two seasons 2016/2017 and 2017/2018 were shown in Table (5). All the treatments, NPK, Compost and seed inoculation with Rhizobium either separately or in combinations significantly decreased the (DS) of chocolate spot and rust during the two seasons under natural infection conditions. 25%NPK+Compost+Rhizobia had the best effect in reducing the disease severity of chocolate spot followed by 50% NPK +Compost, 50% NPK +Rhizobia thenCompost +Rhizobia with disease reduction averages of 5.62, 6.47, 8.09 and 8.62%while, the highest disease severity was obtained by Rhizobia (13.29%) in the first season compared with controltreatment (16.16%). In the second season, the same trend was cleared with light differences in the treatments arrangement. In this respect, the highest reduction was recorded with 25%NPK+Compost+Rhizobia followed by 50% NPK +Compost with the averages of 5.85 and 6.33 disease reduction, respectively.

It is clear from Table (5) that soil and seed treated with 25%NPK + Compost+ Rhizobia had the best effect in reducing the disease severity of rust followed by 50% NPK + Compost, 50% NPK + Rhizobia and Compost + Rhizobia with the averages of 10.67, 11.00, 13.33 and 16.67, respectivelyin the first season 2016/2017. In the second season 2017/2018 the same trend was noticed where 25%NPK + Compost+ Rhizobia and 50% NPK + Composthad the same effect in reducing the disease severity of rust (13.33%) followed 50% NPK + Rhizobiaand Compost + Rhizobia with the averages of14.33and 18.33%, respectively. The best effect of Compostmay be due to its content of antimicrobial activities [11, 36]. There are severalmechanisms of microbial actionsuch as microbial competition for nutrients, antibiotic production, antagonistic microbes' natural ability to produce extracellular lytic enzymes [37], parasitism and induction of systemic acquired resistance [38] are among the major means by which Compost extracts suppress plant pathogenic microorganisms.

Effect of Cultivars × Fertilizer Treatments Interactions: The data in Table (5) indicated wide different responses of the three faba bean cultivars to reduce disease severity of chocolate spot and rust in both seasons. The interaction of Sakha 1× 25% NPK +Compost +Rhizobia and 50% NPK +Compost showed the highest effect on the reduction of disease severity of chocolate spot for both seasons. However, Sakha1×50% NPK + Compost and 25% NPK +Compost +Rhizobia recorded the beast effect in reducing disease severity of rust in both seasons. Giza 716×25% NPK +Compost +Rhizobia, 50% NPK + Rhizobia and50% NPK + Composthad the least diseases severity of chocolate spot in the first season. Followed byGiza 716×25% NPK +Compost +Rhizobia, 50% NPK + Compost and 50% NPK + Rhizobia in the second season. In the first season 2016/2017 treatments of Giza 716×25%NPK + Compost+ Rhizobia and 50% NPK + Compost had the same value in reducing the disease severity of rust (10.00%). Also, Giza 716×50% NPK + Compost and 50% NPK + Rhizobia had the second grade inreducing disease severity of rust in the second season. On the Other hand, Giza 40×NPK and Rhizobia alone had the highest disease severity of chocolate spot and rust in both seasons followed the control treatment.

In this study 25%NPK+Compost+Rhizobia significantly reduce chocolate spot severity in both seasons compared with all other treatments and the control. In this respect, Ibrahim [13] found a positive effect of Compost as an alternative biological fungicide

Table 5: Disease severity (DS) of chocolate spot and rust as affected by cultivar, fertilizer treatments and their interactions during 2016/17 and 2017/18 seasons

		Chocolate spot (DS)		Rust (DS)	
		2016/17	2017/18	2016/17	2017/18
Cultivars					
Sakha 1		9.04^{b}	9.51^{b}	15.75^{c}	15.63^{c}
Giza 40		11.08^{a}	11.08^{a}	23.50^{a}	25.63^{a}
Giza 716		8.98^{b}	8.14^{c}	18.75^{b}	16.92^{b}
LSD 5%		0.19	0.19	1.28	1.16
Treatments					
100% NPK		10.27^{c}	10.04^{c}	25.00^{b}	25.44^{b}
Compost		9.07^{d}	9.07^{d}	18.33^{c}	18.67^{c}
Rhizobia		13.29^{b}	12.37^{b}	24.00^{b}	25.33^{b}
50%NPK+ Compost		6.47^{g}	6.33^{f}	11.00^{f}	13.33^{d}
50%NPK+ Rhizobia		8.09^{f}	8.30^{e}	13.33^{e}	14.33^{d}
Compost + Rhizobia		8.62^{e}	8.54^{e}	16.00^{d}	18.33^{c}
25% NPK+ Compost + Rhizobia		5.62^{h}	5.85^{g}	10.67^{f}	13.33^{d}
Control		16.16^{a}	16.11^{a}	31.00^{a}	31.67^{a}
LSD 5%		0.42	0.41	1.19	2.07
Interactions					
Sakha 1	100% NPK	10.10	10.10	20.00	23.00
	Compost	9.27	9.65	15.00	14.00
	Rhizobia	12.50	12.13	20.00	21.00
	50%NPK+ Compost	5.03	6.18	5.00	10.00
	50%NPK+ Rhizobia	7.52	8.55	10.00	13.00
	Compost + Rhizobia	8.63	8.90	10.00	15.00
	25% NPK+ Compost + Rhizobia	4.15	5.40	7.00	10.00
	Control	15.10	15.13	28.00	30.00
Giza 40	100% NPK	11.20	11.20	30.00	32.00
	Compost	9.77	9.77	20.00	25.00
	Rhizobia	14.27	14.27	30.00	35.00
	50%NPK+ Compost	7.63	7.63	18.00	20.00
	50%NPK+ Rhizobia	10.19	10.19	15.00	18.00
	Compost + Rhizobia	9.68	9.68	20.00	25.00
	25% NPK+ Compost + Rhizobia	7.18	7.18	15.00	15.00
	Control	18.73	18.73	35.00	40.00
Giza 716	100% NPK	9.50	8.83	25.00	21.33
	Compost	8.18	7.78	20.00	17.00
	Rhizobia	13.12	10.72	22.00	20.00
	50%NPK+ Compost	6.75	5.17	10.00	10.00
	50%NPK+ Rhizobia	6.55	6.15	15.00	12.00
	Compost + Rhizobia	7.55	7.03	18.00	15.00
	25% NPK+ Compost + Rhizobia	5.53	4.97	10.00	15.00
	Control	14.63	14.45	30.00	25.00
LSD 5%		1.19	0.60	0.60	2.99

for controlling chocolate leaf spot disease in faba bean, with different application methods. Composts may trigger indirect defense mechanisms by bushed the plant to create an increased state of resistance, similar to systemic acquired resistance [39, 40]. Generally that it can be noticed the combined application treatments of different rats of NPK with Compost or rhizobia showed more reduction in disease severity comparing with application of singly treatments. These results are in agreement with those reported by Addisu [12] mentioned that applied of different sources of Compost to faba bean, *B. fabae* (Chocolate spot) reduced to less than 22% severity and decrease the severity of Ascochyta blight (*Ascochyta fabae*) to 18.5%. Moreover, rust (*Uromyces vicia faba*) could be minimized to about 22.2% severity. Microorganisms in Compost may act through one or more biological control mechanisms, competing for nutrients and/or space [41]. Compost contain antifungal compounds, possess their antibiosis is the main mechanism of action [42]. Al-Mughrabi [43] revealed that,

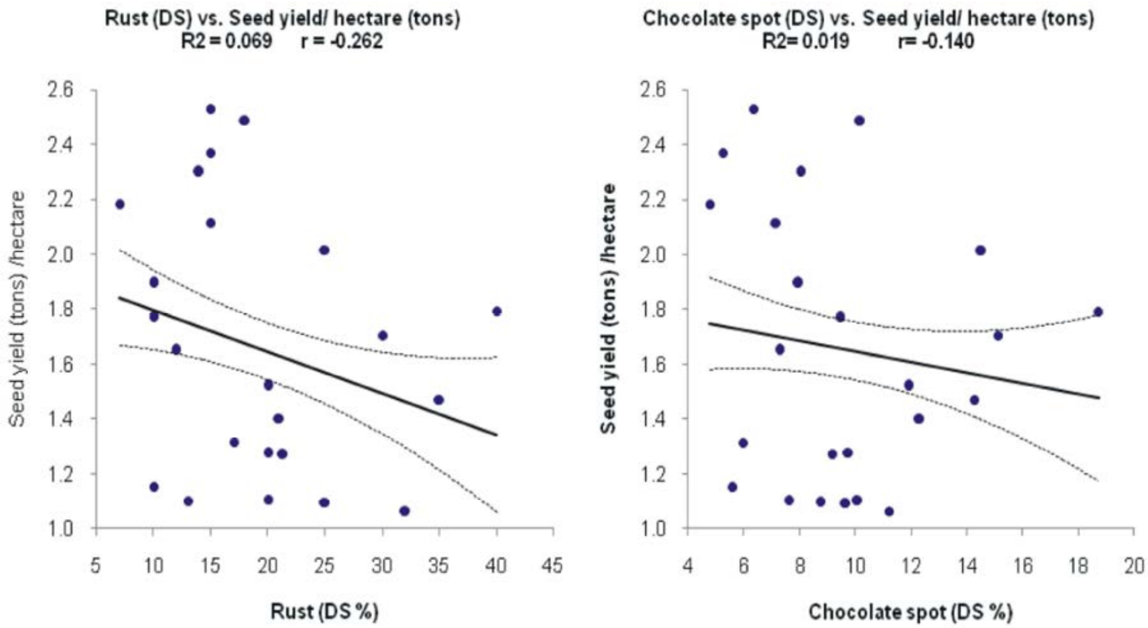


Fig. 1: Correlation coefficients between seed yield (tons/hectare) and chocolate spot disease infection in combined seasons 2016/17, 2017/18

Compost reduced severity by 29 and 27%, when applied as a foliar spray against late blight (*Phytophthora infestans*) of potato (*Solanum tuberosum*). In addition, Compost as a soil drench significantly reduced the late blight disease severity (*Phytophthora infestans*) in tomatoes and potatoes [44].

Correlation Coefficients Between Seed Yield /Hectare (Tons) with Chocolate Spot and Rust Diseasesseverity in Combined Seasons 2016/17and 2017/18: In terms of the coefficient regression (R^2) of chocolate spot and rust diseasesseverity with seed yield /hectare (tons), Figure 1 confirmed that rust was more serious than chocolate spot in reducing faba bean seed yield / hectare (tons). Seed yield/ hectare (tons) negatively correlated with both chocolate spot and rust disease severity. The illustration in Fig. (1) indicated that seed yield/ hectare (tons) was negativelycorrelated with rust severity where the R^2 was 0.069 and insignificant week correlation coefficient of -0.262. Also, the correlation coefficient of seed yield / hectare (tons) with chocolate spot disease severity was negative -0.140and wasinsignificant with regression coefficient (R^2) of 0.019. Negative associations between faba bean yield and diseases impact were shown inother studies such as Kim *et al*. [2] who observed negative and significant correlations between seed yield and each of diseases chocolate spotand rust confirm their negative impact on seed yield of faba bean.

Effect of Cultivars, Fertilizer Treatments and Their Interaction on the Changes of Peroxidase and Phenoloxidase Activities During 2016/17 and 2017/18 Seasons

Effect of Cultivars: Data in Table (6) indicate that the highest activities of peroxidase were presented in Giza 716 cv. (0.49 and 0.54) followed by Sakha 1 (0.44 and 0.48) while, the lowest peroxidase activities were presented in Giza 40 with averages of 0.42 and 0.46 in both seasons, respectively. Data also, showed that Sakha 1 showed the highest polyphenol-oxidase activities (0.14 and 0.15) followed by Giza716 (0.11 and 0.12) while, Giza40 showed the lowest polyphenol-oxidase activities with averages of 0.08 and 0.09 in the 1st and 2nd seasons, respectively.

Effect of Fertilizer Treatments: As for fertilizers treatments either single or in combinations with mineral fertilizer, Compost and seed inoculation with Rhizobium have increased the activities of both PO and PPO over the check treatment. Peroxidase activity was markedly increased withthe treatments of 25%NPK+ Compost+ Rhizobia and 50%NPK + Compost with the averages of (0.60, 0.52 mg/g leaves) and (0.65 and 0.57 mg/g leaves) in both season, respectively. Meanwhile, Rhizobia and either Compost or NPK individually recorded the less increase in PO enzyme activity with averages of 0.43, 0.43 and 0.40 mg/g leaves in the first season, respectively.

Table 6: Defense enzymes peroxidase and phenoloxidase activities as affected by cultivar, fertilizer treatments and their interactions during 2016/17 and 2017/18 seasons

		Peroxidase activity (PO) (mg/g fw.)		Polyphenol oxidase (PPO) (mg/g fw.)	
		2016/17	2017/18	2016/17	2017/18
1-Cultivar					
Sakha 1		0.44[b]	0.48[b]	0.14[a]	0.15[a]
Giza 40		0.42[c]	0.46[b]	0.08[c]	0.09[c]
Giza 716		0.49[a]	0.54[a]	0.11[b]	0.12[b]
LSD 5%		0.02	0.03	0.02	0.02
2-Fertilizer					
100% NPK					
NPK		0.43[de]	0.47[de]	0.09[cd]	0.10[cd]
Compost		0.43[de]	0.47[de]	0.10[c]	0.11[c]
Rhizobia		0.40[e]	0.44[e]	0.07[de]	0.08[de]
50%NPK+ Compost		0.52[b]	0.57[b]	0.15[b]	0.16[b]
50%NPK+ Rhizobia		0.49[bc]	0.54[bc]	0.11[c]	0.12[c]
Compost + Rhizobia		0.45[cd]	0.49[cd]	0.09[cd]	0.09[cd]
25% NPK+ CCompost + Rhizobia		0.60[a]	0.65[a]	0.22[a]	0.23[a]
Control		0.30[f]	0.33[f]	0.05[e]	0.06[e]
LSD 5%		0.05	0.06	0.03	0.04
3-Interaction					
Sakha 1	100% NPK NPK	0.40	0.44	0.11	0.12
	Compost	0.42	0.46	0.11	0.12
	Rhizobia	0.36	0.40	0.11	0.12
	50%NPK+ Compost	0.55	0.59	0.18	0.20
	50%NPK+ Rhizobia	0.48	0.53	0.13	0.15
	Compost + Rhizobia	0.43	0.47	0.13	0.14
	25% NPK+ Compost + Rhizobia	0.59	0.64	0.25	0.27
	Control	0.32	0.35	0.09	0.09
Giza 40	100% NPK NPK	0.42	0.46	0.05	0.06
	Compost	0.39	0.43	0.08	0.09
	Rhizobia	0.39	0.42	0.04	0.05
	50%NPK+ Compost	0.45	0.50	0.10	0.11
	50%NPK+ Rhizobia	0.45	0.49	0.08	0.09
	Compost + Rhizobia	0.40	0.44	0.06	0.07
	25% NPK+ Compost + Rhizobia	0.60	0.65	0.19	0.20
	Control	0.24	0.26	0.01	0.01
Giza 716	100% NPK 100% NPK	0.46	0.50	0.11	0.12
	Compost	0.47	0.51	0.11	0.12
	Rhizobia	0.46	0.50	0.06	0.06
	50%NPK+ Compost	0.56	0.61	0.16	0.17
	50%NPK+ Rhizobia	0.54	0.59	0.11	0.12
	Compost + Rhizobia	0.51	0.55	0.07	0.07
	25% NPK+ Compost + Rhizobia	0.60	0.66	0.21	0.23
	Control	0.34	0.37	0.06	0.06
LSD 5%		0.03	0.03	0.02	0.02

The same trend being obvious in case of polyphenoloxidase where 25%NPK+ Compost+ Rhizobia followed by 50%NPK + Compost and 50%NPK+Rhizobia had the highest values but Compost followed them with averages of 0.22, 0.15, 0.11, 0.10 0, 23, 0.16, 0.12 and 0.11 mg/g leaves in both seasons, respectively.

Effect of Cultivars × Fertilizer Treatments Interactions: Results in Table (6) indicate that all studied cultivars expressed a differ responses under the different fertilizers treatments for peroxidase and polyphenol-oxidase activities in the two seasons of studies. The interaction of Giza 716 x 25% NPK+ Compost + Rhizobia showed the highest peroxidase and polyphenol-oxidase activities in both seasons followed by Sakha 1 x 25% NPK+ Compost + Rhizobia then Giza40 x 25% NPK+ Compost + Rhizobia. On the other side the lowest peroxidase and polyphenol-oxidase activities were presented in Giza 40 x Control in the two seasons of the study.In the present work the least activity, was recorded for singly treatment (NPK, Compost and Rhizobia) on both PPO and PO in both seasons.

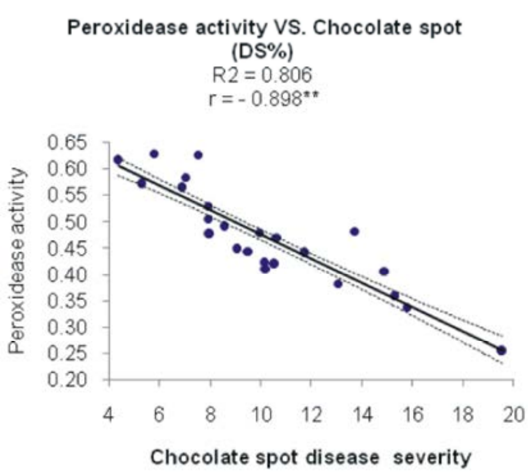
These results are in agreement with the results of Ibrahim [13] who found that Peroxidase enzyme (PO) increased by 200% under all methods of Compost applications. Polyphenol oxidase enzyme (PPO) reached 1411% by integrated treatment with foliar spray, soil drench and seed soaking at 50% Compost concentration. Goldstein [45] reported that Compost activate disease resistant genes in plants, in response to the presence of pathogen; they mobilize chemical defense against the pathogen invasion. Activity of inducible enzymes such as PO and PPO were increased in infected okra plants pretreated with Compost. The induction increments were observed in the early phase of infection [36].

The Relationship Between Diseases Severity of (Chocolate Spot and Rust) and Defense Enzymes of (Peroxidase and Polyphenoloxidase) in Faba Bean: Figures 2 and 3 (a and b) illustrate the chocolate spot and rust severities that associated negatively with the defense enzymes peroxidase and polyphenoloxidase activities where sharp increase of enzymes activities significantly reduce the disease infection. This negative association may be a clear evidence for the role of these enzymes in faba bean defense mechanism against fungi.

Negative correlationsbetween disease severity of chocolate spot and rust and peroxidase and polyphenol oxidase activities were detected. Tarrad *et al*. [46] and Cherif *et al.* [47] reported that the increase in peroxidase activity significantly enhanced in response to chocolate spot disease, which may restrict fungal penetration and play an important role in induced resistance of plant to the pathogen. Another supportive suggestion was made by Nawar and Kuti [48] who stated that an increase in peroxidase activity is considered as clear indicator for resistance in faba beans to chocolate spot disease.

Effect of Cultivars, Fertilizers Treatments and Their Interaction on Leaf Miner Larvae and Adult Aphid Numbers in 2016/17 and 2017/18 Growing Seasons

Effect of Cultivars: Data in Table (7) showed thatnumbers of peaked leaf miner larvae and adult aphid significantly differed in the three cultivars in the 1st season while they were insignificant in the 2ndseason. The data revealed that the lowest numbers of leaf miner (Liromiza congesta) were peaked in the 1st season in cv Sakha 1. (6.92) followed by Giza 40 (8.38). While, the highest numbers of leaf miner(Liromizacongesta) were collected from cv Giza 716. with an average of 9.21. In the sameline, the lowest numbers of aphid in the 1st season were counted in Sakha 1 (5.88) followed by Giza 40 (6.58) respectively. On the other hand, the highest numbers ofaphid were collected from cv Giza 716. with an average of 7.79 in the 1st season. The differences between faba bean genotypes in their resistance to leaf miner and aphid may due to the wide genetic diversity between these genotype.



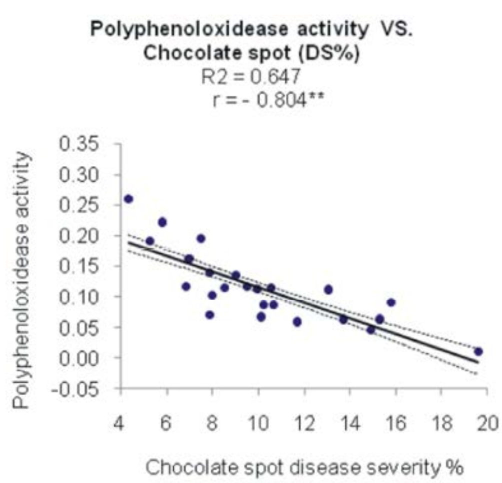


Fig. 2: The relationship between chocolate spot disease severity and the defense enzymes activities (peroxidase and polyphenoloxidase) in faba bean

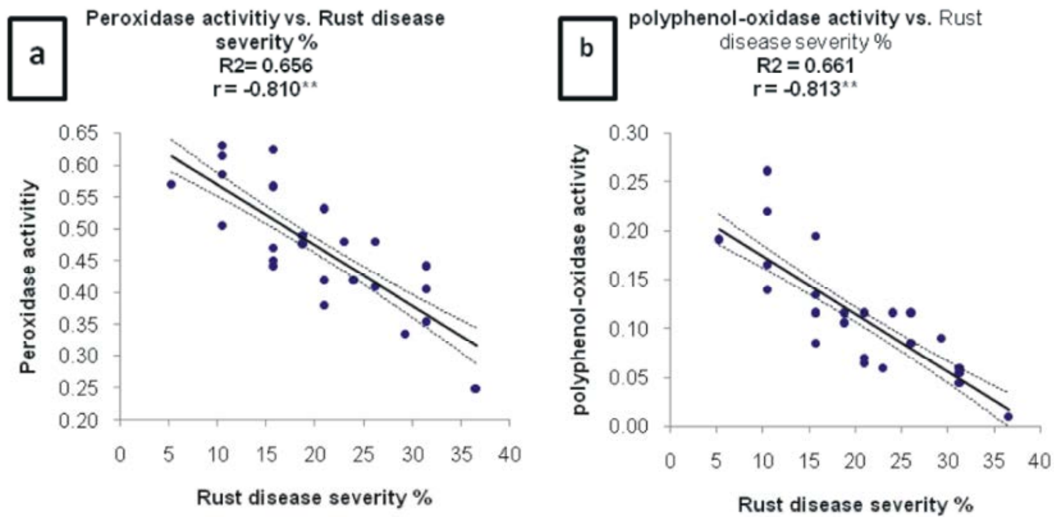


Fig. 3: The relationship between rust disease severity and the defense enzymes activities (peroxidase and polyphenoloxidase) in faba bean

In this study, Giza 40 seemed to be a moderate resistant to aphid and leaf miner infections these finding are in contrast with those by Abou-Elhagag and Salman [3], who found that Giza 40 was low resistantto aphid infestation. Similar results was obtained before by Waly *et al.* [35] who found that, the lowest numbers of leaf miner (Liromiza congesta) in both seasons were counted in cv Misr 1. followed by Nubaria 1 then Giza 40. In the same way, the lowest numbers of aphid were collected from Giza 40 followed by Misr 1 then Nubaria 1 in the two seasons.

Effect of Fertilizer Treatments: As for fertilizer treatments effect on faba bean tolerance to leaf miner and aphid infections, the data in Table (7) indicated that all fertilizers treatments resulted in significant decrease of leaf miner and aphid infections compared with the control treatment in both seasons of this study. The lowest numbers of leaf miner were peaked from faba bean plants which fertilized with 25% NPK+ Compost + Rhizobia (3.33 and 5.00) followed by NPK treatment (7.33 and 7.44) and 50%NPK + Compost (7.89 and 7.00) then Compost treatment with averages of 7.67 and 7.89 in both seasons, respectively. On the other side, the largest numbers of leaf miner were collected form faba bean plants in the control treatment with averages of 12.00 and 11.33 in both seasons, respectively. In the same way, 25% NPK+ Compost + Rhizobia showed the lowest number of adult aphids were collected from faba bean cultivars (3.22 and 3.78) followed by NPK (6.11 and 7.11) then 50%NPK + Compost with averages of 6.67 and 6.89 in both seasons, respectively. On the contrast of this the largest numbers of adult aphids were peaked under the control treatment with averages of 8.67 and 10.33 in both seasons, respectively.

Effect of Cultivars × Fertilizer Treatments Interactions: Results in Table (7) indicated that the three cultivars differ in their responses to the all fertilizers treatments. The results showed that fertilized the three faba bean cultivars with any fertilizers led tosharply decrease in numbers of leaf miner (Liromiza congesta) and aphid compared tocontrol. The three cultivars showed a large decrease in numbers of leaf miner (Liromiza congesta) and aphid under fertilized with 25% NPK+ Compost + Rhizobia. The result indicated that the lowest numbers of leaf miners and aphid were peaked from the interaction of Sakha 1 x 25% NPK+ Compost + Rhizobia followed by Giza 40 x 25% NPK+ Compost + Rhizobia then Giza 716 x 25% NPK+ Compost + Rhizobia in the two seasons of this study. On the contrast of this the largest number of leaf miners and aphids were collected from Giza 716 cv. under the control treatment in both seasons.

In this study the fertilization combination of NPK + Compost + Rhizobia reduces aphid and leaf miner compared to control. Soils with high organic matter and active soil biology generally exhibit good soil fertility as well as complex food webs and beneficial organisms that reduced infection. On the other hand, farming practices that cause nutrition imbalances can lower pest resistance [49]. Morales *et al.* [50] found that fertilized corn fields

Table 7: Effect of cultivars, fertilizers treatments and their interaction on leaf miner larvae and adult aphid numbers during 2016/17 and 2017/18 seasons

		Number of Leaf miner larvae		Adult aphid numbers	
		2016/17	2017/18	2016/17	2017/18
1- Cultivars					
Sakha 1		6.92[c]	7.79	5.88[b]	7.17
Giza 40		8.38[b]	7.96	6.58[b]	7.54
Giza 716		9.21[a]	8.04	7.79[a]	7.58
LSD 5%		0.65	0.72 (ns)	0.82	0.78 (ns)
2-Fertilizers					
100% NPK		7.33[e]	7.44[de]	6.11[d]	7.11[de]
Compost		7.67[e]	7.89[cd]	6.67[cd]	7.67[cd]
Rhizobia		9.22[bc]	8.78[b]	8.11[ab]	8.67[b]
50%NPK+ Compost		7.89[de]	7.00[e]	6.67[cd]	6.89[e]
50%NPK+ Rhizobia		8.56[cd]	7.67[cde]	7.44[bc]	7.11[de]
Compost + Rhizobia		9.33[b]	8.33[bc]	7.11[c]	7.89[c]
25% NPK+ Compost + Rhizobia		3.33[f]	5.00[f]	3.22[e]	3.78[f]
Control		12.00[a]	11.33[a]	8.67[a]	10.33[a]
LSD 5%		0.69	0.74	0.78	0.73
3-Interactions					
Sakha 1	100% NPK	6.00	7.33	6.00	6.33
	Compost	6.33	7.67	6.00	7.00
	Rhizobia	8.33	9.00	7.67	8.33
	50%NPK+ Compost	6.67	7.00	5.67	6.33
	50%NPK+ Rhizobia	7.67	7.67	6.33	6.67
	Compost + Rhizobia	8.67	8.33	6.00	8.00
	25% NPK+ Compost + Rhizobia	2.67	5.00	2.33	3.67
	Control	9.00	10.33	7.00	11.00
Giza 40	100% NPK	7.67	7.67	5.67	7.33
	Compost	8.00	7.33	6.00	8.00
	Rhizobia	9.33	8.33	8.00	8.67
	50%NPK+ Compost	7.67	7.33	6.33	7.33
	50%NPK+ Rhizobia	8.67	8.00	7.33	7.67
	Compost + Rhizobia	9.33	8.67	7.33	8.00
	25% NPK+ Compost + Rhizobia	3.33	4.33	3.00	3.33
	Control	13.00	12.00	9.00	10.00
Giza 716	100% NPK	8.33	7.33	6.67	7.67
	Compost	8.67	8.67	8.00	8.00
	Rhizobia	10.00	9.00	8.67	9.00
	50%NPK+ Compost	9.33	6.67	8.00	7.00
	50%NPK+ Rhizobia	9.33	7.33	8.67	7.00
	Compost + Rhizobia	10.00	8.00	8.00	7.67
	25% NPK+ Compost + Rhizobia	4.00	5.67	4.33	4.33
	Control	14.00	11.67	10.00	10.00
LSD 5%		0.99	1.07	1.13	1.06

with organic fertilizer (applied for 2 years) hosted fewer aphids (*Rhopalosiphummaidis*) than corn fertilized with synthetic fertilizer. This difference may due to a higher concentration of foliar N in corn in the synthetic fertilizer plots, although numbers of fall armyworm (*Spodoptera frugiperda*) showed a weak negative correlation with increased N levels. Rhizobium has been found to a benefit tool to reduce aphids and other insect pests [51]. Rhizobium inclusion with fababean seeds associated with the increase in aphid on fababean shoots, which may due to increase nutritive suitability of the host plant due to nitrogen fixation [52]. Rhizobium on faba bean modified by soil fertility amendments [53]. In the contrast to this Naluyange *et al*. [54] indicated that rhizobium and Compost increased nodulation while *Aphis fabae* population increased.

CONCLUSION

The present study showed that, Compost and rhizobium could be suggested as an eco-friendly strategy that could control chocolate spot rust diseases, leaf miner and aphid in faba bean in addition to increase seed yield, reduce the mineral fertilizer and reduce the chemical-based fungicide dependency with no negative effect on soil microbes and are safe for health and the environment, relatively cheap and advantageous for agronomy.

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