

## Evaluation of some Fodder Beet Genotypes for Yield, Yield Components and Diseases Susceptibility under New Valley Conditions

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### ABSTRACT

A field experiment was conducted to evaluate four fodder beet genotypes under Farm of El-Kharga Research Station of the Agricultural Research Center New Valley Governorate during two successive growing winter seasons of 2013/14 and 2014/15. The experiment was carried out in a randomized complete block design (RCBD) with three replications. The present investigation focused on the growth and yielding properties and diseases development. The obtained results show that the tested genotypes of fodder beet were significantly different for yield characteristics *viz.* average of leaf length, root length, number of leaves/plant and root diameter and yield components *viz.* fresh and dry weight of root and leaves/plant and total fresh and dry weight of root and leaves/fed. Genotype Splendid recorded the highest leaf length, number of leaves /plant, root diameter in both seasons and their combined data, respectively. Also, this genotype recorded the best root fresh weight/plant, total fresh weight of roots/fed and dry weight of roots/fed. in both seasons their combined data, respectively. While genotype Jamon recorded the highest root length, fresh weight of leaves/plant, total fresh weight of leaves / fed. and total dry weight of leaves/fed in both seasons their combined data, respectively. On contrary, Splendid fodder beet genotype recoded the lowest fresh weight of leaves /plant, fresh and dry weight of leaves/fed. While, Jamon recorded the lowest fresh weight of root/plant, fresh and dry weight of roots/fed. The combined analysis of data revealed that the treats leaf length, number of leaves per plant fresh weight of leaves per plant and dry weight of roots per fed were insignificant effect by seasons. While the characters, root length, root diameter, fresh weight of root per plant and fresh weight of roots per fad were significant affected by seasons, whereas the mean values of the second season were more than the first season. On the other hand, the tested genotypes were varied to susceptibility to infection with diseases *viz.* damping-off, root rot/wilt, powdery mildew and leaf spots under natural infection in field. Both Rigour and Jamon genotypes recorded the highest susceptibility to infection with damping-off disease in both growing seasons, while both genotypes recorded the lowest root rot /wilt severity. Splendid and Rigour genotypes were recorded the highest susceptible to infection with powdery mildew in both growing seasons. Starmon and Splendid genotypes were recorded the highest percentage of infection with leaf spot disease in both growing seasons. We could recommend growing genotype Splendid under New Valley Governorate because recorded the highest results in most parameters and resistance to root rot and wilt diseases.

**Keywords:** Fodder beet, Genotypes, Yield and yield components, Diseases

### INTRODUCTION

Fodder beet offers a higher yield potential than any other "arable" fodder crop. The roots have an excellent feed quality and they are very palatable to ruminant stock. The leaf can be utilized if required to boost the total fodder output even further. Fodder beet when grown under suitable conditions, can produce almost 20 t ha<sup>-1</sup> dry matter yield as compared with 13±1.5 t DM/ ha<sup>-1</sup> from four harvests of grass. Approximately 75% of fodder beet dry matter is in the root component (DAF, 1998).

Including fodder beet in diet of cattle increases intake of dry matter that is quantitative and qualitative factors affecting intake of the basal diet. Fodder beet is successively grown as a fodder crop in the many European countries. The plant is used as a valuable source of fodder for cattle (Niazi *et al.*, 2000 and Slavova *et al.*, 2004). Since fodder beet contains more water and sugar, it increases milk product and being suitable forage for dairy cows. The fodder beet is used by being chopped and by mixing with straw in European countries. It is also reported that the plant is suitable to make silage (Akyildiz, 1983 and Ozen *et al.*, 1993).

The types of the fodder beet varieties are different from each other in terms of some important characteristics such as root shape, root color, root dry

matter content, root and leaf yield, proportion of the root above ground (Abdel-Naby *et al.*, 2014). Determination of appropriate genotypes for each region is important for increasing food better farming.

Fodder beet as similar with sugar beet in attacked with many diseases were effecting of root and foliage protection such as damping-off, root crown rots, wilt diseases. Also, Foliar diseases that affecting leaves and stems of the plants constitute one of the most serious groups causing great damage to the crop specially powdery mildew caused by *Erysiphe betae* (Synonym= *Erysiphe polygoni*) (Harveson, *et al.*, 2009). And leaf spots caused by *Cercospora beticola* (Whitney and Duffus, 1986).

In Egypt, no references for diseases of fodder beet are available. Therefore, the objectives of this study were to: 1) evaluate yield and yield components of four genotypes under field conditions in New Valley Governorate and, 2) evaluate the susceptibility of these genotypes to infection with root and foliar diseases under field conditions.

### MATERIALS AND METHODS

This study is conducted in 2013-14 and 2014-15 growing seasons in New Valley Agric. Res. Station. The study was designed to evaluate yield character for four foreign fodder beet genotypes namely Splendid,

Starmon, Rigour and Jamon introduced from France under field conditions.

An experiment was conducted in a randomized complete block design (RCBD) with three replications. Genotypes were sown in plot size 12 m<sup>2</sup> (4 m × 3 m) with five ridges, 60 cm apart. Fodder beet seeds of the four studied genotypes were sown with about three seeds per hill on top of the shoulder of the ridge at 30 cm apart (14 hills per ridge 4 m long). The sowing done on 15 and 20 October in the first and the second season, respectively. The crop was irrigated at 12-15 days intervals. Hand thinning to one plant per hill after 5 weeks from planting during both seasons. Fertilizers application (NPK) at a mount and rates of recommended package ((200:150:150 kg/fad). The harvesting was done about 7 months from sowing in the two growing seasons. At harvest, 10 plants from the central ridges were pulled up to determine the following traits:

1. Average leaf length (cm per plant).
2. Average root length (cm per plant).
3. Average number of total leaves per plant.
4. Average root diameter (cm per plant) by circumference of circle when the maximum width of root divided on 2.14.
5. Average fresh weight of root /plant (kg)
6. Average fresh weight of leaves /plant (kg)
7. Average fresh weight of roots /fad. (Ton)
8. Average dry weight of roots /fad. (Ton)
9. Average fresh weight of leaves /fad. (Ton)
10. Dry weight of leaves /fad. (Ton)

Fresh and dry weight of roots and leaves (ton/fed.) by weight roots and leaves fresh and dry weight per kg/plot and converted and expressed in ton per fed.

**Disease Assessments:**

**Damping-off, Root Rot and Wilt Assessment:**

Percentage of damping-off was recorded 30 days after planting. While severity of root rot / wilt was determined after 120 days according to Abdou *et al.* (2001) using a rating scale of 0 to 5 on the basis of root discoloration or leaf yellowing as follows, 0 = neither root discoloration nor leaf yellowing, 1= 1-25% root discoloration or one leaf yellowed, 2= 26-50% root discoloration or more than one leaf yellowed, 3= 51-75% root discoloration plus one leaf wilted, 4= up to 76% root discoloration or more than one leaf wilted, and 5= completely dead plants. For each replicate a disease severity index (DSI) similar to that one described by Liu *et al.* (1995) was calculated as follows:

$$DSI = \frac{\sum d}{d \text{ max.} \times n} \times 100$$

Whereas: d is the disease rating possible, d max is the maximum disease rating and n is the total number of plants examined in each replicate.

**Powdery Mildew Assessment:**

Powdery mildew disease severity was monitored using 0-5 scale (Akhileshwari *et al.*, 2012), 0 = No symptom of powdery mildew= Immune; 1 = Small scattered powdery mildew specks covering 1-10 per cent or less leaf area (Resistant); 2 = Small powdery lesions covering 11-25 per cent of leaf area (Moderately resistant); 3 = Powdery lesions enlarged covering 26-50

per cent of leaf area (Moderately susceptible); 4 = Powdery lesions coalesce to form big patches covering 51-75 per cent of leaf area (Susceptible) and 5 = Big powdery patches covering >75 per cent of leaf area and defoliation occur (Highly susceptible). Percent disease index (PDI) was calculated by using the formula given by Wheeler(1969) as follows:

$$PDI = \frac{\text{Sum of individual disease ratings}}{\text{Total number of leaves observed}} \times \frac{100}{\text{Maximum disease grade}}$$

**Cercospora leaf spot Assessment:**

Cercospora leaf spot severity was rated on the KWS scale of 1 to 9 (Weiland, 2000). A rating of 1 indicated no disease, a rating of 3 indicated that all outer leaves displayed typical symptoms and was the early stages of economic loss level and a rating of 9 indicated that the plants had only new leaf growth, all earlier leaves being dead. Cercospora leaf spot severity was assessed throughout the season. However, the rating done three days prior to harvest is reported.

**Statistical Analysis:**

All experiments were performed twice. Analysis of variance was carried out using MSTAT-C, 1991 program version 2.10. Least significant difference (LSD) was employed to test for significant difference between treatments at P≤0.05 (Gomez and Gomez, 1984).

**RESULTS AND DISCUSSION**

**Evaluation of fodder beat genotypes for yield and yield components:**

Mean performances of four genotypes of fodder beat in the two seasons and their combined for forage characters were determined and the obtained results presented in Table 1. The means showed that fodder beat genotypes appeared to be varied significantly from character to another, (Abdel-Naby *et al.*, 2014).

The differences between the genotypes were significant at (p=0.05) for yield and yield components in both seasons and their combined data. Splendid genotype was the highest of leaf length (35.72, 36.63 and 36.18 cm), number of leaves per plant (34.60, 33.15 and 33.88 leaf/plant), root diameter (15.20, 16.23 and 15.72 cm), fresh weight of root/plant (2.67, 2.96 and 2.82 kg), fresh weight of roots/fad. (47.87, 50.14 and 49.01 ton) and dry weight of roots/fad. (5.98, 5.98 and 5.98 ton) in both seasons and their combined data, respectively. On contrary, splendid fodder beat genotype recorded the lowest values of root length, fresh weight of leaves/plant, fresh and dry weight of leaves/fad. In the two seasons and their combined data.

While, Jamon fodder beat genotype recorded the lowest mean values of leaf length (30.62, 30.98 and 30.80 cm), number of leaves/plant (13.80, 15.49 and 14.65 cm), root diameter (13.00, 12.96 and 12.98 cm), fresh weight of root/plant (2.29, 2.36 and 2.33 kg), fresh weight of roots/fad. (29.53, 30.14 and 29.84 ton) and dry weight of roots/fad (4.15, 4.22 and 4.19 ton) in the two seasons and their combined data , respectively, the same results were obtained by Abdel-Naby, *et al.*

(2014). On the other hand, Jamon fodder beat genotype recorded the highest mean values of root length (31.67, 34.49 and 33.08 cm), fresh weight of leaves/plant (0.89, 0.83 and 0.86 kg), fresh weight of leaves/fad. (14.23, 14.25 and 14.24 ton) and dry weight of leaves/fad. (2.17, 2.39 and 2.28 ton) in the two seasons, respectively. The data revealed that stem diameter and root weight were the highest effect on root yield per faddan as well as, leaf length and number of leaves per plant (Splendid genotype). On contrary, fresh weight of leaves/fad. ,plant disaffected by leaf length or number of

leaves per plant, whereas, Jamon fodder beat genotype was the lowest leaf length and number of leaves per plant and produce the highest fresh weight of leaves per plant and per faddan, it is may be due to the leaf thick, whereas, for example, Jamon genotype leaf weight is

$$\begin{aligned} \text{Fresh leaves weight/plant} &= \frac{890}{13.8} = 64.5 \text{ gm/leaf,} \\ \text{Number of leaves/plant} &= \frac{450}{34} = 13 \text{ gm/leaf, in the first season} \end{aligned}$$

**Table 1. Mean performances of fodder beet genotypes for yield and yield components under field conditions during 2013-14 and 2014-15 growing seasons and their combined data.**

Genotypes	Leaf length (cm)	Root length (cm)	Number of leaves /plant	Root diameter (cm)	Fresh weight of root/plant (kg)	Fresh weight of leaves /plant (kg)	Fresh weight of roots /fad (Ton)	Dry weight of roots /fad (Ton)	Fresh weight of leaves/fad (Ton)	Dry weight of leaves/fad (Ton)	
Season 2013-2014											
Splendid	35.72	27.33	34.60	15.20	2.67	0.45	47.87	5.98	8.00	1.01	
Starmon	32.71	28.20	27.73	13.37	2.31	0.75	43.81	5.07	13.36	1.69	
Rigour	33.04	29.80	32.20	13.20	2.49	0.65	33.00	4.75	9.62	1.69	
Jamon	30.62	31.67	13.80	13.00	2.29	0.89	29.53	4.15	14.23	2.17	
Mean	33.02	29.25	27.08	13.69	2.44	0.69	38.55	4.99	11.31	1.64	
LSD at 0.05	0.90	1.80	1.40	1.44	0.19	0.06	1.58	0.49	0.89	0.06	
Season 2014-2015											
Splendid	36.63	29.33	33.15	16.23	2.96	0.44	50.14	5.98	8.23	1.03	
Starmon	33.08	32.23	25.42	14.05	2.44	0.76	44.09	5.14	13.65	1.75	
Rigour	33.76	33.10	30.25	14.52	2.88	0.62	36.25	4.85	10.02	1.65	
Jamon	30.98	34.49	15.49	12.96	2.36	0.83	30.14	4.22	14.25	2.39	
Mean	33.61	32.29	26.08	14.44	2.66	0.66	40.16	5.05	11.54	1.71	
LSD at 0.05	1.30	1.26	1.37	0.99	0.20	0.02	2.21	0.14	0.52	0.15	
Source of Variation											
					Combined Analysis						
Seasons	2013-14	33.02	29.25	27.08	13.69	2.44	0.69	38.55	4.99	11.31	1.64
	2014-15	33.61	32.29	26.08	14.44	2.66	0.66	40.16	5.05	11.54	1.71
LSD at 0.05		NS	0.73	NS	NS	0.19	NS	1.01	NS	NS	NS
Genotypes	Splendid	36.18	28.33	33.88	15.72	2.82	0.45	49.01	5.98	8.12	1.02
	Starmon	32.90	30.22	26.58	13.71	2.38	0.76	43.95	5.11	13.51	1.72
	Rigour	33.40	31.45	31.23	13.86	2.69	0.64	34.63	4.80	9.82	1.67
	Jamon	30.80	33.08	14.65	12.98	2.33	0.86	29.84	4.19	14.24	2.28
LSD at 0.05		0.71	0.97	0.87	0.78	0.12	0.02	1.21	0.12	0.46	0.07
Seasons × Genotypes	S1×G1	35.72	27.33	34.60	15.20	2.67	0.45	47.87	5.98	8.00	1.01
	S1×G2	32.71	28.20	27.73	13.37	2.31	0.75	43.81	5.07	13.36	1.69
	S1×G3	33.04	29.80	32.20	13.20	2.49	0.65	33.00	4.75	9.62	1.69
	S1×G4	30.62	31.67	13.80	13.00	2.29	0.89	29.53	4.15	14.24	2.17
	S2×G1	36.63	29.33	33.15	16.23	2.96	0.44	50.14	5.98	8.23	1.03
	S2×G2	33.08	32.23	25.42	14.05	2.44	0.76	44.09	5.14	13.65	1.75
	S2×G3	33.76	33.10	30.25	14.52	2.88	0.62	36.25	4.85	10.02	1.65
	S2×G4	30.98	34.49	15.49	12.96	2.36	0.83	30.14	4.22	14.25	2.39
LSD at 0.05		NS	NS	1.23	NS	NS	0.03	NS	NS	NS	0.10

The combined analysis of data as shown in Table 1 revealed that the treats of leaf length, number of leaves per plant, root diameter, fresh weight of leaves per plant and dry weight of roots per faddan were insignificant effect by seasons. While the characters, root length, root diameter, fresh weight of root per plant and fresh weight of roots per fad. were significant affected by seasons, whereas the mean values of the second season were more than the first season.

The interaction between genotypes and seasons were insignificant for the most characters, except number of leaves per plant and fresh weight of leaves per plant, which were significant affected. Number of leaves per plant for splendid, Starmon and Rigour fodder beat genotypes was significantly decreased at the second season than the first season, while Jamon genotype was significantly increased. The Jamon genotype was significantly decreased of fresh weight

leaves per plant at the second season, also indicate that increased number of leaves per plant (Jamon) decreased leaves fresh weight per plant. The obtained data indicate that Jamon genotypes recorded the lowest Number of leaves /plant, while gave the highest Fresh weight of leaves /plant (kg). These results it may be due to the large size of the paper and the increased thickness

The results indicated that Splendid fodder beat genotype is successful and suitable cultivar under New Valley Governorate, also can be used as a valuable source of fodder for cattle, Niazi, *et al.*, 2000 and Salvova *et al.*, 2004. Suitable forage for dairy cows and suitable to make silage, Akyildiz, 1983 and Ozen *et al.*, 1993.

**Evaluation of fodder beat genotypes to infection with diseases:**

**Damping-off, root rot and wilt diseases:**

Four fodder beet genotypes were tested for their relative susceptibility towards damping-off, root rot and wilt diseases under natural infection with soil borne pathogens in New Valley Governorate.

Data in Figs. 1 and 2 show that the four tested genotypes were susceptible towards the soil borne pathogens however there were some variations among them. Both Rigour and Jamon genotypes recorded the highest susceptibility to infection with damping-off disease in both growing seasons, whereas recorded 48.33 and 52.22% in the first seasons and 50.33 and 54.33% damping-off in the second season, respectively. While Starmon genotype recorded the lowest damping-off (28.89 and 24.89%) in both seasons, respectively. On contrary, Rigour and Jamon recorded least root rot and wilt severity in both growing seasons, while Starmon gave the highest root rot /wilt severity in both seasons. In Egypt, no references for susceptibility to infection with damping-off and root rot/wilt diseases but some researcher isolated some soil borne pathogens from sugar beet and table beet plants such as *Pythium* spp., *Rhizoctonia solani*, *Aphanomyces cochlioides*, and *Phoma betae* (Whitney and Duffus, 1986, 2003 and Piszczek, 2004 and Abo-Elnaga, 2006). In NewYork, *Pythium ultimum* is the primary causal agent of this disease (Martin, et al., 1984) and causes

severe economic losses during cool, wet soil conditions. Although *R. solani* is encountered less frequently, it is capable of causing seed and seedling diseases of table beets as well as infecting older plants later in the growing season during drier and warmer soil conditions.

**Powdery mildew disease:**

Four fodder beet genotypes were tested for their susceptibility towards Powdery mildew disease under open field in New Valley Governorate. Data present in Fig. 3 show that the susceptibility to infection with powdery mildew disease in the tested genotypes were different significantly. Splendid and Rigour genotypes were recorded the highest susceptible to infection with powdery mildew in both growing season, where recorded 38.33 and 35.00% powdery mildew severity in first growing season and 40.12 and 36.25% in second season, respectively. On the other hand, Jaman genotype was recorded the lowest powdery mildew severity in both growing seasons (16.67 and 12.47%, respectively). As in case of root diseases no researcher recorded the infection with powdery mildew in fodder beet plants but some researcher studied the effect of powdery mildew on sugar beet such as Peter et al. (2009) and Basati et al. (2013).

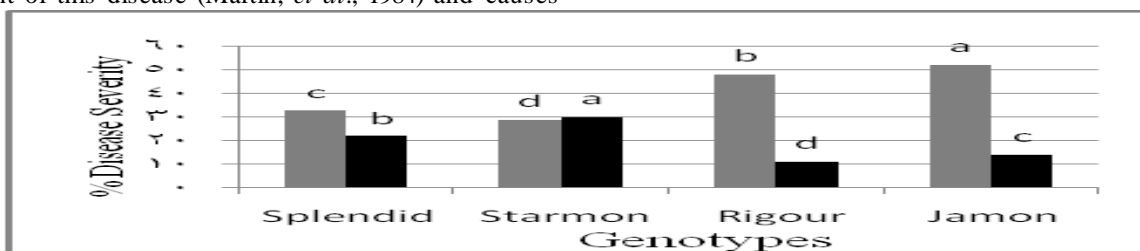


Fig .1. Evaluation of some fodder beet genotypes to damping-off and root rot/ wilt diseases under field conditions during 2013-14 growing season. Different letters indicate significant differences among genotypes within the same colour column according to least significant difference test ( $p \leq 0.05$ ).

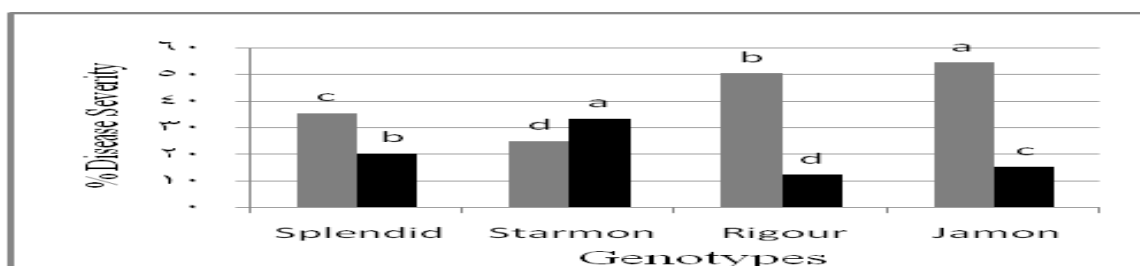


Fig. 2. Evaluation of some fodder beet genotypes to root rot/wilt diseases under field conditions during 2014-15 growing season. Different letters indicate significant differences among genotypes within the same colour column according to least significant difference test ( $p \leq 0.05$ ).

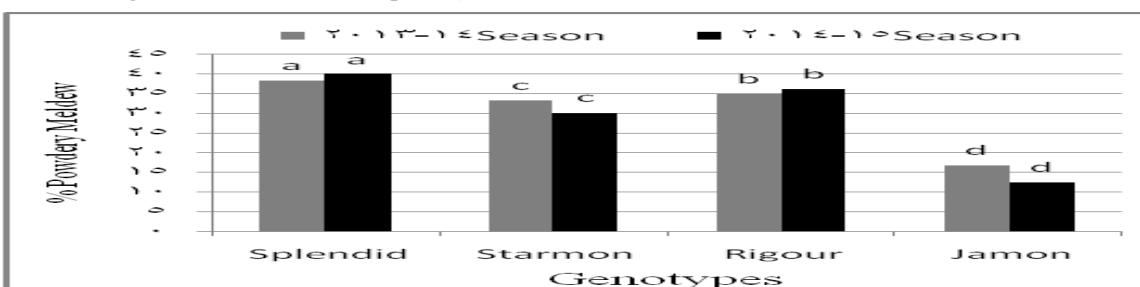


Fig .3. Evaluation of some fodder beet genotypes to powdery mildew disease under field conditions during 2013-14 and 2014-15 growing seasons. Different letters indicate significant differences among genotypes within the same colour column according to least significant difference test ( $p \leq 0.05$ ).

**Leaf spots disease:**

In this study, the four fodder beet genotypes were tested for their susceptibility towards leaf spots disease under open field in New Valley Governorate. Data in Fig. 4 showed that all tested genotypes were infected with leaf spot disease by moderate degrees. The susceptibility to infection with leaf spot disease in the tested genotypes was varied. Starmon and Splendid genotypes were recorded the highest percentage of infection with leaf spot disease in both growing season, where recorded 22.15 and 20.15% leaf spot severity in

first growing season and 24.15 and 20.00% in second season, respectively. On the other hand, Rigour and Jaman genotypes were recorded the lowest leaf spot severity in both growing seasons (14.25 and 10.48%, respectively in first season and 12.36, 9.16% leaf spot severity in second season, respectively). As in case of powdery mildew disease no researcher recoded the infection with leaf spot in fodder beet plants but some researcher studied the effect of powdery mildew on sugar beet such as Whitney and Duffus (1986), Larson (2004) and Gado (2007).

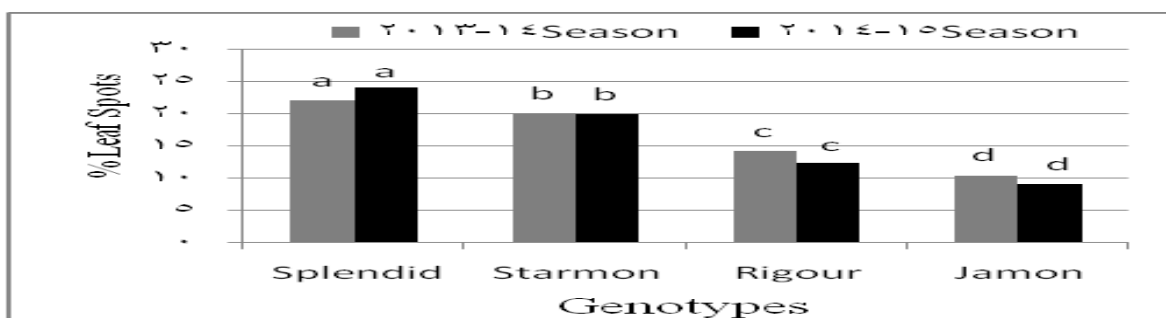


Fig. 4. Evolution of some fodder beet genotypes to leaf spots disease under field conditions during 2013-14 and 2014-15 growing seasons. Different letters indicate significant differences among genotypes within the same colour column according to least significant difference test ( $p \leq 0.05$ ).

**CONCLUSION**

Based on the results obtained in the study focusing on the yielding properties and susceptibility to infection with diseases of four genotypes of fodder beet genotypes grown under four locations in different environmental conditions in Egypt, the following conclusions can be drawn:

1. The tested genotypes of fodder beat were significantly different for yield characteristics viz. average of leaf length, root length, number of leaves/plant and root diameter and yield components viz. fresh and dry weights of roots and leaves/plant and total fresh as well as dry weight of root and leaves / fed.
2. Some the tested characteristics of yield and yield components were significantly varied in both growing seasons.
3. The tested genotypes were varied to susceptibility to infection with diseases viz. damping-off, root rot/wilt, powdery mildew and leaf spots under natural infection in field.

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## تقييم بعض التراكيب الوراثية لبنجر العلف لصفات المحصول ومكوناته والحساسية للإصابة بالأمراض تحت ظروف الوادي الجديد

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اجريت هذه الدراسة بهدف تقييم بعض التراكيب الوراثية لبنجر العلف لصفات المحصول ومكوناته والحساسية للإصابة بالأمراض تحت ظروف مزرعة محطة البحوث الزراعية بالخارجة محافظة الوادي الجديد خلال موسمي الزراعة ٢٠١٣-٢٠١٤ و ٢٠١٤-٢٠١٥م. في هذه الدراسة تم زراعة اربعة تراكيب وراثية وهي *Splendid* و *Starmon* و *Rigour* و *Jamon* في قطاعات كاملة العشوائية وتتلخص أهم النتائج التي تم الحصول عليها فيما يلي: اختلفت التراكيب الوراثية الأربعة موضوع الدراسة فيما بينها في متوسط طول الورقة وطول الجذر وعدد الأوراق لكل نبات وقطر الجذر والوزن الطازج والجاف لكلا من الأوراق والجذور للنبات والفدان. حيث تبين تفوق التركيب الوراثي *Splendid* في متوسط طول الورقة وعدد الأوراق لكل نبات وقطر الجذر والوزن الطازج والجاف للجذور للنبات الواحد وللقدان. في حين تفوق التركيب الوراثي *Jamon* في متوسط طول الجذر والوزن الطازج والجاف للأوراق لكل نبات و للفدان. على العكس من ذلك سجل التركيب الوراثي *Splendid* أقل وزن طازج وجاف للأوراق سواء للنبات الواحد أو للفدان في حين سجل *Jamon* أقل التراكيب الوراثية الأربعة في صفات الوزن الطازج والجاف للجذور سواء للنبات الواحد أو للفدان في كلا موسمي الدراسة. ايضا وجد ان التراكيب الوراثية الأربعة اختلفت معنويا في بعض القياسات الخاصة بالمحصول في الموسمين ولم تختلف في بعض الصفات الأخرى. من ناحية أخرى تبين أن التراكيب الوراثية الأربعة اختلفت فيما بينها في مدى الحساسية للإصابة بأمراض سقوط البادرات وأعفان الجذور والذبول والبياض الدقيقي وتبعت الأوراق. حيث كان *Jamon* و *Rigour* أكثر التراكيب الوراثية حساسية للإصابة بأمراض سقوط البادرات وكانا أقلهما حساسية للإصابة بأمراض عفن الجذور والذبول. في حين كان *Rigour* و *Splendid* أكثر التراكيب الوراثية حساسية للإصابة بأمراض البياض الدقيقي في كلا موسمي الدراسة وكان التركيبين الوراثيين *Starmon* و *Splendid* أكثرهم حساسية للإصابة بأمراض تبقع الأوراق في كلا موسمي الدراسة. وفي النهاية توصي الدراسة بزراعة صنف *Splendid* تحت ظروف الوادي الجديد نظرا لانه سجل أعلى نتائج في معظم الصفات المحصولية ومقاومة أمراض اعفان الجذور والذبول.