RESEARCH ARTICLE SCIENCE INTERNATIONAL

DOI: 10.17311/sciintl.2014.1.12

Rate of Variations Between Field Bean Cultivars Due to Sowing Dates and Foliar Spraying Treatments

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ABSTRACT

Background: Shedding phenomena of field bean plant usually took place in serious values especially for buds, flowers and immature pods leading to a great reduction in seed yield. Thus, the main objective of this study was to study the performance of some field bean cultivars under sowing dates and foliar treatments. **Methods:** Field experiments were carried out during 2011-2012 and 2012-2013 seasons to find out the performance of cultivars (Sakha 1, Sakha 2 and Giza 3 improved) under sowing dates (15th October, 1st November and 15th November) and foliar treatments (without, spraying with water, yeast extract, GA_3 and mixture of yeast extract + GA_3). Each sowing date was performed in a separate experiment. Every experiment was carried out in strip-plot design with four replications. The vertical plots were assigned to cultivars and the horizontal plots were occupied with foliar treatments. **Results:** Sowing on 1st November gave highest growth parameters, seed yield and its components and protein%. However, sowing on 15th October produced highest shedding% and lowest values of other characters. Sakha 1 cultivar significantly superior Sakha 2 and Giza 3 improved and recorded highest values of all studied characters. Sakha 2 cultivar recorded highest percentages of shedding. Foliar spraying with mixture of yeast extract and GA_3 surpassed other foliar treatments and resulted in highest values of all studied characters, excluding shedding percentage. **Conclusion:** Sowing Sakha 1 cultivar on 1st November and spraying with mixture of yeast extract + GA_3 reducing shedding percentage and maximizing field bean seed productivity.

Key words: Field bean, cultivars, sowing dates, yeast extract, GA_3, shedding percentage, protein content

Science International 2 (1): 1-12, 2014

INTRODUCTION

Field bean (*Vicia faba* L.) is one of essential winter crops in Egypt due to its high nutritive value and high protein contents i.e., 25-40%[1]. Moreover, it is a good source of nutritive minerals, such as phosphorus, potassium, calcium, sulphur and iron. Its seed produced a cheap source of protein and food of high nutritive value especially in the diet of low-income people. Its protein is a good alternative compared with expensive meat and fish protein[2]. Field bean fixed nitrogen in agricultural systems through the unique process of biological fixation of atmospheric nitrogen by symbiosis with Rhizobium nitrogen fixation bacteria in the root system of the field bean lead to more soil nitrogen available to the next crop. This substantially reduces the need for nitrogen fertilizers and reduction pollution[3]. Thus, this research have been conducted on various agronomic aspects such as sowing dates, promising cultivars and foliar spraying treatments as major factors determining shedding, yield, its components and seed quality of field bean.

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Sowing dates refer to the effect of all environmental conditions on large scale on growth and yield of field bean crop which differ widely from region to another as reported by many researchers. Moreover, sowing dates is an important factor which significantly affects the timing and duration of vegetative and reproductive stages consequently yield its components and seed quality[4,5]. Since, environmental factors i.e., temperature and light differ due to sowing dates. Whereas, early date of sowing (late October and early November) significantly increased vegetative growth, seed yield and its quality[6,7,8]. However, each delay in sowing date beyond mid November resulted steadily reduction in growth and yield[7,9,10]. Attia *et al.*[11] reported that sowing field bean in the intermediate date (10th November) produced highest values of seed yield and its components and high seed quality traits ranked by early (20th October) then late planting dates (1st December). El-Metwally *et al.*[12] showed that sowing date at 25th October recorded the highest values of growth characters and pigment content (total chlorophyll). While, the greatest values of yield and its components were resulted from the sowing date 25th November.

No doubt that chosen the high yielding cultivars is very important to raise crop productivity and quality. Field bean cultivars markedly differed in their growth characteristics and potential yield. In this connection, Bakheit *et al.*[13] compared field bean cultivars i.e., Giza 402, Giza 2, Giza 429 and Giza 674 and concluded that these cultivars differed significantly in plant height, seed yield fedG[1] and 100-seed weight. Giza 429 and Giza 674 cultivars gave the highest seed yield fedG[1] and 100-seed weight. Abou-Taleb[14] reported that Giza 429 cultivar surpassed Cairo 375 cultivar in number of branches plantG[1]. However, Cairo 375 cultivar surpassed Giza 429 cultivar in plant height. Mekky *et al.*[15] stated that Giza 429 cultivar recorded the highest values of plant height, number of branches plantG[1], pods weight plantG[1], number of seeds plantG[1] and seed yield fedG[1]. Mohamed and El-Abbas[16] concluded that Sakha 1 cultivar surpassed Giza 3 and Giza 2 cultivars in seed weight plantG[1], 100-seed weight and seed yield (ardab/fed). Salama and Awaad[17] reported that Sakha 1 cultivar had the tallest plants compared with eight genotypes i.e. Sakha 1, Sakha 2, Nubaria 1, Giza 461, Giza 714, Giza 716, Giza blanka and Giza 3. Giza 714 cultivar was th e best cultivar for seed yield and its components (number of branches plantG[1], number of pods plantG[1] and seed yield plantG[1]). Attia *et al.*[11] revealed that Sakha 1 cultivar ranked first, whereas Giza 843 and Masr 1 were ranked second and third, respectively in seed yield and its components (number of pods plantG[1], number of seeds plantG[1], seeds weight plantG[1] and 100-seed weight). Bakry *et al.*[18] indicated that field bean cultivars significantly varied in all studied characters. Nubaria-1 and Cairo-25 cultivars produced highest seed and protein yields fedG[1] as compared with other varieties. Kandil *et al.*[19] found that Giza 716 cultivar significantly exceeded other studied cultivars (Sakha 1 and Giza 3) in plant height, number of branches plantG[1], number of pods plantG[1], number of seeds podG[1], number of seeds plantG[1], seed yield plantG[1], 100-seed weight and seed yield haG[1]. While, Sakha 1 cultivar produced the lowest number of shedding flower and shedding percentage and other studied characters. Mulualem *et al.*[20] revealed that significant differences were observed among ten field bean improved varieties in plant height, number of pods plantG[1], 100-seed weight and seed yield haG[1]. Therefore, this study is aiming to evaluate the field bean cultivars for focusing light on the most promising cultivars that can be used on a large scale at studying area.

Yeast is natural source of cytokinins and has stimulatory effects on field bean plants[21]. Furthermore, yeast extract was recommended to participate in a beneficial role during plant growth stages through improving flower formation and their set in some plants due to its high auxin and cytokinins content and enhancement carbohydrates accumulation[22]. Also, yeast extract had stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation[23]. Furthermore, foliar spraying with yeast extract represents the more quick and efficient treatments in many cases lead to vigorous vegetative growth and plenty of chemical constituents[24]. Mady[25] revealed that foliar application with yeast extract at 50 mL LG[1] significantly increased photosynthetic pigments and total leaf area as compared with the control treatments. Also, yeast extract treatment not only increased number of formed flowers and setted pods plantG[1] but also showed contradictory effect upon shedding percentage of both flowers and immature pods plantG[1], consequently that was reversed upon increment of pod weight plantG[1] and final seed yield. Nassar *et al.*[26] stated that yeast extract has stimulatory effects on growth and yield of bean plants by inducing significant promotive effects on plant height, number of branches plantG[1], total leaf area plantG[1], number of pods plantG[1], number of seeds plantG[1], seed yield plantG[1] and crude protein percentage in seeds. Abou El-Yazied and Mady[27] found that yeast extract treatments not only increased auxins and cytokinins but also decreased abscisic acid at 75 days after sowing. Yeast extract increased number of formed flowers, setted pods plantG[1], seed yields and satisfactory effect upon shedding percentage.

Gibberellic Acid (GA_3) which is readily extracted from fungal cultures and is most common commercially available form and widely used as growth promotion[28]. One of the important functions of gibberellins is synthesis of "-amylase enzyme in the aleurone layer surrounding the endosperm of cereal grains during germination. This enzyme hydrolysis starch to form simple sugars which translocated to growing embryo to provide energy source[29]. On the other hand, GA_3 application enhances the catabolism of abscisic acid "ABA" [30]. Ibrahim *et al.*[31] and Al-Whaibi *et al.*[32] indicated that GA_3 application increased plant height, stem diameter, leaf area plantG[1], number of branches plantG[1], number of pods plantG[1], number of seeds podG[1], seed yield plantG[1], 100-seed weight and protein percentage and decreased the percent of aborted flowers and pods. Khan *et al.*[33] and Iqbal *et al.*[34] stated that gibberellins alter the source-sink metabolism through their effect on photosynthesis and sink formation. GA_3 promoted fructose 1,6- diphosphatase and sucrose phosphate synthase and stimulated phloem loading. Khafaga *et al.*[35] indicated that seed soaking with growth regulators lead to highest values of leaf area, number of pods plantG[1], number of seed podG[1], 100-seed weight and seed yield than the foliar

application. Whereas, Unamba *et al.*[36] found that foliar spraying with GA_3 have a significant effect on the plant growth as compared with seeds soaking application technique. Khan *et al.*[37] and Ghalandari *et al.*[38] found that spraying field bean plants with GA_3 at the rate of 50 ppm before flowering gave maximum plant height and total leaf area plant^{-1}. Kandil *et al.*[19] reported that spraying field bean plants with 100 ppm GA_3 produced the highest values of growth, seed yield and its components as well as lowest values of shedding flowers and shedding percentage compared with control treatment.

The present investigation was conducted to determine the effect of sowing dates and foliar spraying treatments on growth, shedding%, productivity and seed quality of some filed bean cultivars under the environmental conditions of Kafr El-Sheikh Governorate, Egypt.

MATERIALS AND METHODS

Study site and objective: A field experiment was carried out at El-Garayda Village, Bialla district, Kafr El-Sheikh Governorate (31°7' latitude and 30° 93' longitude) during the two growing winter seasons of 2011/2012 and 2012/2013. The main objective of this study was to study the influence of sowing dates and foliar spraying treatments on some field bean cultivars as well as their interactions on growth, flowers and pods shedding, seed yield and it attributes as well as seed quality.

Experimental design and treatments: Each sowing date (15th October, 1st November and 15th November) was performed in a separate experiment. Every experiment of sowing date was carried out in a strip-plot design with four replications. The vertical plots were assigned to the three field bean cultivars, i.e., Sakha 1, Sakha 2 and Giza 3 improved. Studied cultivars were obtained from Food Legumes Research Department, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt. The horizontal plots were occupied with the following five foliar spraying treatments, i.e., without foliar spraying (control treatment), spraying with water, spraying with yeast extract at the rate of 50 mL L^{-1}, spraying with Gibberellic Acid (GA_3) at the rate of 100 ppm and spraying with yeast extract at the rate of 50 mL L^{-1} plus gibberellic Acid (GA_3) at the rate of 100 ppm. Foliar spraying treatments were carried out twice at the aforementioned rates after 45 and 60 Days From Sowing (DFS).

Active dry yeast were dissolved in water at the rate of 1 g L^{-1} followed by adding sugar at ratio 1:1 and kept overnight for activation and reproduction of yeast. Yeast extract was prepared by using a technique allowed yeast cells (pure dry yeast) to be grown and multiplied efficiently during conducive aerobic and nutritional conditions that allowed to produce denovo beneficial bioconstituent, (carbohydrates, sugars, proteins, amino acids, fatty acids, hormones and etc.), then these constituents could release out of yeast cells in readily form by two cycles of freezing and thawing for disruption of yeast cells and releasing their content according to Spencer *et al.*[39].

The commercial natural plant growth regulator Gibberellic acid 10% was obtained from Kanza Group Company for the development of projects and services.

The soil of experimental site was characterized as a clayey soil with an Electrical Conductivity (EC) of 1.67 dS m^{-1} and a pH of 7.85. Each experimental basic unit included five ridges, each of 60 cm width and 3.5 m long, resulted an area of 10.5 m^2 (1/400 fed, 1 fed = 4200 m^2). The preceding summer crop was rice (*Oryza sativa* L.) in both seasons.

Agricultural practices: Calcium superphosphate (15.5% P_2O_5) was applied during soil preparation at the rate of 100 kg fed^{-1}. Planting time was carried out at three dates as mentioned before on both sides of ridges at 25 cm between hills and 60 cm between ridges which expressed 112000 plants fed^{-1}. After full germination plant densities were adjusted by replanting the missing hills or thinning the over plants at 21 days from planting leaving healthy plant per hill. Hand hoeing was achieved twice every 21 days to control weeds (before time of irrigations). Nitrogen fertilizer was added before the first irrigation in the form of ammonium nitrate (33.0% N) at the rate of 15 kg N fed^{-1} as starter dose. Potassium sulphate (48% K_2O) at the rate of 50 kg fed^{-1} was applied to soil in two equal portions, before the first and second irrigations. The recommended agricultural practices for growing field bean were followed except the factors under study.

Studied characters: During the growing period (after 85 days from sowing), randomized samples of five plants from the outer ridges of each plot were obtained to estimate the following characters:

- Total chlorophyll (SPAD): Leaf chlorophyll content was assessed by SPAD-502 (Minolta Co. Ltd., Osaka, Japan)
- Total leaf area plant^{-1} (cm^2) was determined using Field Portable Leaf Area Meter AM-300 (Bio-Scientific, Ltd., Great Am well, Herefordshire, England)

- Plant height (cm)
- Stem diameter (cm)
- No. of branches plant^{-1}

At harvest time, five guarded plants were taken from the outer ridges of each plot to estimate the following characters.

- Shedding percentage (%). It was calculated using the fowling equation:

$$\text{No. of total flowers per plant}^{-1} = \frac{\text{No. of setted pods plant}^{-1}}{\text{No. of total flowers plant}^{-1}}$$

- No. of pods plant^{-1}
- Pod length (cm)
- No. of seeds pod^{-1}
- 100-seed weight (g)
- Seed yield plant^{-1} (g)
- Seed yield (ardab fed^{-1}). Whole plants in the three inner ridges of each plot were harvested and left for air drying, then they were threshed and the seeds (12% moisture) were weighted (kg), then converted to ardab per feddan (one ardab = 155 kg)
- Protein percentage (%). Crude protein percentage in the dry seeds was estimated according the improved Kjeldahl method of [40]

Statistical analysis: All data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip-plot design to each experiment (planting date), then the combined analysis was achieved between planting dates as outlined by Gomes and Gomes[41] using MSTAT statistical package (MSTAT-C with MGRAPH version 2.10, Crop and Soil Sciences Department, Michigan State University, USA). Least Significant Difference (LSD) method was used to test the differences between treatment means at 5% level of probability as described by Snedecor and Cochran[42].

RESULTS AND DISCUSSION

Sowing dates effect: Sowing dates caused significant effects on field bean growth, shedding percentage, seed yield and its components as well as protein percentage in both seasons (Table 1-3). Intermediate sowing date (1st November) markedly resulted highest total chlorophyll, total leaf area plant^{-1}, plant height, stem diameter and number of branches plant^{-1}, (Table 1), number of pods plant^{-1}, pod length and number of seeds pod^{-1}, (Table 2), 100-seed weight, seed yield plant^{-1}, seed yield fed^{-1} and protein percentage (Table 3) comp ared with other studied sowing dates in both seasons. In this regard, Mohamed[7] concluded sowing field bean on early November resulted significant increase in vegetative

Table 1: Mean of total chlorophyll, total leaf area plant^{-1}, plant height, stem diameter and No. of branches plant^{-1} as affected by sowing dates, field bean cultivars and foliar spraying treatments as well as their interactions during 2011-2012 and 2012-2013 seasons

	Characters									
	Total chlorophyll (SPAD)		Total leaf area plant^{-1} (cm^2)		Plant height (cm)		Stem diameter (cm)		No. of branches plant^{-1}	
Treatments	2011-2012	2012-2013	2011-2012	2012-2013	2011-2012	2012-2013	2011-2012	2012-2013	2011-2012	2012-2013
Sowing dates										
15th October	32.11	30.39	1297.0	1271.8	91.80	90.04	0.798	0.758	2.85	2.59
1st November	35.02	33.44	1397.0	1359.1	101.40	99.88	0.927	0.903	3.32	3.14
15th November	34.08	30.93	1355.4	1327.6	96.95	94.64	0.893	0.876	3.15	2.87
LSD at 5%	0.42	0.40	23.7	20.5	1.98	2.09	0.012	0.012	0.11	0.09
Cultivars										
Sakha 1	35.59	32.96	1377.4	1350.4	100.10	98.68	0.907	0.884	3.41	3.12
Sakha 2	32.20	29.99	1323.3	1286.0	93.04	91.17	0.839	0.811	2.80	2.65
Giza 3 improved	33.40	31.81	1348.7	1322.2	97.04	94.71	0.872	0.841	3.12	2.82
LSD at 5%	0.37	0.37	14.0	13.9	1.27	1.57	0.007	0.009	0.06	0.09
Foliar spraying treatments										
Without (control)	31.46	29.58	1270.1	1235.9	92.25	90.81	0.824	0.794	2.65	2.33
Spraying with water	33.01	30.78	1288.3	1265.5	93.55	92.22	0.851	0.823	2.84	2.72
Spraying with yeast extract	34.03	31.31	1374.2	1348.8	99.11	96.96	0.871	0.843	3.06	2.88
Spraying with GA_3	34.65	32.42	1386.2	1348.1	96.81	94.66	0.897	0.871	3.39	3.09
Spraying with yeast extract + GA_3	35.51	33.85	1430.1	1399.2	102.00	99.63	0.920	0.897	3.60	3.29
LSD at 5%	0.25	0.26	16.4	17.31	0.61	0.63	0.006	0.007	0.05	0.06
Interactions										
A × B	ns	*	ns	*	ns	ns	ns	*	*	*
A × C	ns	*	ns	*	ns	ns	*	*	*	*
B × C	ns	*	ns	*	ns	ns	ns	*	*	ns
A × B × C	ns	ns	ns	*	ns	ns	ns	ns	*	ns

*Significant at 0.05 level of probability and ns: Non-significant at 0.05 level of probability

Table 2: Mean of shedding percentage, No. of pods plant^{-1}, pod length and number of seeds pod^{-1} as affected by sowing dates, field bean cultivars and foliar spraying treatments as well as their interactions during 2011-2012 and 2012-2013 seasons

	Characters							
	Shedding (%)		No. of pods plant^{-1}		Pod length (cm)		No. of seeds pod^{-1}	
Treatments	2011-2012	2012-2013	2011-2012	2012-2013	2011-2012	2012-2013	2011-2012	2012-2013
Sowing dates								
15th October	85.55	85.37	13.31	13.18	7.10	6.94	3.33	3.25
1st November	83.16	82.73	13.77	13.60	8.52	8.29	3.70	3.62
15th November	84.87	83.66	13.53	13.33	7.58	7.52	3.48	3.41
LSD at 5%	0.29	0.30	0.13	0.12	0.41	0.53	0.12	0.09
Cultivars								
Sakha 1	84.16	83.21	13.77	13.60	8.21	8.02	3.69	3.60
Sakha 2	84.78	84.44	13.30	13.18	7.26	7.13	3.33	3.25
Giza 3 improved	84.64	84.11	13.54	13.33	7.72	7.60	3.48	3.43
LSD at 5%	0.24	0.24	0.07	0.07	0.17	0.16	0.09	0.06
Foliar spraying treatments								
Without (control)	84.92	84.22	12.28	12.15	7.19	6.68	3.12	3.03
Spraying with water	84.67	84.19	12.64	12.49	7.19	7.11	3.22	3.18
Spraying with yeast extract	84.52	83.95	14.13	13.88	7.73	7.53	3.62	3.57
Spraying with GA_3	84.47	83.87	14.11	13.94	8.07	8.02	3.67	3.58
Spraying with yeast extract + GA_3	84.04	83.38	14.52	14.39	8.81	8.58	3.88	3.77
LSD at 5%	0.14	0.16	0.06	0.05	0.11	0.11	0.04	0.03
Interactions								
A × B	*	*	*	*	*	*	ns	*
A × C	*	*	*	*	*	*	ns	*
B × C	*	*	*	*	ns	ns	ns	*
A × B × C	ns	ns	*	*	ns	ns	*	*

*Significant at 0.05 level of probability and ns: Non-significant at 0.05 level of probability

Table 3: Mean of 100-seed weight, seed yield plant^{-1}, seed yield fed^{-1} and protein percentage as affected by sowing dates, field bean cultivars and foliar spraying treatments as well as their interactions during 2011-2012 and 2012-2013 seasons

	Characters							
	100-seed weight (g)		Seed yield (g plant^{-1})		Seed yield (ardab fed^{-1})		Protein (%)	
Treatments	2011-2012	2012-2013	2011-2012	2012-2013	2011-2012	2012-2013	2011-2012	2012-2013
Sowing dates								
15th October	84.74	83.70	51.95	48.78	9.36	9.29	24.37	24.36
1st November	93.35	92.04	58.55	56.46	9.82	9.76	24.66	24.59
15th November	87.92	87.11	54.34	52.39	9.69	9.64	24.54	24.47
LSD at 5%	0.53	0.49	0.89	0.52	0.09	0.08	0.03	0.08
Cultivars								
Sakha 1	90.80	89.98	57.29	54.90	9.93	9.87	24.63	24.57
Sakha 2	86.55	85.26	52.57	50.29	9.36	9.29	24.40	24.34
Giza 3 improved	88.67	87.60	54.99	52.44	9.58	9.52	24.54	24.51
LSD at 5%	0.46	0.58	0.47	0.34	0.04	0.04	0.03	0.10
Foliar spraying treatments								
Without (control)	84.98	84.23	46.41	44.76	9.22	9.16	23.98	23.92
Spraying with water	86.94	86.05	50.05	46.46	9.30	9.25	24.04	24.00
Spraying with yeast extract	88.96	87.52	58.07	56.21	9.83	9.77	24.84	24.80
Spraying with GA_3	90.42	89.04	57.91	55.11	9.74	9.67	24.76	24.72
Spraying with yeast extract + GA_3	92.05	91.24	62.31	60.18	10.03	9.95	25.00	24.92
LSD at 5%	0.47	0.38	0.35	0.31	0.04	0.05	0.02	0.05
Interactions								
A × B	ns	*	ns	*	*	*	*	*
A × C	*	*	*	*	*	*	*	*
B × C	*	*	ns	*	*	*	*	*
A × B × C	*	*	*	*	*	*	*	ns

*Significant at 0.05 level of probability and ns: Non-significant at 0.05 level of probability

growth and production more pods per plant, consequently increased yield and quality of seed. Early sowing date (15th October) resulted in the highest valuesof shedding percentage and the lowest values of

other studied characters in both seasons. Late sowing date (15th November) was ranked secondly after intermediate sowing date (1st November) in both seasons. It could benoticed that sowing field bean on 15th October induced an increase in shedding percentage about 2.94 and 1.40% as compared with sowing on 1st November and 15th November over both seasons, respectively. Thus, Sowing on 1st November caused an increase in seed yield fed^{-1}, by 1.28 and 4.75% as compared with sowing on 15th November and 15th October over both seasons, respectively. The increases in field bean growth, seed yield and its component characters due to sowing on 1st November might be attributed to the seasonable environmental conditions during this period such as temperature, day length and light intensity which allow rapid germination, establishment, vegetative growth, development and ripening, consequently increasing dry matter accumulation, yield components as well as seed yield per unit area. These results are in agreement with those reported by[6,11,12]. Whereas, Mohamed[7] and Grenz *et al.*[10] suggested that delaying sowing of field bean over mid November resulted in progressively reduction in growth and seed yield.

Cultivars performance: Data presented in Table 1-3 show significant differences among the three tested cultivars of field bean for total chlorophyll, total leaf area plant^{-1}, plant height, stem diameter and number of branches plant^{-1}, (Table 1), shedding percentage, number of pods plant^{-1}, pod length and number of seeds pod^{-1}, (Table 2), 100-seed weight, seed yield plant^{-1}, seed yield fed^{-1} and protein percentage (Table 3) in both seasons. From obtained results of this study it could be observed that Sakha 1 cultivar significantly surpassed other studied cultivars (Sakha 2 and Giza 3 improved) and recorded the highest values of all studied characters in both seasons. Whereas, Giza 3 improved cultivar came in the second rank after Sakha 1 cultivar and followed by Sakha 2 cultivar with respect of all studied traits in the two growing seasons. Concerning shedding percentage, the highest values were resulted from Sakha 2 cultivar followed by Giza 3 improved cultivar then Sakha 1 cultivar in both seasons. These findings might be attributed to the differences in their genetical constitution and genetic factors makeup. Similar results were stated by[11,16,17,18,19]. The performance of Sakha 1 cultivar out yielded the other two cultivars and might be recommended.

Foliar spraying treatments effect: From obtained results foliar spraying treatments (without, spraying with water, yeast extract, GA_3 and yeast extract + GA_3) showed significant effect on total chlorophyll, total leaf area plant^{-1}, plant height, stem diameter and number of branches plant^{-1}, shedding percentage, number of pods plant^{-1}, pod length and number of seeds pod^{-1}, 100-seed weight, seed yield plant^{-1}, seed yield fed^{-1} and protein percentage in both growing seasons (Tables 1, 2 and 3). It can be noticed that foliar spraying field bean plants twice after 45 and 60 days from sowing with the mixture of yeast extract and GA_3 surpassed other studied foliar spraying treatments and resulted in the highest values of all studied characters, excluding shedding percentage which highest means were resulted from control treatment (without foliar spraying) in both seasons. However, foliar spraying with yeast extract ranked after application the mixture of yeast extract and GA_3 concerning number of pods plant^{-1} (in the first season), total leaf area plant^{-1} (in the second season), plant height, seed yield plant^{-1}, seed yield fed^{-1} and protein percentage in both seasons. These results may be ascribed to the beneficial role of yeast extract during plant growth stages through improving flower formation and their set due to its high auxin and cytokinins content, enhancement carbohydrates accumulation[22], cell division and enlargement, protein and nucleic acid synthesis, chlorophyll formation[23], consequently lead to vigorous vegetative growth and increasing seed yield and chemical constituents[24]. Whereas, spraying field bean plants with GA_3 solution came in the second rank after using the mixture of yeast extract and GA_3 regarding total leaf area plant^{-1} (in the first season), number of pods plant^{-1} (in the second season), total chlorophyll, stem diameter, number of branches plant^{-1}, pod length, number of seeds pod^{-1} and 100-seed weight in both seasons. The stimulatory effect of gibberellins (GA_3) on field bean growth and yield attributes may be due to the role of GA_3 in enhances the catabolism of ABA which reduces shedding[30] as well as alter the source-sink metabolism through their effect on photosynthesis and sink formation therefore stimulated plant growth[34]. Noteworthy, the increases in seed yield per plant and feddan due to foliar spraying with water, yeast extract, GA_3 and the mixture of yeast extract + GA_3 were (5.86 and 0.92%), (25.35 and 6.64%), (23.97 and 5.90%) and (34.35 and 8.71%) as compared with control treatment over both seasons. The increase in field bean growth and seed yield due to foliar spraying with the mixture of yeast extract and GA_3 can be easily ascribed to combining beneficial effect for each yeast extract and GA_3 in improvement early growth, reduced shedding percentage, more dry matter accumulation and stimulation the building of metabolic products, hence

increasing seeds yield per plant and unit area. These results are in compatible with those found by[19,25,26,27,37,38].

Interactions effect: Regarding the effect of interactions, there are many significant effects of the interactions among studied factors on studied characters as shown in Tables 1, 2 and 3. Therefore, the significant triple interactions only among studied factors were focused herein. As shown from data graphically illustrated in Fig. 1-8, the highest

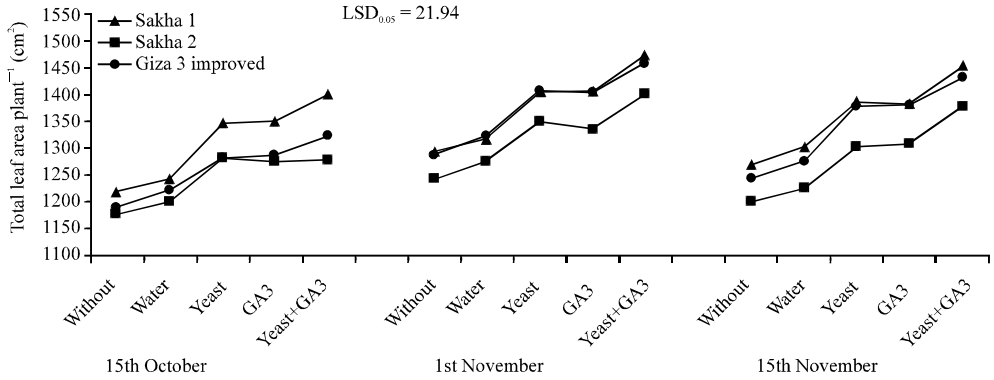

Fig. 1: Mean of total leaf area plant^{-1} as affected by the interaction among sowing dates, field bean cultivars and foliar spraying treatments during 2012-2013 season

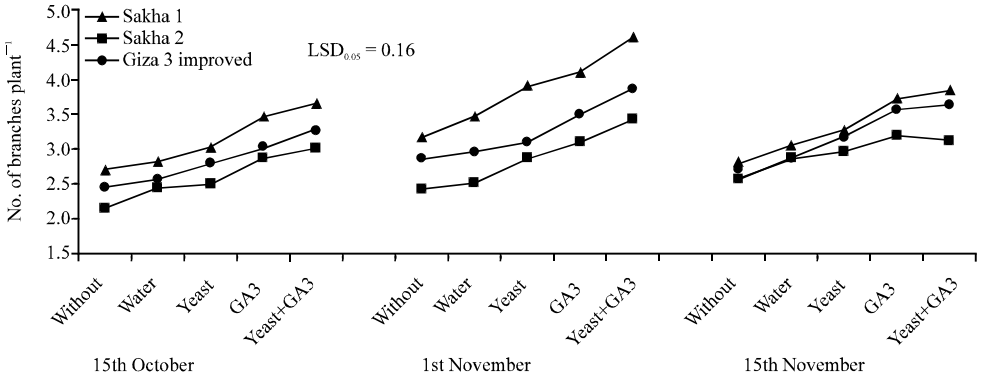

Fig. 2: Mean No. of branches plant^{-1} as affected by the interaction among sowing dates, field bean cultivars and foliar spraying treatments during 2011-2012 season

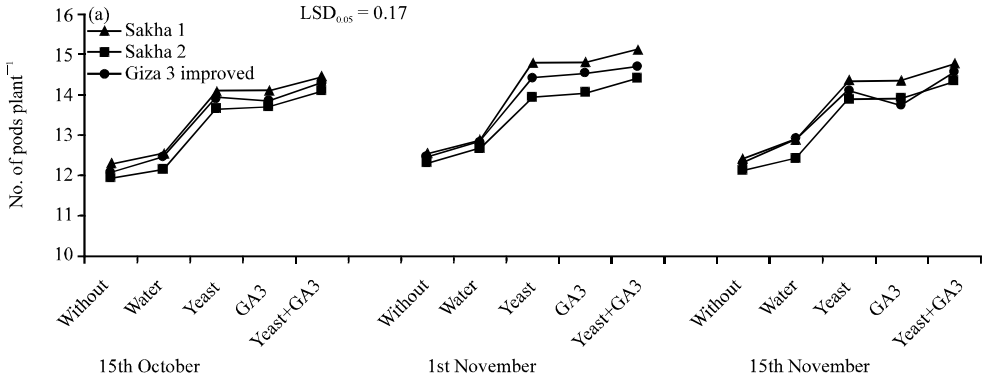

Fig. 3: Countinue

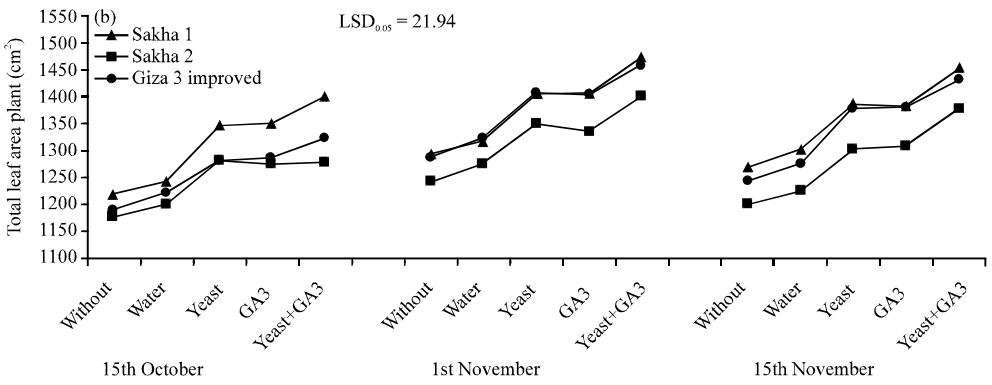

Fig. 3: Mean No. of pods plant^{-1} as affected by the interaction among sowing dates, field bean cultivars and foliar spraying treatments during (a) 2011-2012 and (b) 2012-2013 seasons

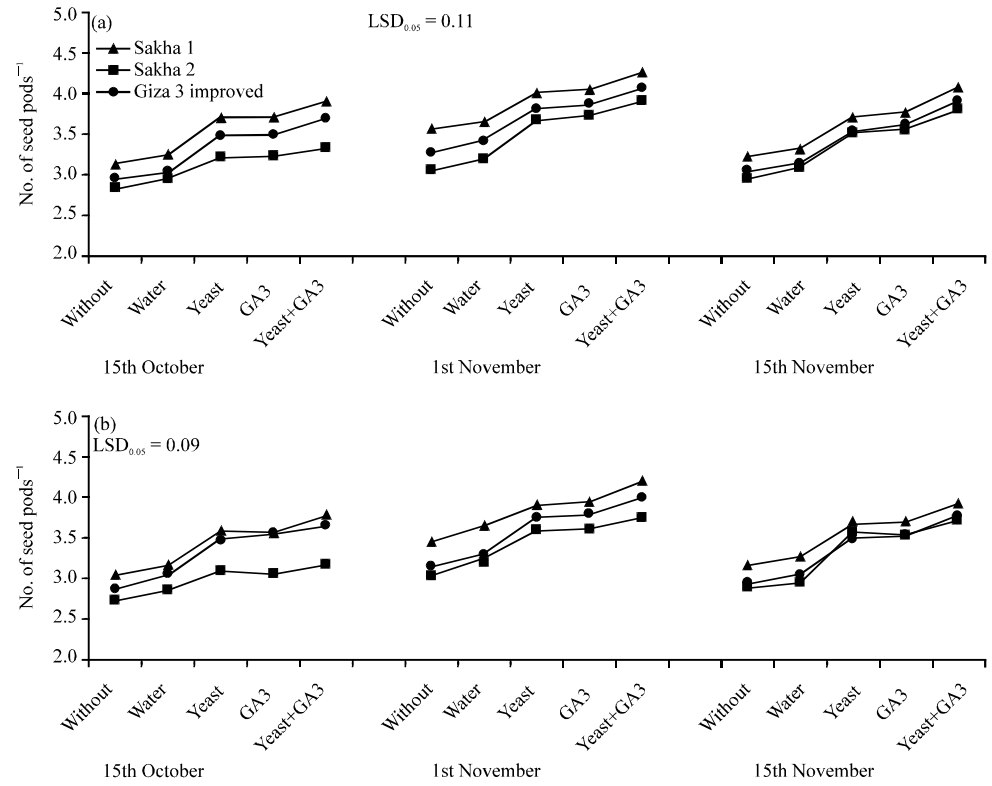

Fig. 4: Mean No. of seeds pod^{-1} as affected by the interaction among sowing dates, field bean cultivars and foliar spraying treatments during (a) 2011-2012 and (b) 2012-2013 seasons

values of total leaf area plant^{-1} in the second season (Fig. 1), number of branches plant^{-1} in the first season (Fig. 2), number of pods plant^{-1} (Fig. 3), number of seeds pod^{-1} (Fig. 4), 100-seed weight (Fig. 5), seed yield plant^{-1} (Fig. 6), seed yield fed $^{-1}$ (Fig. 7) in the first (a) and second (b) seasons and protein percentage in the first season (Fig. 8) were obtained from sowing Sakha 1 cultivar on 1st November and foliar spraying with the mixture of yeast extract and GA_3. On the other hand, lowest values of these traits

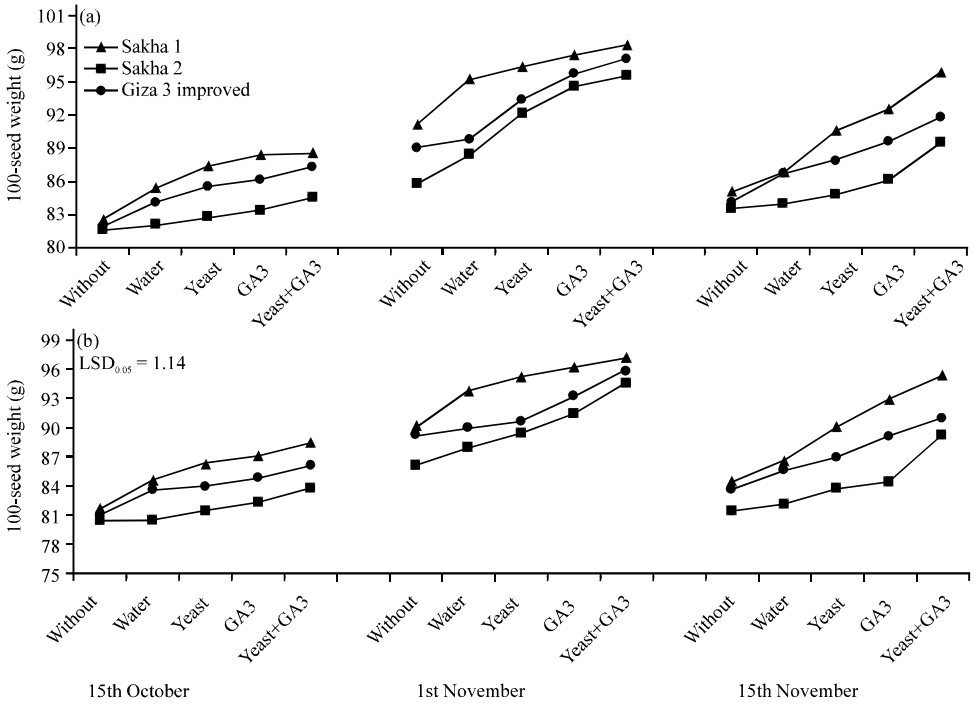

Fig. 5: Mean of 100-seed weight as affected by the interaction among sowing dates, field bean cultivars and foliar spraying treatments during (a) 2011-2012 and (b) 2012-2013 seasons

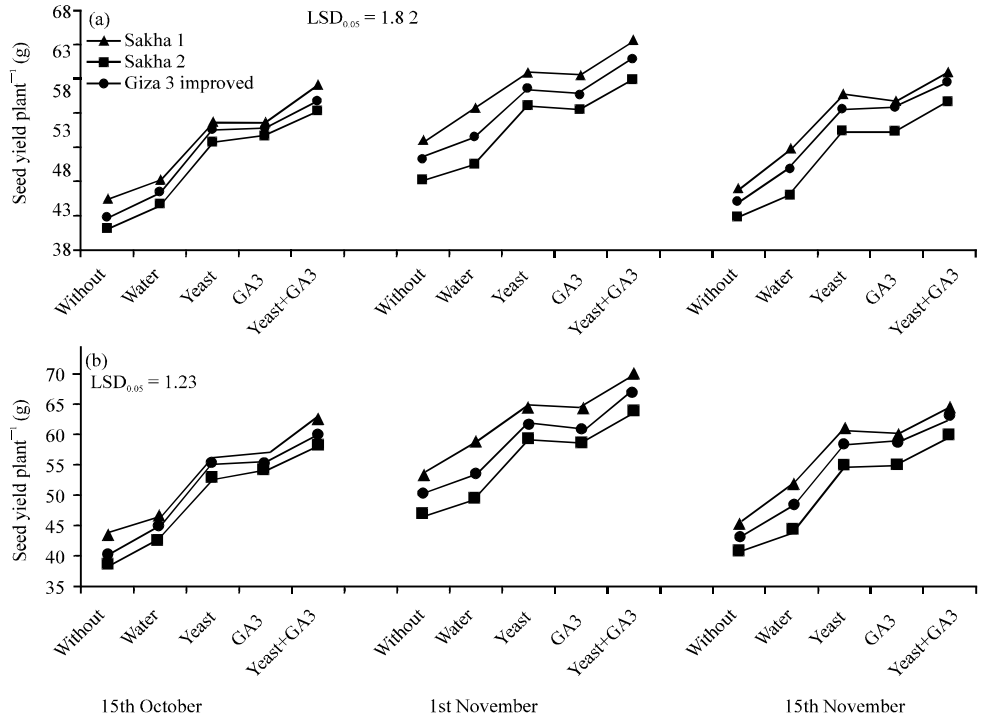

Fig. 6: Mean of seed yield plantG¹ as affected by the interaction among sowing dates, field bean cultivars and foliar spraying treatments during (a) 2011-2012 and (b) 2012-2013 seasons

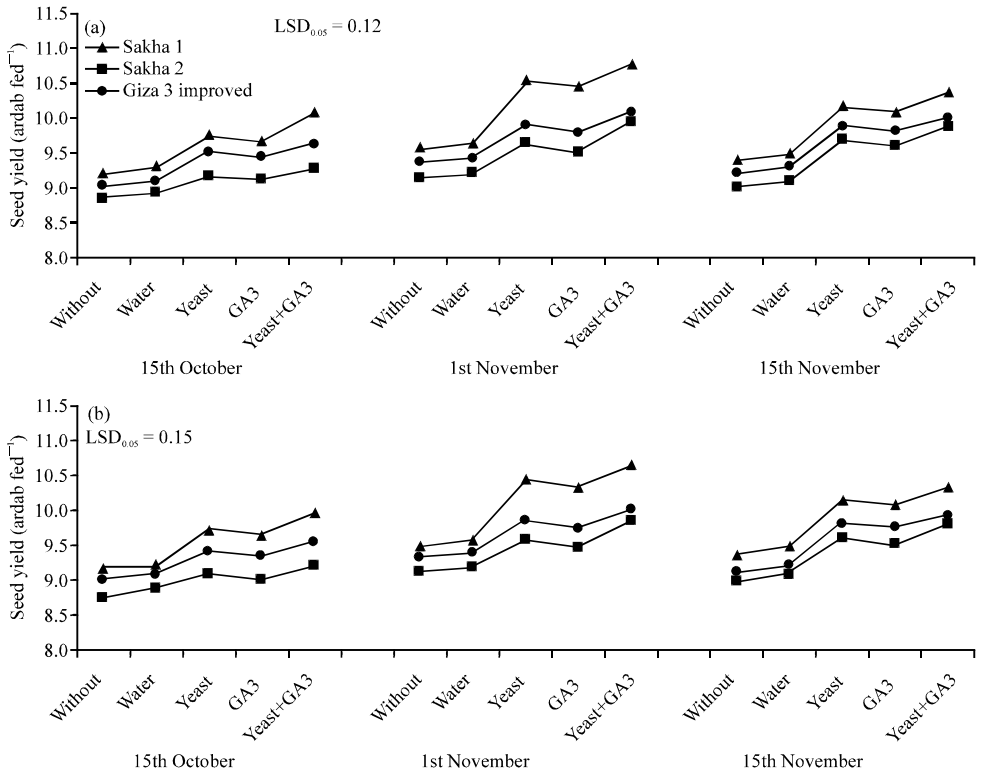

Fig. 7: Mean of seed yield fedG^{1} as affected by the interaction among sowing dates, field bean cultivars and foliar spraying treatments during (a) 2011/2012 and (b) 2012-2013 seasons

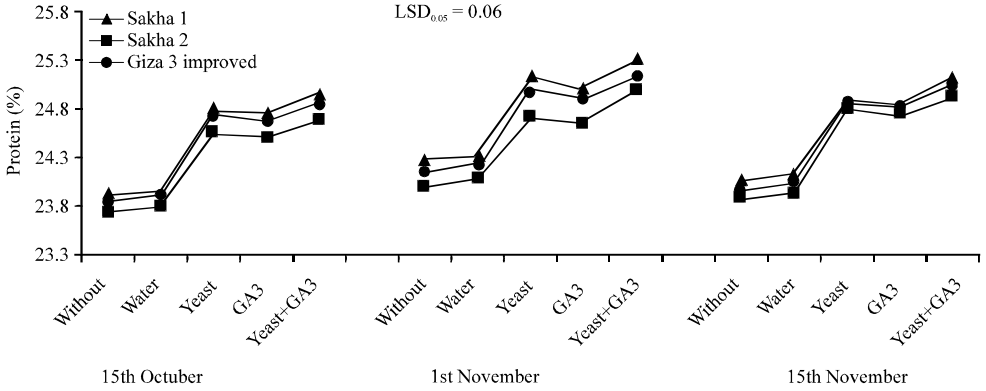

Fig. 8: Mean of protein percentage as affected by the interaction among sowing dates, field bean cultivars and foliar spraying treatments during 2011-2012 season

were produced from sowing Sakha 2 cultivar on 15th October without foliar spraying.

CONCLUSION

According to the obtained results from this study it can be concluded that sowing Sakha 1 cultivar on 1st November and foliar spraying with the mixture of yeast extract and GA_3 could be recommend to reduce shedding percentage and m aximizing field bean growth and productivity under the environmental conditions of Kafr El-Sheikh Governorate.

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