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Effect of Sowing Dates and Biofertilizer on Growth Attributes, Yield and its Components of Two Faba Bean (*Vicia faba* L.) Cultivars

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Abstract: Two field experiments were carried out at the Experimental Farm of the Faculty of Agriculture (Saba Basha), Alexandria University, Egypt during two successive winter seasons (2011/2012 and 2012/2013) to study the effect of sowing dates (31st Oct, 15th Nov and 30th Nov) and VA-mycorrhizal inoculation (Biofertilizer) on growth yield and its components of two faba bean cultivars (Sakha-1and Giza- 461). The results showed significant increases in plant height, root length, crop growth rate, number of leaves/plant, dry weight per plant and seed yield as well as nitrogen and phosphorus contents with early sowing Oct.31th in both seasons. Sakha-1 cultivar significantly surpassed Giza-461 cultivar and produced higher dry weight per plant, number of pods/plant, seed yield/plant and seed yield/ha in both seasons compared to the other cultivar Giza-1. The average increase of total dry weight per plant in both seasons was 54%, 51% and 54.8% at 50, 70 and 90 days after sowing, respectively and the same increases were obtained by VA-mycorrhizal inoculation. Moreover, seed yield/ha of both faba bean cultivars treated with VA-mycorrhizal was increased by 20.7% and 23.2% more than the non-inoculation treatment.

Key words: Faba bean · Growth · Sowing date · VA-mycorrhizal · Yield

INTRODUCTION

Legumes are the major direct source of proteins for both man and livestock, especially in poor countries, where animals protein is expensive [1]. Grain legumes play an essential role in human nutrition balancing the deficiencies of cereal –based diet [2]. The importance of legumes is that they can fix nitrogen in symbiotic association with rhizobia and so the increase the soil nitrogen content [3].This association enables legumes to benefit from an augmented nitrogen supply and can grow well on relatively poor soils [4]. Faba bean (*Vicia faba* L.) is one of the major legume crops cultivated in the Northern and the River Nile States of Sudan produced in an average area of 69720ha with an average yield of 1896 kg/ha [5]. It is the main food for millions of people and the source of protein for the middle and low income groups [6]. Faba bean is an important cash crop for farmers [7]. Crop productivity can be increased by the application of chemical, organic, biological fertilizers [8] and sowing date is one of the most important agronomic factor related to crop growth and yield it affects greatly the time and duration of vegetative and reproductive growth as well as the degree of infection with plant diseases and insect pests [9] found that early sowing date produced the highest faba bean seed yield (3.50 t/h). Hassan [10] and Ibrahim *et al*. [11] mentioned a reduction in seed yield and seed yield components with late sowing. Many workers studied the relationship between varieties and sowing date under Egyptian conditions, for example, Amer *et al.* [9] and Elemry [12] reported that most of the Egyptian varieties responded favorably for earlier sowing dates. However, they indicated that sowing before end October inversely affected seed yield. Addition Arbuscular Mycorrhizal fungi (AMF), which from symbotic association with most economically important crop plants, improved plant growth under low fertility conditions and have attracted a considerable research due to their agricultural potential use [13]. Legumes are the major direct source of proteins for both man and livestock.

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Table 1: Physical and chemical soil properties.

Sand %	Silt %	Clay %	Soil texture	pH	EC (dSm^{-1}) (1:1)	OM %	$CaCO_3$ %	Total N %	P (mg/kg)
14.90	42.60	42.70	Clay loam	7.9	1.73	1.75	0.90	0.88	3.25

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of the Faculty of Agriculture, Saba Basha, Alexandria University, Egypt during the successive winter seasons of 2011/2012 and 2012/2013. Physical and chemical soil properties are presented in Table 1. The treatments were arranged in split-split plot design with four replicates, where the main plots were assigned at random for the three sowing dates i.e. Oct 31st, Nov 15th and 30th Nov, while the sub plots were assigned at random for two faba bean cultivars i.e. Sakha-1 and Giza-461 obtained from the Agricultural Research center, Giza Egypt. The sub-sub plots were assigned to the VA mycorrhizal species. The fungi treatments were: (a) inoculation with strain of VA-mycorrhizal fungi *Glomus* macrocarpium (M1) *Glomus manihitis* (M2) obtained from Gottingen University, Germany at the rate of 100 spores added with seeds at sowing time and (b) without inoculation (NM). Phosphorus fertilizer was applied before sowing at the rate of 50kg P_2O_5/faddan (one faddan = 0.42 ha) in the form of superphospate (15.5% P_2O_5). Each plot consisted of 4 rows (60 cm) apart and (3.5m) length. Seeds were sown in hills 20cm between each at both sides of the ridge. All cultural practices were applied as recommended for faba bean production. Samples of five plants were taken at random from each sub-sub plot at 50, 70 and 90 days after sowing (DAS) for determining the following growth characters and attributes such as plant height (cm), root length (cm), crop growth rate (CGR) (g/day/m^2) was calculated according to the formula suggested by Brown [14]:

$$CGR= (W_2 – W_{1)} / SA (T_2 – T_1)$$

where W_1 and W_2 are plant dry weight at time one (T_1) and at time two (T_2) respectively. T_1 and T_2 corresponding days.

Number of leaves/plant, dry weight of whole plant (g) and roots were stained for mycorrhizal fungi using the modified technique of Phillips and Haman [15]. At harvest time, ten plants from each sub-sub plot were taken randomly to determining the yield and its components: plant height (cm), number of branches/plant, number of pods/plant, number of seeds/plant, 100-seed weight (g), seed yield/faddan. Nitrogen content using the micro-Kjeldhl method according to Chapman and Pratt [16] and Phosphorus content was determined colorimetrically as described by Hesse [17].

Statistical Analysis: The obtained date were exposed to the statistical analysis of variance of split-split-plot design as reported by Gomez and Gomez [18], means were compared by Duncan's multiple range test.

RESULTS AND DISCUSSION

Effect of Sowing Date: The faba bean growth characters and growth attributes significantly differed among the three sowing dates as shown in Tables 2 and 3. The early sowing date (Oct 31st) produced the highest values of growth attributes at the three sampling dates in both seasons. While, the late sowing date (Nov 30th) produced the lowest growth attributes as average of the two growing seasons. Similar results were obtained by Hassan [10] and Ibrahim *et al*. [11] at different locations in Egypt. The results presented in Table 2 and 3 showed that a significant increase on yield and its components with different sowing dates. The highest seed yields (3.11t/ha) were obtained from the early sowing date (Oct 31st), while the late sowing date (Nov 30th) produced the lowest seed yield (2.07 t/ha) in both seasons, respectively. Also, delaying sowing until Nov 30th significantly decreased all studied traits. The superiority of seed yield observed with the early sowing date might be attributed to the increase in number of pods and seeds per plant and 100-seed weight. These findings confirm the results obtained by Salih [6] and Amer *et al*. [9], who noted that the optimum sowing date for faba bean in middle and Upper Egypt was from Oct 15th and Nov15th and increased the average length of pod, weight of 100-seed and shelling percentage as compared with the late sowing Nov 25th. On the other hand, Hassan [10] and Abd El-Rahman *et al*. [19] reported that November, 15 and November 20 were the best for sowing faba bean in Assiut and Shandaweel. El-Masry [20] stated that planting dates in Oct. significantly affected days to 50% flowering pods plant, leaves plant leaf area (LA) leaf weight (LW) and specific leaf area (SLA).

Table 2: Effect of sowing dates, cultivars and VA-mycorrhizal inoculation on three stages growth attributes of faba bean plants (Combined analysis of two seasons)

	Plant height (cm)			Root length (cm)			Crop growth rate (g/day/m^2)		Number of leaves/plant			Dry weight / plant (g)		
Treatment	50	70	90	50	70	90	(70-50)	(90-70)	50	70	90	50	70	90
Sowing dates (S)														
Oct. 31	42.35a	73.71a	82.91a	8.09a	15.86a	18.78a	9.08a	8.29a	14.19a	23.91a	31.33a	26.65a	53.89a	78.67a
Nov. 15	36.41b	66.68b	72.97b	7.52b	14.57b	16.71b	6.99b	6.29b	11.72b	18.7b	24.82b	18.92b	39.87b	58.77b
Nov. 30	28.62c	56.69c	64.20c	6.49c	12.53c	14.7c	4.76c	4.83c	9.73c	14.74c	18.35c	12.03c	26.31c	40.81c
Cultivars (C)														
Sakha 1	41.26a	74.98a	80.68a	7.79a	15.31a	17.58a	7.29a	6.87a	12.20a	19.55a	25.69a	19.46a	40.80a	61.46a
Giza 461	30.45b	56.31b	66.04b	6.95b	13.33b	15.88b	6.59a	6.10b	11.45b	18.43b	23.54b	18.92b	39.33a	57.35b
VA-mycorrhizal (M)														
NM	32.07b	59.27c	66.92b	6.16c	11.48b	13.08b	6.05b	4.96b	11.34b	18.25b	23.41b	16.29b	34.40b	49.23b
M1	37.78a	68.26b	76.32a	8.11a	15.80a	18.55a	7.38a	7.31a	12.12a	19.58a	25.53a	20.67a	42.80a	64.63a
M2	37.52a	69.32a	76.20a	7.89b	15.69a	18.56a	7.39a	7.18a	12.18a	19.51a	25.56a	20.63a	42.83a	64.38a
Interaction														
S x C	**	*	**	**	**	**	*	*	**	**	**	**	**	**
S x M	*	*	NS	**	**	**	*	*	**	**	**	**	**	**
C x M	**	**	**	**	**	**	NS	*	**	**	**	**	**	**
S x C x M	**	*	*	**	**	**	*	*	**	**	**	NS	**	*

Table 3: Effect of sowing dates, cultivars and VA-mycorrhizal inoculation on yield and its components of faba bean plants (Combined analysis of two seasons)

Treatment	Plant height (cm)	No. of branches/plant	No. of pods/plant	No of seeds /plant	Seed yield /plant (g)	100-seed weight (g)	Seed yield (t/ha)	N %	P %
Sowing dates (S)									
Oct. 31	101.3a	2.49a	17.27a	41.14a	22.50a	69.12a	3.11a	1.78a	0.28a
Nov. 15	94.81b	2.39b	15.88b	36.86b	19.54b	67.09b	2.69b	1.55b	0.19b
Nov. 30	90.09c	2.24c	12.17c	24.15c	14.96c	63.45c	2.07c	1.26c	0.15c
Cultivars (C)									
Sakha 1	102.83a	2.03b	18.26a	40.73a	22.72a	64.03b	3.06a	1.63a	0.20a
Giza 461	87.96b	2.65a	11.97b	27.33b	15.40b	69.00a	2.19b	1.44b	0.21a
VA-mycorrhizal (M)									
NM	91.27c	2.22c	13.50c	28.92c	15.97c	64.58c	2.21c	1.37b	0.15b
M1	96.75b	2.43b	15.77b	35.95b	20.14b	67.24b	2.79b	1.63a	0.23a
M2	98.17a	2.47a	16.06a	37.28a	20.80a	67.73a	2.88a	1.62a	0.24a
Interaction									
S x C	**	**	**	**	**	**	**	*	**
S x M	**	**	**	**	**	**	**	**	**
C x M	**	**	**	**	**	**	**	**	**
S x C x M	**	*	*	**	**	*	**	NS	*

Effect of Cultivars: Significant cultivars differences were reported in growth attributes as presented in Tables 2 and 3 as average of the growing seasons. Sakha-1 cultivar was surpassed the other cultivar Giza-461 in plant height, root length, crop growth rate, number of leaves and dry weight per plant at all three sampling stages. These results may be attributed to the differences between studied cultivars in growth habit and response of each one to environmental conditions during the growing season which are controlled by genetically factors. That may be reflected on nodulation and N-fixation consequently growth characteristics. Similar results were obtained by El-Masry [20]. The data presented in Table 2 and 3 demonstrated clearly that both cultivars exerted significant differences in seed yield and its components in both seasons. The highest seed yields of (3.06 t/ha) were produced by Sakha-1, while the lowest (2.19 t/ha) were obtained by Giza -461 in both seasons, respectively. With respect to yield components although Giza-461cultivar had more branches and produced the highest 100-seed weight compared with Sakha1 cultivar it was significantly the lowest in plant height and the number of pods and seeds per plant. These results are in accordance with those obtained by Salih [6] and Amer *et al*. [9].

VA-Mycorrhizal Inoculation: Data presented in Tables 2 and 3 indicated that a significant effect of VA-mycorrhizal fungi in all growth attributes at 50, 70 and 90 DAS. The dry weight per plant was increased by 21.1%, 19.6% and 23.8% at 50, 70 and 90 DAS with inoculated plants (M1 and M2) as compared with non inoculated NM plants, respectively. Similar results were reported by Kucey and Jansen [21] and Arafa [22]. In addition to increasing plant biomass by VA-mycorrhizal fungi, also it seems it helps in the enhancement of nutrient uptake and its translocation increase photosynthetic rate and accumulation of photosynthates in shoot [23]. The data presented in Tables 2 and 3 indicated that inoculation with VA-mycorrhizal fungi (M2) and (M1) led to highly significant increases in plant height, number of branches, pods, seeds per plant, seed yield/plant, 100-seed weight, seed yield/ha and N and P contents. The increases (%) in seed yield/ha of faba bean treated with VA-mycorrhizal reached to 20.7%-23.2% respectively, as compared with non-mycorrhizal inoculated plants. These results are in accordance with those obtained by Kurle and Pfleger [24], Radwan [25] and Harley and Smith [26], who found that vesicular-arbuscular mycorrhizal (VAM) fungi stimulated the growth of many plants by improving their ability to recover P from P-deficient soils.

Effect of Interactions: The response of faba bean plant to the interactions between sowing dates, varieties' and VA-mycorrhizal inoculation are shown in Tables 2 and 3. The results indicated that the combination of early sowing date, Sakha 1 cultivar and VA-mycorrhizal inoculation gave the highest values for growth attributes yield components of faba bean and nutrient uptake.. It could be concluded from this study that early sowing combined with VA-mycorrhizal inoculation may improve the growth and yield of faba bean cultivars. Also Sakha-1 is preferably recommended because of its superior positive response to such conditions.

CONCLUSION

Generally, it can be concluded that the early sowing date in combination with VA-mycorrhizal inoculation may be improve the growth and yield of faba bean cultivars and the Sakha-1 cultivar is preferably recommended because of its superior positive response to such conditions.

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