Effect of Planting Dates and Foliar Application of Gibberellin on the Growth and Productivity of Broad beans (*Vicia faba* L.)

Dr. Mohammad Al-Sheikh[1] Dr. Samer Al-Amer[2]

(1). Researcher, Faculty of Agricultural Engineering. Al-Furat University. Deir Ezzor. Syria. mohammadalsheikh13190@gmail.com

(2). Researcher, Syrian Grain company. Deir Ezzor. Syria. sa10.8.1978am@gmail.com

Abstract

The research was carried out in a private farm in Deir Ezzor Governorate during 2024/2025 agricultural season using broad bean plants, to study the effect of planting dates, (October 10–November 10), and foliar application of 4 levels of gibberellin (0 -15 – 30 – 45 mg/ L) on growth and productivity characteristics. The plants sprayed twice with GA3, 30 days after germination and 30 days after the first one. The results showed that Octoer 10 planting date was superior in all studied plant characteristics (plant height, leaf area, fresh plant weight, 100-seed weight, and seed yield). Furthermore, Application of GA3 (45mg/L) showed significant superiority Compared to other treatments including the control in plant height, leaf area, fresh plant weight, 100-seed weight, and seed yield. Synergic effect of planting date and GA3 treatments had a noticeable effect Over all treatments, the best synergic effect was obtained when October 10 planting date and GA3 (45mgL) implicated together.

Keywords: Broad beans, planting dates, gibberellin, growth, seed yield.

تأثير مواعيد الزراعة والرش الورقي بالجبرلين في نمو وإنتاجية الفول البلدي

(*Vicia faba* L.)

د. محمد الشيخ[1] د. سامر العامر[2]

(1). باحث، كلية الهندسة الزراعية، جامعة الفرات، دير الزور، سوريا.

mohammadalsheikh13190@gmail.com

(2). باحث، السورية للحبوب، دير الزور، سوريا. sa10.8.1978am@gmail.com

الملخص:

نفذ البحث في مزرعة خاصة في محافظة ديرالزور خلال الموسم الزراعي 2025/2024 باستخدام نبات الفول البلدي بهدف دراسة تأثير مواعيد الزراعة وذلك بموعدين (10 تشرين الأول – 10 تشرين الثاني) والرشّ الورقيّ بالجبرلين بأربعة مستويات (0– 15– 30– 45 مغ/لتر) في صفات النمو والصفات الإنتاجية، رشت النباتات بالجبرلين بمعدل رشتان، الأولى بعد شهر من الإنبات والثانية بعد الرشة الأولى بشهر.

بينت النتائج تفوق موعد الزراعة الأول (10 تشرين الاول) في جميع صفات النبات المدروسة (ارتفاع النبات، مساحة المسطح الورقي، الوزن الطازج للنبات، وزن 100 بذرة، الغلة الحبية). كما حقق الرشّ بالجبرلين عند المستوى (45 مغ/ لتر) تفوقاً معنوياً على بقية معاملات الرشّ وعلى الشاهد في كلٍّ من (ارتفاع النبات، مساحة المسطح الورقي، الوزن الطري للنبات، وزن 100 بذرة، الغلة الحبية). كما أحدث تداخل مواعيد الزراعة والرش الورقي بالجبرلين تأثيراً ملحوظاً في جميع الصفات، إذ كانت أفضل القيم لجميع الصفات المدروسة عند تداخل موعد الزراعة (10 تشرين الأول) مع المستوى (45 مغ/لتر) من الرش الورقي بالجبرلين.

الكلمات المفتاحية: الفول البلدي، مواعيد الزراعة، الجبرلين، النمو، الغلة الحبية.

Introduction

Broad beans (*Vicia faba* L.) are one of the most important and widely used economic winter legume crops. Their seeds are characterized by a high protein and fiber content and a low fat content [19]. Broad beans are grown in various crop rotations [3]. Small and large varieties are mainly used as mature, dry seeds for food or fodder, while large varieties are harvested either as dry or fresh seeds or pods for human consumption and have various culinary uses [23]. The crop is widely cultivated in all continents, and the the global broad bean cultivated area has decreased from 5.5 million hectares in 1960 to 2.78 million hectares in (2023) [7].

Broad beans are considered as an important source of protein, comprising up to 28%, and considered as the cheapest sources of protein. They also contain carbohydrates and numerous vitamins and nutrients. Furthermore, their cultivation in the soil improves nitrogen fixation, which decrease nitrogen fertilizers requirement. Broad beans are also used in the production of high-nutritional-value animal feed [2].

Broad beans are an annual herbaceous plant with an upright, ribbed stem, it may arrived to 80 – 110 cm height. Their flowers are white with black or purple spots. They contain many minerals such as potassium, calcium, iron, zinc, and magnesium [15]. Broad bean productivity depends on fertilization, And they considered as moderate sensitive legume [18].

Determining the planting date is Not less important than other crop management processes To obtain the best yield by using the most suitable growth conditions. It has been observed that high temperatures during the flowering period lead to flower damage and failure to form pods, while low temperatures during the flowering period prevent fertilization and reduce the percentage of seeds Formed in pods or in complete -formation, which decrease seed weight [21].

Sowing date is considered one of the most important factors that may affect the timing and duration of the vegetative and reproductive stages, which contribute primarily to seed productivity. [13].

In a study conducted by [6] on broad beans, they reported that early planting (October 1) resulted in a 157% increase in broad bean yield because planting In this date provided all environmental requirements to plants during growth stages compared to December end. They concluded that most of these advantages were due to the extended period of vegetative growth, which resulted in the improvement of many agricultural characteristics.

[14] showed significant differences when they studied Two bean planting date (October 5 and October 20), the first date was superior in (plant height, number of branches, number of leaves).

[5] reported significant differences when they studied three planting dates (November 7, December 7, and January 7), And found that November 7 was the best compared to other dates.

In a study conducted by [29] on broad beans, Planted at three spring planting dates (late February, late March, and mid-April) and three autumn planting dates (late September, early October, and late October). The results showed that planting date significantly affects the yield and composition of broad beans. Autumn planting dates generally resulted in better growth, yield, and maturity. Specifically, broad beans planted in autumn showed a 58% increase in the number of branches, a 100% increase in bud dry matter, a 34% increase in 100-seed weight, a doubling of grain production, and an 8% increase in the harvest index compared to broad beans planted in spring.

[16] showed that the term growth regulator can refer to any organic chemical whose use at a low concentration promotes, inhibits, or modifies growth and development, they are a group of organic compounds produced by plants and control plant growth and development produced by plants known as plant growth regulators control plant growth.

Several studies have shown that growth-promoting hormones, including gibberellins, reduce plant resistance to water scarcity [9].

Gibberellic acid (GA3) is at the most common plant growth regulator. It stimulates stem and node elongation, seed germination, and promotes enzyme

production during germination, fruit set, and development. Gibberellic acid is an important growth regulator with multiple effects in modifying plant growth and productivity. Therefore, it is necessary to determine effective dose which give the best growth [27].

The growth-promoting hormone gibberellin regulates numerous developmental processes throughout the plant life cycle, from seed germination to fruit development [10F. Gibberellic acid is widely used in agriculture to control germination, stem elongation, plant structure, flowering time, and fruit development [25].

Gibberellins have the ability to influence genetic traits and physiological processes in plants, such as flowering, parthenocarpy, and carbohydrate mobilization during germination [31].

[12] stated that treatment with high concentration of gibberellic acid give a highest average in all studied traits of the broad bean plant (plant height, number of pods/plant, number of seeds/pod, seed index, and total yield per plant/ha).

[24] reported that foliar application of gibberellin acid at high concentrations on broad bean plants resulted in height and number of seeds per pod per plant.

[26] evaluated several growth regulators. They confirmed that the 100-seed weight and seed yield per $acre^{-1}$ were significantly affected in plants treated with gibberellic acid or salicylic acid.

Research importance and objective

The variable climatic conditions and the different adaptations of different varieties of broad bean, especially the local variety of broad bean which is greatly affected by planting date, are significant factors. Planting too early or too late exposes the plants to fluctuating temperatures, causing flower drop and thus impacting productivity. Given the crucial role of growth regulators, particularly gibberellin, in plant growth, flowering, and fruit ripening, and considering that broad beans are a major agricultural crop whose growth and

productivity are significantly influenced by planting date and growth regulators, this research is essential to determine the optimal planting date and the best gibberellin concentration for optimal growth and productivity characteristics in broad beans.

Materials and methods

Research situs

The research was conducted on a private farm in Deir Ezzor Governorate, Syria. during the 2024/2025. Soil characters were pH=7.78, EC=1.16 dS m^{-1}, organic matter 0.76%, mineral nitrogen 4.86 ppm, available phosphorus 7.1 ppm, available potassium 236 ppm, and mechanical analysis of the soil: 24.32% sand, 36.24% silt, 39.44% clay.

Plant material

A good quality of Broad bean seeds were used in this experiment, they had a good productivity, high disease resistance, suitable for field and greenhouse, and a good marketing.

Experimental Treatments

Factor 1: Planting dates, (October 10th and November 10th).

Factor 2: Foliar application with gibberellin at four levels (0, 15, 30, and 45 mg/ L), repeated twice: 1 month after germination, and 1 month after the first treatment,

Working methods

land preparing

The soil was plowed, smoothed, leveled, and divided into three sectors, each the sector was divided into 8 units ,the unit contained 4 rows of 1.5m long, and o.4 m space between rows, making 2.40 m2 surface,(1.5* 1.6 m). local broad bean seeds were planted at 5cm depth, and 15 cm distance between holes. Seeds were germinated at 10/10/ 2024 of October, and at 10/11/2024 of November. Plants were thinned to 1 plant per hole.

Fertiliation

According to agricultural ministry recommendation, 30 kg/ha of nitrogen fertilizer were added before sowing , 60 kg P_2O_5/ha, 60 kg K_2O/ ha were added at soil preparation. Growth parameters were registered (plant high/cm, leaf area/ cm^2 , plant fresh weight (g), and grain yield (kg/ha).

Experiment design and statistical analysis

randomized complete factorial block design (RCBD) was used, with 3 replications , contained 40 plants/ unit. with three replicates and 40 plants per experimental unit. 24 experimental units were required. The results were statistically analyzed using ANOVA by calculating the least significant difference (LSD) at a 5% level for the field results using the GenStat 12th statistical software.

Results and discussion

plant height (cm)

The results showed an increase in plants height when the seeds sowed at October 10^{th}, (63.30 cm), compared to those sowed at November 10^{th} (56.80 cm). This effect may be attributed to the favorable weather conditions, particularly the temperature, at the earlier planting date. Furthermore, early planting extends the growing season by protecting plants from low temperatures and allowing them to receive a high percentage of sunlight, which positively impacts their vegetative growth. the suitable temperature increase mineral elements absorption which are necessary for photosynthesis and build up carbohydrates and growth regulators including GA3 which known to promote cell elongation and then plant height [29].

On the other hand, Treatment with GA3 (45mg/L),significantly exceeded other treatments in plant height (63.14 cm) compared to the control (56.71 cm). We also note an increase in height with increasing rates of foliar spraying with gibberellin. These results can be attributed to the distinctive physiological effects of gibberellin acid on plant growth and its role in photosynthesis and the activation and development of other vital processes that take place in the parts of the plant cell in cell division and increase their elongation, thus increasing the plant height. This result is consistent with [8 and 24].

The combination between GA3 and planting time (45g/L+ October 10th) resulted in higher stem elongation (66.84cm) compared to November 10th and control (54.31 cm).

Table 1. Effect of planting dates and foliar spraying with gibberellin on average plant height (cm).

Planting Dates	Foliar spray with gibberellin mg/L				Average planting dates treatments
	0	15	30	45	
October 10	59.12	62.75	64.52	66.84	63.30b
November 10	54.31	55.76	57.68	59.45	56.8a
Average Gibberellin Spray Applications	56.71d	59.25c	61.1b	63.14a	60.05
LSD5% For Planting dates LSD5% For spraying with gibberellin LSD5% for reaction	3.12 1.34 2.18				

Surface area of leaf (cm^2)

The results in table (2) demonstrate the significant difference of sowing time, GA3 treatment, and their interaction on leaf area. October 10th planting date increased leaf area (4231.45 cm2) compared to November 10th planting date (3408.66 cm2), this increase could be attributed to The increase in the plant's leaf area may be attributed to the significant increase in stem length from the beginning of growth, which resulted in an increase in the number of branches and then an increase in the number of leaves, which directly affected the leaf area. These results are consistent with what was found in 20. These results are consistent with [20].

The results showed as well an increase in leaf area (4171.35 cm^2) after treatment with GA3 (45mg/L), compared to the control (3491.52 cm^2 This increase may be due to the role of GA3 as stimulator of growth including

enhancement of cell division and enlargement which lead to the increase of leaf area. This is consistent with the results of [22].

Table (2) demonstrates as well that the combination of planting date (October 10th) and GA3 concentration (45 mg/L) resulted in higher leaf area (4596.76 cm^2) compared to (November 10th) planting date and control (3156.21 cm^2)

Table 2. Effect of planting dates and foliar application with gibberellin on the average leaf area (cm^2).

Planting Dates	Foliar spray with gibberellin mg/L				Average planting dates treatments
	0	15	30	45	
October 10	3826.84	4165.95	4336.25	4596.76	4231.45a
November 10	3156.21	3238.25	3494.25	3745.95	3408.66b
Average Gibberellin Spray Applications	3491.52d	3702.1c	3915.25b	4171.35a	3820.05
LSD5% For Planting dates LSD5% For spraying with gibberellin LSD5% for reaction	212.03 86.21 136.24				

Fresh weight of the vegetative parts (g)

Statistical analysis of table (3) data indicates an significant increase of plant vegetative fresh weight of October 10^{th}planting date (279.42 g) compared to November 10 planting date (235.16 g), this could be attributed to the increase of leaf area, duration of sun light, and suitable temperature of October 10 date. and this is consistent with what was found by [1].

Fresh weight of vegetative parts treated with GA3 (45 mg/ L) increased significantly (284.44g) compared to control (277.99 g) and other treatments. This increase may be contributed to the role of GA3 on plant growth and production. Suitable temperature elevate mineral nutrients absorption that activate photosynthesis and carbohydrate production which lead to ameliorate cell division and vegetative growth. Suitable temperature and the increase in leaf area, may lead to synthesis of growth regulators which affect plant physiology and growth processes. The increased activity of with [30].

The interaction of panting date(October 10) and GA3 concentration (45 mg/L) increased significantly fresh weight (314.58 g) compared to the control (212.35 g) and other treatments.

Table 3. Effect of planting dates and foliar spraying with gibberellin on the fresh weight of the vegetative part (g).

Planting Dates	Foliar spray with gibberellin mg/L				Average planting dates treatments
	0	15	30	45	
October 10	243.64	266.21	293.25	314.58	279.42a
November 10	212.35	230.69	243.32	254.3	235.16b
Average Gibberellin Spray Applications	227.99d	248.45c	268.28b	284.44a	257.29
LSD5% For Planting dates LSD5% For spraying with gibberellin LSD5% for reaction	10.35 8.76 9.11				

100 seeds weight / g

A significant difference in 100 seeds weight of planting date (October 10, 368.4 g)) and (November 10, 327.72 g) was recorded. This may be due to the environmental conditions that accompanied the first date, which were more suitable for Plant growth and development, This Affected positively on the overall physiological processes taking place within the plant, the most important Is photosynthesis efficiency And organic materials production ,photosynthesis translocation to seeds, Table (4). [17].

GA3 (45 mg/L) increased 100 seeds weight (372.96 g) compared to the control (321.22 g). GA3 treatment increased leaf area, vegetative growth, leaf chlorophyll content, prevents chlorophyll degradation, by maintaining chloroplast membrane integrity. This lead to This led to an increase in the plant's photosynthetic efficiency and carbohydrate synthesis, accompanied by an increase in the amount of dry matter produced in the leaves, which was transferred to storage sites (seeds). This is consistent with [11].

Table (4) demonstrate as well that the interaction between planting date (October 10) and GA3 (45 mg/L) increased 100 seeds weight (392.57 g) compared to control (298.24 g) and other GA3 treatments + November 10 date.

Table 4. Effect of planting dates and foliar spraying with gibberellin on the weight of 100 seeds (g).

Planting Dates	Foliar spray with gibberellin mg/L				Average planting dates treatments
	0	15	30	45	
October 10	344.21	361.27	374.91	392.57	368.24a
November 10	298.24	317.68	341.64	353.35	327.72b
Average Gibberellin Spray Applications	321.22d	339.47c	358.27b	372.96a	347.98
LSD5% For Planting dates LSD5% For spraying with gibberellin LSD5% for reaction	20.54 10.98 15.24				

Seed yield (kg/ha)

Table (5) indicates that there was a significant increase in seed yield of broad beans at the planting date of October 10 (5627.06 kg/ha) compared to compeared to November 10 date (4648.95 kg/ ha) this may attributed to the

good vegetative growth recorded by the first planting date, especially the plant's vegetative weight and leaf area, which ameliorated photosynthesis and products translocation efficiency from leaves to the pods. This could be due to the suitable weather conditions , long sun light duration which benefit vegetative growth and productivity. and this is consistent with [28].

GA3 (45 mg/L) recorded higher grain yield (5565.53 kg/ha) compared to other GA3 treatments and control (4707.44 kg/ha). This may be attributed to the effect of gibberellin on vegetative characteristics, As stimulator of cell division and elongation, which in turn increased vegetative growth. It increased osmotic pressure of cells by inducing starch degradation enzymes which break down starch into glucose and fructose. This sugars accumulation increase osmotic pressure which lead to water and nutrients absorption. Consequently, this contributes to an increase in fresh weight and dry matter. The growth of lateral buds and the number of leaves increase as well, resulting in increased leaf area and photosynthetic efficiency. This, in turn, affects plant growth and development, ultimately leading to an increase in grain yield. This result is consistent with the conclusion reached by [4].

The results also indicate an increase in grain yield in all interaction treatments compared to the control, (6052.91 kg/ ha), compared to October 10th and GA3 (45 mg/L) + other treatments. (4268.32 kg ha^{-1}) when the October 10th date was combined with foliar spraying of gibberellin (45 mg/ L) compared to the other treatments.

Table 5. Effect of planting dates and gibberellin foliar spraying on seed yield kg ha^{-1}

Planting Dates	Foliar spray with gibberellin mg/L				Average planting dates treatments
	0	15	30	45	
October 10	5146.57	5561.87	5746.90	6052.91	5627.06a
November 10	4268.32	4421.76	4827.58	5078.15	4648.95b
Average Gibberellin Spray Applications	4707.44d	4991.81c	5287.24b	5565.53a	5138

LSD5% For Planting dates	196.45
LSD5% For spraying with gibberellin	132.75
LSD5% for reaction	152.45

Conclusion

This study highlights the importance of selecting the right planting date and GA3 concentration to improve broad bean growth and yield. The results indicate that planting in October 10th was significantly greater than all studied parameters (plant height, leaf area, fresh weight, 100-seed weight, and grain yield). Furthermore, applying gibberellin at 45 mg/L Resulted in a best growth parameters compared to other treatments including control. These findings Realized the importance of selecting the appropriate planting date and gibberellin concentration to achieve optimal results. Future research should focus on selecting suitable planting dates and utilizing growth regulators that contribute to improved plant growth and yield, thereby enhancing farmers' agricultural practices.

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