Effect of vermicompost fertilization and planting dates on the vegetative growth traits of mung bean (*Vigna radiata* L)

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Abstract

This study was conducted during the 2025 at the Agricultural Research Station of the Field Crops Department, College of Agriculture, Tikrit University, in Salah al-Din Governorate, located at latitude 34.6°N and longitude 43.6°E growing season and aimed to evaluate the effect of planting dates and vermicompost levels on the vegetative growth traits of mung bean, with the goal of determining the optimal planting date and level of organic fertilization. The experiment was carried out using a randomized complete block design (RCBD) with a split-plot arrangement and three replicates to study two factors. The main plots represented three planting dates: May 15, May 30, and June 15, while the subplots represented three levels of vermicompost: 0, 2, and 4 tons ha^{-1}, applied before planting. The results showed a significant effect of planting dates on several studied traits. Planting on May 30th resulted in excelled plant height, number of leaves per plant, leaf area, leaf area index, and dry weight, registering averages of 89.98 cm, 78.62 leaves per plant, 4285.6 cm^2, 5.12 , and 98.99 $g.plant^{-1}$, respectively. The results also indicated that the application of vermicompost at levels of 2 and 4 tons ha^{-1} resulted in a significant improvement in most traits, although no statistically significant differences were observed.

Keywords: Vermicompost, mung beans, planting dates.

Introduction

Mung beans (*Vigna radiata* L.) belong to the legume family (Fabaceae). They are an economically important crop, being a key component of human nutrition. They are cultivated on 7.3 million hectares annually worldwide [5]. Mung beans are an important food crop for vegetarians in Asian countries, particularly Southeast Asia [7]. They are an excellent source of protein, containing 24.5%, and are also high in tryptophan (60 $mg.g^{-1}$), lysine (460 $mg.g^{-1}$), fat (0.6%), ash (3.7%), and fiber (0.9%) [11].Vermicompost is a fertilizer produced by earthworms of the species Eisenia fetidak, which are classified within the order Oligocheata, belonging to the order Megadrilacea. Vermicompost, an organic material similar to fine peat, is characterized by properties that improve the physical structure of the soils in which it is used, including moisture retention, porosity, and drainage [16] The nutrient content

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of vermicompost is closely related to the nature and type of food the worms consume, and it generally contains significantly more readily available nutrients for plant growth compared to the parent material. It also promotes plant growth. Vermicompost is an effective soil conditioner, improving soil structure, increasing nutrient content, and enhancing microbial activity [1]. Studies have shown that using vermicompost significantly increases plant height and biomass productivity [2]. Vermicompost contains a large number of minerals such as magnesium, calcium, iron, sulfur, zinc, boron, copper, phosphorus, nitrogen, and potassium, as well as humic acids [15] and it also promotes plant growth through its enzyme and hormone content [10]. Numerous studies have highlighted it as a good alternative to mineral fertilizers [8]. A study by [13] showed that using worm compost can increase soil potassium by 57%, nitrogen by approximately 42%, and phosphorus by 29%. The appropriate planting date is a crucial factor influencing growth characteristics, which vary depending on environmental conditions, particularly temperature, humidity, and light [12]. In Iraq, mung beans are cultivated in two seasons: spring and autumn. Therefore, the planting date is of great importance in determining the optimal time for the crop, due to changing climatic conditions and the varying adaptations of different varieties, especially the local variety, which is often affected by the planting date. Agriculture, and its effect on most vegetative and yield characteristics [9].).The study aimed to:

1-Determine the optimal level of vermicompost fertilizer for field trits and yield in gypsum soil.

2- Determine the optimal planting date.

3- Determine the optimal interaction between the two factors.

Materials and Methods:

The field experiment was conducted during the summer growing season (2025) at the Agricultural Research Station of the Field Crops Department, College of Agriculture, Tikrit University, in Salah al-Din Governorate, located at latitude 34.6°N and longitude 43.6°E. Five random soil samples were taken from the field before planting at a depth of 30 cm and analyzed in the laboratory of the Soil and Water Resources Department, College of Agriculture, Tikrit University (Table 1), to determine the chemical and physical properties of the field soil. The land was plowed twice perpendicularly with a disc plow and divided according to a randomized complete block design (RCBD) using a split-plot system. With three replicates, spaced 1 m apart, each replicate contained three main plots measuring 6 x 2 m², representing the planting dates. Each main plot contained three secondary plots measuring 2 x 2 m², representing the vermicompost fertilization treatments. Vermicompost was added to each plot in rows, and the soil was turned over to mix the fertilizer. Vermicompost was added to

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the experimental units at rates of 0, 2, and 4 tons ha^{-1} in a single application before planting and after planning the experiment. Planting was done in rows, with each experimental unit (sub plot) containing four rows. The distance between rows was 0.4 m, and the distance between planting holes was 0.2 m. Three seeds were placed in each hole to ensure germination, and thinning was conducted to one plant per hole. Thinning was performed when the seeders reached the appropriate height. Irrigation and weeding were carried out as needed.

Table 1. Analysis of the chemical and physical properties of the experimental soil before sowing

Soil traits	Value	units
PH	3.43	MS
EC	7.35	– – – –
Ca++	134	ppm
K+	113	ppm
Na+	469	ppm
N	12	ppm
P	4.3	ppm
Mg++	14	ppm
Lime	22	%
Gypsum	18	%
Organic matter	0.7	%
Sand	43.6	%
Clay	45	%
Silt	11.4	%
Soil structure	-------	Loam

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Table 2. Some chemical properties of the vermicompost used

Soil traits	EC	PH	N	P	K
Value	4.1	6.34	1.73	1.06	0.85
The untis	MS	------	%	%	%

The first factor is planting dates, denoted as A, and was implemented in the main plots.

1- First planting date: May 1, 2025, denoted as A1.

2- Second planting date: May 30, 2025, denoted as A2.

3- Third planting date: June 15, 2025, denoted as A3.

The second factor is vermicompost fertilization, denoted as B, and was implemented in the secondary plots.

1) No adding (0), denoted as 1B.

2) Vermicompost at a rate of 2 tons . ha^{-1}, denoted as B2.

3) Vermicompost at an average of 4 tons per hectare, denoted as B3.

Studied traits

1. Number of days from planting to 50% flowering (days)

The number of days was calculated in the field from the first irrigation after planting until the plants in each experimental unit reached 50% flowering [14].

2. Plant height (cm)

The plant height was measured at maturity, starting from the base of the stem near the soil surface to the tip of the stem, using a measuring tape. The average was calculated for each experimental unit.

3. Number of leaves per plant (plant pod^{-1})

The number of leaves was counted individually for each plant, and the average was calculated for each experimental unit.

4- Leaf Area (cm^2)

The leaf area was calculated using the wet weight method. A plant from the central rows was selected to represent the experimental unit. All the plant's leaves were taken, and their total weight was recorded. The leaves were then counted and pierced with a drill of known diameter. The weight of the discs was recorded, and the following equation was applied to calculate the circular area of the discs: Area of the discs (cm^2) = 3.14 * $(radius)^2$ * number of discs.

The total leaf area was calculated using the following equation: Leaf area of the plant (cm^2) = * Circular area of the discs (cm^2)[3].

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5- Leaf Area Index

6. Plant Dry Weight (g plant^{-1}):

When the plant reached full maturity, five plants were randomly harvested from the two midlines of each experimental unit, including all above-ground parts (leaves, stems, and pods). They were dried until their weight stabilized, and the average weight was calculated.

Statistical Analysis

The data were statistically analyzed as a factorial experiment using a randomized complete block design (RCBD) and a split-plot system, based on the SAS software [4]. Differences between the means for main effects and interactions were compared using Duncan's multivariable test at a significance level of 0.05.

Results and Discussion:

1. Number of days from planting to 50% of flowering (days):

Table (3) shows the effect of vermicompost levels, planting dates, and their interaction on the time from planting to 50% flowering, according to Duncan's multivariable test. The effect of planting dates was significant on the trait, with the earliest planting date (May 15th) recording the shortest growth period (48.33 days), while the later planting date (June 15th) recorded the longest growth period (53.67 days).

The effect of vermicompost was also significant on the trait. The 2-ton and 4-ton treatments resulted in the shortest growth periods (51.44 and 50.78 days, respectively), with no significant difference between them. The control treatment (level 0) recorded the longest growth period (52.44 days).

The combined treatment (first date × level 4 tons.ha^{-1}) resulted in the shortest duration of the trait at 47.67 days, while the combined treatment (third date × level 0 tons.ha^{-1}) resulted in the longest duration of the trait at 54.67 days.

Table (3) shows the effect of vermicompost levels, planting dates, and their interaction on the time from planting to 50% flowering (days).

Planting dates	Vermicompost levels (tons ha^{-1})			average
	0	2 tons ha^{-1}	4 tons ha^{-1}	
5/15	48.67e	48.67e	47.67e	48.33c
5/30	54.00ab	52.33cd	51.67d	52.67b
6/15	54.67a	53.33bc	53.00bc	53.67a
average	52.44a	51.44b	50.78b	51.55

2- Plant Height (cm):

The results in Table (4) show that the planting date has a significant effect on mung bean plant height. The planting date of May 30th recorded the highest average height (89.98 cm), compared to the planting dates of May 15th and June 15th, which recorded the lowest average heights (37.52 and 69.97 cm), respectively. This is due to the higher temperatures recorded at the end of May and the beginning of June, as well as the longer photoperiod, which allows the plant more time for division and elongation. The results in Table (4) below also show the significant effect of vermicompost levels on this trait. The 2-ton and 4-ton treatments achieved the highest average heights (66.76 and 68.64 cm), respectively. This is because vermicompost promotes biological activity, particularly cell division and elongation, as well as increasing the activity of enzymes that break down organic compounds and release elements from them. The high nitrogen content also stimulates plants to increase their auxin production, as shown in Table (2). This, in turn, promotes cell division and consequently increases plant height. These results are consistent with those found by [6]who also found that vermicompost fertilization led to increased plant height.The interaction between planting dates and vermicompost levels had a significant effect. The interaction between (second planting date × third fertilizer level) resulted in the highest plant height (92.07 cm), while the interaction between (first planting date × first fertilizer level) resulted in the lowest plant height (33.23 cm).

Table (4) shows the effect of vermicompost levels, planting dates, and their interaction on plant height (cm).

Planting dates	Vermicompost levels (tons ha-1)			average
	0	2 tons ha^{-1}	4 tons ha^{-1}	
5/15	33.23f	39.87e	39.47e	37.52c
5/30	86.80b	91.07ab	92.07a	89.98a
6/15	66.17d	69.33d	74.40c	69.97b
average	62.06b	66.76a	68.64a	65.82

3- Number of leaves per plant (leaf plant $^{-1}$)

Table (5) shows the effect of planting date on the number of leaves per plant. The second planting date recorded the highest average number of leaves, reaching (78.62) leaf plant $^{-1}$, while the first and third planting dates recorded the lowest average for this trait, at (38.20) and (38.24) leaf plant $^{-1}$, respectively. This is attributed to the

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superiority of the second planting date due to the ideal thermal balance, as mung bean is a very heat-sensitive crop, as well as to the longer photoperiod, compatibility with atmospheric humidity, and the development of the root system. The reason for the superiority of the second planting date is that it provides ideal thermal balance, as mung bean is a very heat-sensitive crop, and also to the longer photoperiod, compatibility with atmospheric humidity, and the development of the root system. Table (5) also shows the significance of the fertilization rate, where the second and third levels recorded the highest average for the trait (53.47 and 55.07 leaf plant $^{-1}$, respectively), while the first level recorded the lowest average for the trait (46.47 leaf plant $^{-1}$). The superiority of the fertilizer levels (2 and 4 tons ha^{-1}) may be attributed to the high percentage of beneficial nutrients, which provided a greater opportunity for the formation of a larger number of leaves.The interaction between planting date and vermicompost levels significantly affected the leaf count trait. The treatment combining (the second planting date × the second fertilizer level) recorded the highest average for the trait (91.53 leaf plant $^{-1}$), while the interaction combining (the third planting date × the control treatment) recorded the lowest average for the trait (35.87 leaf plant $^{-1}$). This interaction indicates that combining the second planting date and the second fertilizer level contributes to increasing the number of leaves per plant.

Table (5) The effect of vermicompost levels, planting dates and their interaction on the number of leaves per plant (leaf. plant^{-1}).

Planting dates	Vermicompost levels (tons ha-1)			average
	0	2 tons ha^{-1}	4 tons ha^{-1}	
5/15	36.73ef	35.73f	42.13de	38.20b
5/30	67.00c	91.53a	77.33b	78.62a
6/15	35.87f	33.13f	45.73d	38.24b
average	46.53b	53.47a	55.07a	51.68

4- Leaf Area (cm²)

The results in Table (6) indicate significant differences between planting dates. The May 30th planting date was superior to the other two, with an average of (4285.6 cm²). The May 15th and June 14th planting dates recorded the lowest average leaf area, at (2991.8 and 2739.4 cm²), respectively. The increase in leaf area with the second planting date is attributed to the availability of suitable growth conditions, including moderate

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temperatures and appropriate humidity, which led to increased photosynthesis and a positive effect on the leaves.The results in the table below show no significant differences between fertilization levels.The interaction between planting dates and fertilizer levels showed significant differences in leaf area. The interaction between May 30th and a fertilizer level of 2 tons ha^{-1} resulted in the highest average leaf area (4820.3 cm^2), which did not differ significantly from the interaction between the second planting date and the control treatment (both of which recorded an average of 4599.3 cm^2). In contrast, the interaction between May 15th and the control treatment resulted in the lowest average leaf area (2317.2 cm^2).

Table (6) shows the effect of vermicompost levels, planting dates, and their interaction on leaf area (cm^2).

Planting dates	Vermicompost levels (tons ha-1)			average
	0	2 tons ha-1	4 tons ha-1	
5/15	2317.2d	3036.5bcd	3621.8b	2991.8b
5/30	4599.3a	4820.3a	3437.0b	4285.6a
6/15	2443.7cd	2632.3cd	3142.3bc	2739.4b
average	3120.1a	3496.4a	3400.4a	3338.95

5- Leaf Area Index

From Table (7), we find that planting dates significantly affected the leaf area index of mung bean plants. The date of May 30th recorded the highest average for this trait, reaching 5.12, compared to the dates of May 15th (3.74) and June 15th (3.42). This superiority is attributed to the fact that temperatures were within the optimal growth range and other conditions, such as humidity, were available, enabling us to control irrigation and maintain moderate humidity, as shown in Appendix (2). The superior leaf area achieved by this date was also reflected in the leaf area index for the same date.Table 7 shows significant differences between fertilizer levels. Level 4 tons ha^{-1} outperformed the other two levels, with an average value of 5.30 for the trait. Levels 0 and 2 tons ha^{-1} recorded the lowest average values (3.12 and 3.86, respectively), but the difference was not significant. The superiority of level 4 tons ha^{-1} is attributed to the continuous availability of necessary nutrients throughout the growing season, creating optimal conditions for prolonged vegetative growth, which positively impacted the trait.The interaction between planting dates and fertilizer application significantly affected the leaf area index. The interaction between May 15th and the 4 tons ha^{-1} level resulted in the highest leaf area index (6.53), while the index was lower with other interaction combinations.

Table (7) Effect of Vermicompost Levels, Planting Dates, and Their Interaction on Leaf Area Index.

Planting dates	Vermicompost levels (tons ha-1)			average
	0	2 tons ha^{-1}	4 tons ha^{-1}	
5/15	1.56d	3.13c	6.53a	3.74b
5/30	4.75b	5.84ab	4.77b	5.12a
6/15	3.06c	2.62cd	4.59b	3.42b
average	3.12b	3.86b	5.30a	4.08

6- Plant Dry Weight (g. $plant^{-1}$)

The results in Table (8) indicate that the planting date significantly affected plant dry weight. The planting date of May 15th recorded the highest average dry weight at 100.33 g. $plant^{-1}$, which did not differ significantly from the planting date of May 30th, which recorded an average of 98.99 g. $plant^{-1}$. Conversely, the planting date of June 15th recorded the lowest average dry weight at 39.79 g. $plant^{-1}$. The superiority of the May 15th and 30th planting dates is attributed to favorable weather conditions, as shown in Appendix (2). Temperatures were near-optimum, leading to increased photosynthesis and greater plant mass, as well as an extended photoperiod.The results in Table 8 showed no significant differences in plant dry weight between fertilizer levels for mung bean crops. Table (8) shows significant differences in the interaction between planting dates and fertilizer application. The interaction between May 15th and 30th was most pronounced across all fertilizer levels, with no significant differences observed. However, the interaction between June 15th and 2 tons ha^{-1} resulted in the lowest average value for the trait, at 33.60, which did not differ significantly from the control treatment for the same planting date.

Table (8) Effect of Vermicompost Levels, Planting Dates, and Their Interaction on Plant Dry Weight (g. $plant^{-1}$).

Planting dates	Vermicompost levels (tons ha-1)			average
	0	2 tons ha^{-1}	4 tons ha^{-1}	
5/15	100.80a	100.07a	100.33a	100.40a
5/30	95.43a	99.83a	101.7a	98.99a
6/15	39.30bc	33.60c	46.47b	39.79b
average	78.51a	77.83a	82.83a	79.73

Conclusions:

1- Planting on May 30th for the early summer crop resulted in a significant increase in all studied traits, except for the number of pods.

2- A vermicompost application rate of 4 tons ha⁻ ¹ had a significant effect on most of the studied traits.

3- The interaction between planting dates and vermicompost application had a significant effect, as the combination of the fertilizer level and the May 30th planting date led to a clear improvement in productivity.

Mean squares of the studied traits

Studies traits / Sources of difference	degrees of freedom	Number of days from planting to 50% flowering	Plant height	Number of leaves per plant	Leaf area	Leaf area index	Dry weight
replicates	**2**	**4.11**	**8.49**	**14.67**	**106184.83**	**0.63**	**14.53**
A	**2**	**72.33****	**6307****	**4896.48****	**6191808.42****	**7.32***	**10770.51****
First experimental error	**4**	**0.11**	**5.88**	**16.25**	**334301.65**	**0.77**	**75.25**
B	**2**	**6.33****	**103.23 ns**	**185.17****	**344137.15 ns**	**11****	**66.21 ns**
A ×B	**4**	**0.67 ns**	**6.75 ns**	**218.66****	**1492796.10****	**6.34****	**44.98 ns**
Second experimental error	**12**	**0.50**	**6.55**	**11.95**	**175682.95**	**0.65**	**39.17**

**Highly significant, * significant, ns No significant differences.

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