# Effect of Sowing Date, Bio-health and Amino Acid on Vegetative Growth and Yield of Pea (*Pisum sativum* L.)

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## Abstract

This experiment was carried out during the 2021-2022 growth season to test the effect of the sowing date (1st October and 21st October), three levels of bio-health (0.0, 5.0, and 10.0 $g.L^{-1}$), and three levels of the amino acid (0.0, 2.0 and 4.0 $ml.L^{-1}$) on different growth and yield parameters of the pea plant. The experiment was implicated in a Randomized Complete Block Design (R.C.B.D) and replicated three times. The result showed that the 21st October sowing date was superior to the 1st October in branch number $plant^{-1}$, pod number $plant^{-1,}$ and total yield ($t.ha^{-1}$). Applications of bio-health significantly increased most traits. It was also noticed spraying amino acid at a concentration of 2.0 $ml.L^{-1}$ had a significant effect on branch number $plant^{-1}$, total chlorophyll%, pod number $plant^{-1}$, pod weight (g), and total yield ($t.ha^{-1}$). The combination of sowing date, bio-health, and amino acid significantly enhanced all studied traits, especially on 21st October, 5.0 $g.L^{-1}$ bio-health and 2.0 $ml.L^{-1}$ amino acid.

**Keywords:** Pea, Swing date, Bio-health, biofertilizer, Amino acid

## Introduction

Pea (*Pisum sativum* L.) is one of the legume plants which is grown for its green and dried seeds, in addition to its importance in improving the soil. The common pea (also known as the garden or field pea), is an herbaceous annual in the Fabaceae (formerly Leguminosae) family, originally from the Mediterranean basin and Near East, but now widely grown for its seedpod or legume (a simple dry pod containing several seeds and splitting along seams into two sides). Fresh green peas contain 17–22g carbohydrates, 20-50g starch, 14-26g dietary fiber, 6.2-6.5g protein, 0.4g fat, 1.0g ash,9-10mg calcium, 3- 5mg sodium, 97-99mg potassium per 100 g and vitamin contents are 0.7-mg riboflavin, 5- 6mg thiamine and folate 0.54 mg per kg (9). Pea is grown on over 25 million acres worldwide, the total cultivated area in 2017 in Iraq is about 107 donum with a total yield of 272 tons and 2542 $kg.ha^{-1}$ (5).

Sowing date is one of the important cultural practices that result in the greatest differences in the growth and yield of grain legumes without involving additional costs such as the addition of fertilizers. The optimum sowing date varies according to the cultivar planted. The sowing date is a major determinant of crop yield as it determines crop duration. The trend in crop production is for early sowing to optimize yield (3). Singh and Singh (23) have found a significant interaction between sowing date and varieties for plant height, number of branches $plant^{-1}$. Tiwari *et al*. (24) also observed a significant influence of interaction between sowing dates and varieties on plant height, number of primary branches. Abuo El-kasem and Elkassas (1) showed that sowing ($15^{th}$ October) gave the highest values of all growth parameters; i.e., plant height, number of branches, number of leaves as well as pod number $plant^{-1}$ and yield $plant^{-1}$.

Biofertilizers (bio-health), also called microbial inoculants, are organic products containing specific microorganisms, which are derived from plant roots and root zones. They have been shown to improve the growth and yield of the plant by 10–40% (11). They not only improve soil fertility and crop productivity by adding nutrients to the soil but also protect the plant from pests and diseases. They have been shown to enhance the growth of the root system, extend its life, degrade harmful materials, increase the survival of seedlings, and reduce the time to flowering (25). Kothyari *et al*. (14) Found that biofertilizers increased plant height, branch number $plant^{-1,}$ and number of pods $plant^{-1}$. Rather *et al*. (18) reported the highest growth in terms of plant height (45.26 cm), number of branches $plant^{-1}$ (4.20), and number of pods $plant^{-1}$ by using biofertilizers. Pramanik and Bera (17) reported that Rhizobium, PSB, and VAM significantly increased number of pods $plant^{-1}$ and weight of pod $plant^{-1}$ in chickpeas. Khan (13) observed that treatment-8 (100% RDF + Rhizobium $30g.kg^{-1}$) was found best treatment for plant growth and seed yield. This author also obtained high values for plant height (cm), number of primary branches $plant^{-1}$, and number of pods $plant^{-1}$.

Amino acids are organic chemical compounds and are the building blocks of proteins, which perform structural, metabolic, and transport functions in plants

(15). Amino acids improve the efficiency of the plant's metabolism to induce yield increases, increasing plant tolerance to abiotic stresses, facilitating nutrient assimilation, translocation, and use (4), promoting the processes of plant respiration, photosynthesis, protein synthesis, strengthening plant growth and yield formation (6). Saeed *et al*. (20) found that treatments of amino acids significantly improved the growth parameters of shoots and fresh weight as well as the pod yield of soybean. Mohsen (16) observed that amino acids significantly affect and the level of 3 mg $L^{-1}$ was superior in plant pods number (53.23 pods), plant yield (870 g), and economic yield (2425 kg $ha^{-1}$) in pea plants.

The Objectives of this study are to know the effect of sowing date, bio-health, and Amino acid for ensuring the maximum growth and higher yield of peas.

## Materials and Methods

This study was carried out at the field of Agricultural Engineering Sciences College, Duhok University, Iraq during 2021-2022. The land was plowed twice, and then it was divided into lines. Two seeds per hole were sown, and thinning was done after 15 days of sowing when the seedling had 2-3 true leaves. Two sowing dates (1$^{st}$ October and 21$^{st}$ October), three levels of bio-health (0.0, 5.0, and 10.0 g.$L^{-1}$), and three levels of amino acid (0.0, 2.0, and 4.0 ml.$L^{-1}$) were utilized in this experiment. As for the bio-health, the decided concentration was dissolved in a liter of water, then the solution was added to the soil around the seedlings after four-true leaf stage, then the treatment was repeated a month after the first application, and the third one was added during the beginning of flower stage. Spraying with amino acid was applied also three times, starting after 4 true leaves stages.

This study consisted of 18 treatments (2*3*3) implicated in a factorial experiment with a Randomized Complete Block Design (RCBD). Each treatment was replicated 3 times, each unit was set up in two lines, leaving 25 cm between plants and 65 cm between lines. The collected data were subjected to analysis variance and means were separated through Duncan Multiple Range Test at the alpha level of 0.05%. Data were analyzed statistically using SAS program (21). The result of the soil analysis at (Table,1).

Experimental measurements were as follows:

Vegetative growth characteristic

1- Plant height (cm)

2- Branch number $plant^{-1}$

3- Total Chlorophyll% (by using Chlorophyll Meter, SPAD-502, Konica Minolta.INC. Made in Japan).

Yield characteristics

1- Number of pods $plant^{-1}$

2- Average pod weight (g)

3- Yield (t.$ha^{-1}$)

**Table (1): Some physical and chemical characteristics of the field studied soil.**

| Characteristics | Measuring units | Test |
|---|---|---|
| Sand | (%) | 41.2 |
| Silt | (%) | 20.6 |
| Clay | (%) | 38.2 |
| Texture | ---------- | Sandy clay loam |
| Total – N | (%) | 1.215 |
| Available phosphorus | (%) | 2.147 |
| Available potassium | (%) | 29.651 |
| Organic matter | (%) | 1.029 |
| Ph | 1:1 | 7.01 |
| Ec conductivity | ($ds.m^{-1}$) | 1.194 |

***The analysis was carried out at the soil and water science laboratory, College of Agricultural Engineering Science, Duhok University.**

## Results

It is clear from table (2), that the sowing date had no significant effect on plant height. Using bio-health at level 10 $g.L^{-1}$ gave the highest value (68.46 cm). Spraying 4.0 $ml.L^{-1}$ of amino acid significantly increased plant height (66.33 cm).

The better interaction occurred between ($21^{st}$ October sowing date and 10 $g.L^{-1}$ bio-health) which gave (72.00 cm). Concerning the combination of the sowing date and amino acid, the data clearly showed that the best interaction was between the $21^{st}$ October sowing date and 2.0 $ml.L^{-1}$ of amino acid (68.89 cm). The combination treatment of bio-health and amino acid showed that (10$g.L^{-1}$ bio-health and 2.0 $ml.L^{-1}$ amino acid) resulted in better plant height (69.98 cm). The interaction among sowing date, bio-health, and amino acid on plant height revealed the best significant effect obtained from the combination of ($21^{st}$ October sowing date, 10.0 $g.L^{-1}$ bio-health, and 2.0 $ml.L^{-1}$ amino acid) which gave (73.58 cm).

The results in Table (3) revealed that the sowing date on $21^{st}$ October significantly increased branch number $plant^{-1}$ (8.26) compared with $1^{st}$ October. Application of 5.0 and 10.0 $g.L^{-1}$ of bio-health was the most effective treatment, which gave the highest branch number $plant^{-1}$ (8.17 and 8.18) respectively. The amino acid at a concentration of 2.0 $ml.L^{-1}$ had a significant effect on branch number $plant^{-1}$ (8.33). The interactions between $21^{st}$ October and 10.0 $g.L^{-1}$ bio-health gave the highest value (8.67). The interactions between the sowing date and amino acid had a significant effect on branch number $plant^{-1}$, the most effective treatment was through the $21^{st}$ October sowing date and 2.0 $ml.L^{-1}$ amino acid (8.69). The combination of (10.0 $g.L^{-1}$ bio-health and 2.0 $ml.L^{-1}$ amino acid appeared to be the most effective treatment (8.58). The best triple interaction was observed on $21^{st}$ October, 5.0 $g.L^{-1}$ bio-health, and 2.0 $ml.L^{-1}$ amino acid (9.08

**Table (2) Effect of sowing date, bio-health, amino acid and their interactions on plant height (cm) of the pea plant.**

| Sowing date | Bio-health ($g.L^{-1}$) | Amino acid $ml.L^{-1}$ 0.0 | 2.0 | 4.0 | Sowing date*Bio-health | Mean effect of sowing date |
|---|---|---|---|---|---|---|
| 1st Oct. | 0.0 | 62.67 c-e | 65.83 a-d | 66.33 a-d | 64.94 b | 65.59 a |
| | 5.0 | 69.50 a-c | 66.83 a-d | 64.33 b-e | 66.89 b | |
| | 10.0 | 59.33 de | 66.37 a-d | 69.08 a-c | 64.93 b | |
| 21st Oct. | 0.0 | 56.67 e | 68.33 a-c | 65.00 b-d | 63.33 b | 66.52 a |
| | 5.0 | 64.58 b-e | 64.75 b-e | 63.33 c-e | 64.22 b | |
| | 10.0 | 72.50 ab | 73.58 a | 69.92 a-c | 72.00 a | |
| Mean effect of Amino acid | | 64.21 b | 67.62 ab | 66.33 a | | |
| Sowing date* Amino acid | 1st Oct. | 63.83 b | 66.34 ab | 66.58 ab | Mean effect of bio-health | |
| | 21st Oct. | 64.58 ab | 68.89 a | 66.08 ab | | |
| Bio-health* Amino acid | 0.0 | 59.67 c | 67.08 ab | 65.67 ab | 64.14 b | |
| | 5.0 | 67.04 ab | 65.79 ab | 63.83 bc | 65.56 ab | |
| | 10.0 | 65.92 ab | 69.98 a | 69.50 ab | 68.46 a | |

Mean within a column, row and their interaction following with the same letter are not significantly different according to Duncan multiple range test at the probability of 0.05 level

**Table (3) Effect of sowing date, bio-health, amino acid and their interactions on the number of branches per plant of the pea plant.**

| Sowing date | Bio-health ($g.L^{-1}$) | Amino acid $ml.L^{-1}$ 0.0 | 2.0 | 4.0 | Sowing date*Bio- health | Mean effect of sowing date |
|---|---|---|---|---|---|---|
| 1st Oct. | 0.0 | 6.00 e | 7.73 a-d | 7.33 c-e | 7.02 b | 7.49 b |
| | 5.0 | 7.75 a-d | 8.00 a-d | 7.50 b-d | 7.75 b | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 10.0 | 7.43 b-e | 8.17 a-d | 7.50 b-d | 7.70 b | |
| | 0.0 | 6.67 de | 8.00 a-d | 7.93 a-d | 7.53 b | |
| 21st Oct. | 5.0 | 8.00 a-d | 9.08 a | 8.67 a-c | 8.58 a | 8.26 a |
| | 10.0 | 8.67 a-c | 9.00 ab | 8.33 a-c | 8.67 a | |
| Mean effect of Amino acid | | 7.42 b | 8.33 a | 7.88 ab | | |
| Sowing date* Amino acid | 1st Oct. | 7.06 d | 7.97 a-c | 7.44 cd | Mean effect of bio-health | |
| | 21st Oct. | 7.78 b-d | 8.69 a | 8.31 ab | | |
| | 0.0 | 6.33 b | 7.87 a | 7.63 a | 7.28 b | |
| Bio-health* Amino acid | 5.0 | 7.88 a | 8.54 a | 8.08 a | 8.17 a | |
| | 10.0 | 8.05 a | 8.58 a | 7.92 a | 8.18 a | |

Mean within a column, row and their interaction following with the same letter are not significantly different according to Duncan multiple range test at the probability of 0.05 level

Table (4) showed that the sowing date had no significant effect on the total chlorophyll percentage. Using bio-health led to an increase in total chlorophyll% at both concentrations (5.0 and 10.0 $g.L^{-1}$). Application amino acid at concentration 2.0 $g.L^{-1}$ gave the highest significant value.

Regarding the interaction of the 21st October sowing date and 10.0 $ml.L^{-1}$ bio-health gave a better total chlorophyll percentage. The interaction between the 21st October sowing date and 2.0 $ml.L^{-1}$ amino acid gave the highest significant value. Better interaction between bio-health and the amino acid was observed by using 5.0 $g.L^{-1}$ bio-health and 2.0 $ml.L^{-1}$ amino acid. The combination of three factors had a significant effect on total chlorophyll percentage. The better combination realized among (21st October, 10.0 $g.L^{-1}$ bio-health and 2.0 $ml.L^{-1}$ amino acid).

**Table (4) Effect of sowing date, bio-health, amino acid and their interactions on total chlorophyll% of the pea plant.**

| Sowing date | Bio-health ($g.L^{-1}$) | Amino acid $ml.L^{-1}$ 0.0 | 2.0 | 4.0 | Sowing date*Bio-health | Mean effect of sowing date |
|---|---|---|---|---|---|---|
| 1st Oct. | 0.0 | 42.00 de | 43.93 a-d | 42.83 c-e | 42.92 b | 43.37 a |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 5.0 | 43.57 a-e | 45.23 a | 43.13 b-e | 43.98 ab | |
| | 10.0 | 44.47 a-c | 42.77 c-e | 42.43 c-e | 43.22 b | |
| 21st Oct. | 0.0 | 41.80 e | 43.60 a-e | 44.13 a-c | 43.18 b | |
| | 5.0 | 44.90 ab | 44.03 a-d | 42.73 c-e | 43.89 ab | 43.79 a |
| | 10.0 | 43.40 a-e | 45.30 a | 44.23 a-c | 44.31 a | |
| Mean effect of Amino acid | | 43.36 b | 44.14 a | 43.25 b | | |
| Sowing date* Amino acid | 1st Oct. | 43.34 ab | 43.98 a | 42.80 b | Mean effect of bio-health | |
| | 21st Oct. | 43.37 ab | 44.31 a | 43.70 ab | | |
| Bio-health* Amino acid | 0.0 | 41.90 c | 43.77 ab | 43.48 ab | 43.05 b | |
| | 5.0 | 44.23 ab | 44.63 a | 42.93 bc | 43.93 a | |
| | 10.0 | 43.93 ab | 44.03 ab | 43.33 ab | 43.77 a | |

Mean within a column, row and their interaction following with the same letter are not significantly different according to Duncan multiple range test at the probability of 0.05 level

Data in table (5) obtained that the 21st October sowing date was superior in comparison to the 1st October sowing date (154.04). Application of bio-health at both concentrations led to a significant increment in pod number plant$^{-1}$ (126.61 and 118.58) respectively. Spraying 2.0 ml.L$^{-1}$ amino acid significantly increased pods number plant$^{-1}$ (127.94).

As for the interaction between the sowing date and amino acid, the largest number of pods resulted from (21st October sowing date with 2.0 ml.L$^{-1}$ amino acid) which gave ( 172.33). The most influential interaction treatment between bio-health and the amino acid was observed by using 5.0 g.L$^{-1}$ bio-health and 2.0 ml.L$^{-1}$ amino acid (137.08). The best triple interaction was observed among (21st October sowing date, 5.0 g.L$^{-1}$ bio-health and 2.0 ml.L$^{-1}$ amino acid) which gave (190.00) pod plant$^{-1}$.

**Table (5) Effect of sowing date, bio-health, amino acid and their interactions on the number of pods plant$^{-1}$ of the pea plant.**

| Sowing date | Bio-health (g.L$^{-1}$) | Amino acid ml.L$^{-1}$ 0.0 | 2.0 | 4.0 | Sowing date*Bio-health | Mean effect of sowing date |
|---|---|---|---|---|---|---|
| | 0.0 | 49.00 e | 83.17 d | 77.33 de | 69.83 d | |
| 1st Oct. | 5.0 | 85.00 d | 84.17 d | 98.17 d | 89.11 c | 79.52 b |
| | 10.0 | 85.50 d | 83.33 d | 70.00 de | 79.61 cd | |
| 21st Oct. | 0.0 | 94.00 d | 171.00 ab | 156.33 bc | 140.44 b | 154.04 a |

| | | | | | |
|---|---|---|---|---|---|
| | 5.0 | 170.50 ab | 190.00 a | 131.83 c | 164.11 a |
| | 10.0 | 163.33 ab | 156.00 bc | 153.33 bc | 157.56 a |
| Mean effect of Amino acid | | 107.89 b | 127.94 a | 114.50 b | |
| Sowing date* | 1st Oct. | 73.17 c | 83.56 c | 81.83 c | Mean effect of bio-health |
| Amino acid | 21st Oct. | 142.61 b | 172.33 a | 147.17 b | |
| Bio-health* | 0.0 | 71.50 c | 127.08 ab | 116.83 ab | 105.14 b |
| Amino | 5.0 | 127.75 ab | 137.08 a | 115.00 ab | 126.61 a |
| acid | 10.0 | 124.42 ab | 119.67 ab | 111.67 b | 118.58 a |

Mean within a column, row and their interaction following with the same letter are not significantly different according to Duncan multiple range test at the probability of 0.05 level

Table (6) showed that sowing date and bio-health had no significant effect on pod weight. The amino acid at both concentrations had a significant effect on pod weight.

The interaction between the sowing date and biohealth had no significant effect. The maximum interaction between the sowing date and the amino acid was obtained between (1st October sowing date and 4.0 ml.$L^{-1}$ amino acid). The most operative combination treatment between bio-health and the amino acid was observed between (5.0 g.$L^{-1}$ bio-health and 4.0 ml.$L^{-1}$ amino acid). The combination of the three factors significantly affected this trait.

**Table (6) Effect of sowing date, bio-health, amino acid, and their interactions on average pod weight (g) of the pea plant.**

| Sowing date | Bio-health (g.$L^{-1}$) | Amino acid ml.$L^{-1}$ 0.0 | 2.0 | 4.0 | Sowing date*Bio-health | Mean effect of sowing date |
|---|---|---|---|---|---|---|
| 1st Oct. | 0.0 | 2.32 b | 2.77 a | 2.97 a | 2.69 a | 2.77 a |
| | 5.0 | 2.70 a | 2.75 a | 2.93 a | 2.79 a | |
| | 10.0 | 2.87 a | 2.87 a | 2.73 a | 2.82 a | |
| 21st Oct. | 0.0 | 2.58 ab | 2.77 a | 2.58 ab | 2.64 a | 2.70 a |
| | 5.0 | 2.68 ab | 2.75 a | 2.72 a | 2.72 a | |
| | 10.0 | 2.61 ab | 2.72 a | 2.88 a | 2.74 a | |
| Mean effect of Amino acid | | 2.63 b | 2.77 a | 2.80 a | | |
| Sowing date* Amino acid | 1st Oct. | 2.63 b | 2.80 ab | 2.88 a | Mean effect of bio-health | |
| | 21st Oct. | 2.62 b | 2.75 ab | 2.73 ab | | |

| | | | | | |
|---|---|---|---|---|---|
| Bio-health* Amino acid | 0.0 | 2.45 b | 2.77 a | 2.78 a | 2.67 a |
| | 5.0 | 2.69 a | 2.75 a | 2.82 a | 2.76 a |
| | 10.0 | 2.74 a | 2.80 a | 2.81 a | 2.78 a |

Mean within a column, row and their interaction following with the same letter are not significantly different according to Duncan multiple range test at the probability of 0.05 level

Table (7) found that the 21st October sowing date gave the highest significant rate (22 t.ha$^{-1}$) compared with the 1st October (12.00 t.ha$^{-1}$). Application 5.0 and 10.0 g.L$^{-1}$ bio-health had a significant effect and resulted in increased total yield (18.82 and 17.77 t.ha$^{-1}$) respectively. Spraying 2.0 ml.L$^{-1}$ amino acid significantly increased the total yield (19.16 t.ha$^{-1}$).

The combination of (21st October sowing date and 5.0 g.L$^{-1}$ bio-health gave the maximum total yield (24.13 t.ha$^{-1}$). Whereas the interaction between the 21st October sowing date and 2.0 ml.L$^{-1}$ amino acid gave the better yield (25.75 t.ha$^{-1}$). The interaction between bio-health and amino acid has a significant effect and the largest total yield was obtained between (5.0 g.L$^{-1}$ bio-health and 2.0 ml.L$^{-1}$ amino acid) which gave (20.40 t.ha$^{-1}$). The maximal combination occurred among the 21st October sowing date, 5.0 g.L$^{-1}$ bio-health and 2.0 ml.L$^{-1}$ amino acid measure as (28.34 t.ha$^{-1}$).

**Table (7) Effect of sowing date, bio-health, amino acid and their interactions on total yield (t.ha$^{-1}$) of the pea plant.**

| Sowing date | Bio-health (g.L$^{-1}$) | Amino acid ml.L$^{-1}$ 0.0 | 2.0 | 4.0 | Sowing date*Bio-health | Mean effect of sowing date |
|---|---|---|---|---|---|---|
| 1st Oct. | 0.0 | 6.16 f | 12.23 e | 12.51 e | 10.30 d | 12.00 b |
| | 5.0 | 12.44 e | 12.46 e | 15.61 de | 13.50 c | |
| | 10.0 | 13.24 e | 13.03 e | 10.34 f | 12.21 cd | |
| 21st Oct. | 0.0 | 13.12 e | 25.58 ab | 21.75 bc | 20.15 b | 22.54 a |
| | 5.0 | 24.74 ab | 28.34 a | 19.32 cd | 24.13 a | |
| | 10.0 | 22.93 bc | 23.34 a-c | 23.74 a-c | 23.33 a | |
| Mean effect of Amino acid | | 15.44 b | 19.16 a | 17.21 b | | |
| Sowing date* Amino acid | 1st Oct. | 10.61 c | 12.58 c | 12.82 c | Mean effect of bio-health | |
| | 21st Oct. | 20.26 b | 25.75 a | 21.60 b | | |

| | | | | | |
|---|---|---|---|---|---|
| Bio-health* Amino acid | 0.0 | 9.64 b | 18.90 a | 17.13 a | 15.22 b |
| | 5.0 | 18.59 a | 20.40 a | 17.46 a | 18.82 a |
| | 10.0 | 18.08 a | 18.19 a | 17.04 a | 17.77 a |

Mean within a column, row and their interaction following with the same letter are not significantly different according to Duncan multiple range test at the probability of 0.05 level

## Discussion

The results in table (2) confirms the results found by Sharma (22) on pea plants, who observed that when sowing pea plant in (31$^{st}$ October) it gave the highest values from primary branches. Showed that in tables (5 and 7) the 21$^{st}$ October sowing date significantly increased pods number and total yield. These results are similar to the results presented by Sharma on peas when the sowing date (31$^{st}$ October) gave a significant increase in pod per plant and yield.

It is concluded that improvement in plant growth and yield due to the application of amino acid may be due to providing a ready source of growing substances that form the constituents of protein in the living tissues (8) on pea plants. Our results are consistent with those found by Khalilzadeh *et al*. (12) who reported that the spraying amino acid at 36% significantly increased the pod number plant$^{-1}$ and the biological yield of bean plants. The increase in chlorophyll percentage may be due to the availability of amino acid to the treated plants as amino acids and this may lead to an increase in different growth traits (2). Commercially available amino acid stimulants can improve fertilizer assimilation, increase the uptake of water and nutrients, enhance the photosynthetic rate and dry matter partitioning and hence increase yield. Many studies have proved that amino acids can directly or indirectly influence the physiological activities in plant growth and development. Ghaith (8) observed that spraying pea plants with a mixture of amino acid at 100 ppm significantly increased plant growth traits, total pod yield, and pod quality.

The maximum mean of plant height and number of branches in table (1 and 2) might be attributed to the fact that the component biofertilizers such as Rhizobium fixed atmospheric nitrogen through nodules hence increasing plant height and brunch numbers per plant (18). The results observed in this investigation are in line with El-Mansi (7) who revealed the increase in branch number by using biofertilizers. Biofertilizer application might have helped in greater uptake of nutrients which ultimately improved the yield attributing characters like pod weight, pod yield, and pods number plant$^{-1}$ (10).

## Conclusion

According to the results of this study, we can conclude that the best sowing date was on 21$^{st}$ October. The bio-health is beneficial in increasing most of the traits undertaken in this study. Spraying amino acid at a concentration of 2.0 ml.L$^{-1}$ caused an increase in all vegetative growth characters and yield characters. The

interaction treatment between the three factors led to high and positive effects on the vegetative growth and yield of the pea plant.

## Conflict of interest

The authors have no conflict of interest.

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