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EVALUATION OF THE EFFECT OF SOIL TILLAGE AND MINERAL NPK IN COMBINATIONS WITH HUMIC AND FULVIC ACIDS ON IMPROVING THE PRODUCTIVITY AND NITROGEN USE EFFICIENCY OF SNAP BEAN

Eman A.I. Mohamed[1*], Dalia A.S. Nawar[1], H.G. Zyada[1], S.D. Abou-Hussein[2] and Enas A. Bardisi[1]

1. Hort. Dept., Fac. Agric., Zagazig Univ., Egypt

2. Veg. Res., Dept., Agric. Bio. Inst., NRC, Egypt

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ABSTRACT: This study was conducted during the autumn seasons of 2022/2023 and 2023/2024 at the Horticultural Research Station in El-Kassasin, Ismailia Governorate, Egypt, to test the effect of some agricultural practices such as soil tillage and the use of some organic alternatives to partially replace mineral fertilizers such as humic acid and fulvic acid as a soil additive with the aim of improving the growth parameters, green yield , nitrogen use efficiency and pods quality of snap bean plants. Soil tillage and fertilization with mineral NPK at 75% of recommended rate (60 kg N, 27.75 kg P_2O_5 and 37.5 kg K_2O/fed.) in combinations with humic acid and fulvic acids at 6 kg /fed. of each as organic fertilization increased fresh and dry weight of roots, branches and leaves, s well as chlorophyll a, b in leaf tissues, N, P and K contents in shoots, yield / plant and total yield /feddan, in addition of N, P, K and total protein contents in pod, while fertilizing snap bean plants with mineral NPK at 50% RR combined with HA+FA at 6 kg /fed. each under tillage practice produced the highest values of nitrogen use efficiency of snap bean (Paulista cultivar) grown in sandy soil.

Key wards: Snap bean (*Phaseolus vulgaris*), soil tillage, humic acid, fulvic acid, growth and yield.

INTRODUCTION

One of the most significant crops in Egypt is the snap bean (*Phaseolus vulgaris* L.), which is eaten as a cooked vegetable or as dried seeds or green pods. It is regarded as one of the most significant vegetable crops grown in Egypt for both local and export markets, and it contributes significantly to human nutrition as an inexpensive source of protein, carbohydrates, vitamins and minerals (**Abdelhakim *et al*., 2012**).

The total snap bean cultivated area in Egypt during 2022/2023 was 34389 fed. which produced 155181 tons with average 4.512 ton/feddan. The cultivated area and production of the three plantations of snap bean, the cultivated area in autumn plantation was 3034 fed. (about 8.82% from the total area) which produced 10560 tons with average 3.481 ton/ fed., in winter plantation was 26529 fed. (about 77.15% from the total area) which produced 118060 tons with average 4.450 ton/fed. and in summer plantation was 4826 fed. (about14.03% from the total area). which produced 26561 tons with average 5.504 ton/feddan. This means that winter plantation represents the main plantation followed by summer and autumn plantations **(Agricultural Statistics, 2023, Ministry of Agriculture and Land Reclamation, Egypt, 2023)**.

Tillage is used in vegetable production to loosen compacted soil, add organic matter or integrate crop residue, incorporate fertilizers and prepare the seedbeds for planting. Seedbed preparation includes breaking up soil clods to

* **Corresponding author: Tel. :+201093688798**
E-mail address: Eabdelaziz724@gmail.com
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create a fine uniform texture that helps facilitate uniform soil moisture, planting depths, seedling emergence and root growth. Tillage also helps manage weeds and plant diseases. In conventional tillage systems, soil is turned over and soil aggregates are broken up using equipment such as mold board plows, chisel plows, field cultivators, disk cultivators and rot tillers. Often multiple tillage passes are used to create the finely textured seedbed required for adequate stand establishment, especially for small seeded vegetable crops such as lettuce, onions and carrots. Finely textured seedbeds are also needed to create raised beds in plasticulture systems that allow for good soil-to-plastic contact needed to help maximize early-season soil heating.

Soil tillage is a management practice that can alleviate soil compaction in diverse agricultural systems (**Abu-Hamdeh, 2003; Wortmann *et al.*, 2008). Erbach *et al*. (1992**) reported that different forms of tillage reduced differentially soil bulk density and resistance to penetration within the depth of tilled soil. The most effective tillage practices increase availability of soil water to crops due to increased infiltration (**Lampurlanés *et al.*, 2001).**

Tillage promotes microbial decomposition by altering temperature and moisture levels, enhancing aeration, and stimulating (C) losses. Additionally, tillage exposes previously protected organic matter to decomposition by disrupting soil aggregates. (**Scala *et al*., 2008**). Conventional tillage tended to increase the concentration of inorganic N in the 0 to 30cm soil layer relative to no- tillage (**NeSmith and McKracken, 1994)**. Yields of snap bean were higher with Conventional tillage (CT) than no-tillage (NT), and rotary strip-tillage (RT) methods (**Mullins and Straw, 1988**). Also, yields of snap bean were greatest with CT methods (**Grenoble *et al*., 1989**).

In this concern, **El-Douby and Mohamed (2002**), who reported that conventional tillage had a positive effect on faba bean seed yield. In addition, **Nawar *et al.* (2010**) showed that tillage treatment had significant effect on yield and its components as compared no tillage of bean.

It's known that fertilization is important method to all plants by improving soil fertility and quality then increasing crop production. The application of nitrogen, phosphorus and potassium play pivotal roles in plant growth and development. N is major for synthesis of chlorophyll, enzymes and proteins.

There is cause for concern regarding the overuse of chemical fertilizers in agriculture. It results in increased fruit pollution, reduced soil fertility, and groundwater contamination (**Hernandez *et al*., 2010**). By lowering the quantity of harmful substances (such nitrate) generated by mineral fertilizers, organic fertilizers can enhance both human health and the quality of vegetables produced (**Mahmoud *et al*., 2009**). For agricultural production to be sustainable and soil fertility to be maintained, organic amendments must be used in place of artificial fertilizers (**Parakash and Prasad, 2000**).The most important requirement for recycling organic waste and using it as organic amendments in agriculture is the addition of humic or fulvic acid. These substances can meet the nutrient needs of crops and drastically cut down on the use of chemical fertilizers (**Mavaddati *et al*., 2010**).

The main component of humic substances, such as fulvic acid or humic acid, is utilized in suitable amounts as a fertilizer and soil conditioner to enhance the growth of roots and entire plants (**Rady *et al*. 2016**).According to **Selim and Mosa (2012**), humic acid can improve the physical, chemical, and biological qualities of soil by increasing the availability of nutrients. According to **Hamieh *et al*. (2013**), humic acid has both direct and indirect positive effects on plant growth and development through its effects on cell membranes, which increase nutrient transport, plant activity hormone, protein synthesis, photosynthesis, enzyme activities, macro- and micro-element solubility, decrease active levels of toxic minerals, and boost microbial populations.

In this regret, **El-Bassiony *et al*. (2010)** showed that the highest values of vegetative growth parameters and pod length and weight as well as pod content of chlorophyll, total proteins as well as green pod yield and its quality, i.e., N, P and K were recorded with plants received NPK-fertilizers at 100% RR with humic acid at 2g/l., followed by those received NPK fertilizers at 65% and 35% RR with humic acid at 2g/l. level. On the other hand, fiber content recorded the highest values by adding the lowest level of mineral fertilizers (35% RR) without humic acid spraying, However, **Canellas *et al*. (2015)** indicted that the application of fulvic and humic acid fertilizer amendments have been shown to enhance root growth, increase nutrient uptake, alleviate stress, and increase yield in various crops. Additionally, **Abou El-Hassan *et al*. (2017)** showed that 50% mineral N, P and K fertilizers combined with 50% mineral +50% organic fertilizer produced the highest values of plant height, number of leaves/ plant and fresh weight of shoot, total chlorophyll, while 100% mineral NP and k produced the highest contents of NP and K in shoots of snap bean. Pods number/ plant, yield/plant and total yield kg /m^2, pod length, pod diameter, both fresh and dry weight/ pod. In addition, **Abd El-Basir *et al*., (2020)** showed that on snap bean soil application with fulvic acid (1 L/fed.) markedly improved snap bean plants vegetative growth behavior, minerals content and photosynthetic pigments of leaves, yield and its quality in the two seasons. In addition, **El-Sawy *et al*., (2020)** indicated that treated snap bean plants by fulvic acid at rate of 6 g/L produced the highest significant values of plant height, number of leaves and branches per plant, total fresh weight and dry weight of plant as well as total chlorophyll. Also, the maximum values of pod length and diameter, fresh and dry weights of pods, total green pods yield per feddan, TSS and total protein percentage were obtained with 6 g/L treatment.

Therefore, the aim of this study was to improving the growth parameters, physical and chemical properties of pods and green yield of snap bean using some agricultural practices such as tillage and the use of some organic alternatives such as humic and fulvic acid in order to partially replace mineral fertilizers.

MATERIALS AND METHODS

The study was conducted during the 2022/ 2023 and 2023/2024 autumn seasons at the Horticultural Research Station in El-Kassasin, Ismailia Governorate, Egypt, with the aim of improving the growth parameters, green yield, nitrogen use efficiency and chemical properties of pods of snap bean using some agricultural practices such as tillage and the use of some organic alternatives such as humic and fulvic acid in order to partially replace mineral fertilizers.

The used soil properties were: sandy soil in texture for the two experimental seasons 2022/ 2023 and 2023/2024, while it had 0.37 and 0.38% organic matter, 8.02 and 7.98 pH, 2.11 and 2.16 mmhos/cm EC, 3.73 and 3.32 ppm available N, 63.53 and 65.42ppm 13.52 and 13.82 ppm available P and 61.28 and 60.45 ppm available K during the 1st and 2nd seasons, respectively

This experiment included 14 treatments, which were the combinations between two tillage (without and with) and seven fertilization treatments (which were the combination between mineral N, P and K + humic or fulvic acid) as follows: 100% of the recommended rate (RR) of mineral NPK as control treatment, 50% RR + humic acid (HA), 50% RR + fulvic acid (FA), 75% RR + HA, 75% RR + FA, 50% RR + HA + FA and 75% RR + HA + FA.

100%RR of NPK were about 80 kg N, 37 kg P_2O_5 and 50 kg K_2O/fed., 75% RR of NPK were about 60 kg N, 27.75 kg P_2O_5 and 37.5 kg K_2O/fed. and 50% RR of NPK were about 40 kg N, 18.5 kg P_2O_5 and 25 kg K_2O/feddan. Also, the rates of HA and FA were about 6 kg /fed. of each as soil application.

The treatments were arranged in a split plot in a complete randomized block design with three replications. Tillage practices was distributed in the main plot, while fertilization treatments were randomly arranged in the sub plot.

The experimental unit area was 12.6 m^2 it contained three dripper lines (6m length and 70 cm wide). Seeds were sown on the first week of October in both autumn seasons of 2022/2023 and 2023/2024. Seeds were sown in hills on both sides of dripper line, after 20 days from sowing it thinned to leave one plant / hill. The distance between each two hills was 15 cm. The middle dripper line was used for data collection and others were used for yield determination.

Humic and fulvic acids were added as soil application beside plants at the rate of 6 kg /fed. each six times weekly till 42 days after sowing. Both humic and fulvic acid were obtained from the Agricultural Balance Fund, Ministry of Agriculture and Land Reclamation, Giza, Egypt.

Different rates of N and K fertilizers, in the form of ammonium sulphate (20.6%N) and potassium sulphate (48% K_2O) were split into two equal parts, at 20 and 40 days after sowing, while calcium super phosphate (15.5% P_2O_5) was added during soil preparation. The other normal agricultural treatments for growing snap bean plants were practiced.

Data Recorded

A random sample of ten plants from every plot was taken after 50 days from sowing. The following traits were studied in both growing seasons:

Vegetate parameters

Fresh weight of root, branches and leaves were recorded.

Dry weight

After 50 days from sowing, the roots, branches and leaves were separated from the plant and then dried in a drying oven at 70ºC till constant weight, and then dry weight of roots, branches and leaves were recorded.

Photosynthetic pigments

Using the method outlined by **Wettestein (1957**), disk samples from the fourth upper leaf were taken 50 days after planting in each plot in order to measure the levels of chlorophyll a and b in both seasons.

Plant chemical composition

At 50 days after seeding, a representative sample of dried shoots (branches + leaves) was randomly selected from each plot to measure the contents of nitrogen, phosphorus, and potassium using techniques outlined by **Bremner and Mulvaney (1982), Olsen and Sommers (1982) and Jackson (1970).**

Pod yield and its components

Green pods of each plot were harvested at the proper maturity stage (nearly 70 days after sowing), counted and weighted in each harvest and yield/plant (g) and total pod yield (ton/ fed.) were determined.

Nitrogen use efficiency (NUE)

It was determined by dividing the green pods yield/fed., by the nitrogen quantity/fad., and expressed as kg pods /kg N according to **Clark (1982**).

Pod Quality

Nitrogen, P and K in green pods

Random samples of pods were taken from each plot to analyze the nitrogen, phosphorus and potassium content of these pods and they were estimated as previously mentioned in estimation of Nitrogen, Phosphorus and Potassium in shoots. Pod total N percentage was converted to protein% using a factor of 6.25 (**Kelly and Bliss, 1975**).

Statistical Analysis

In accordance with **Snedecor and Cochran (1980**), the collected data underwent appropriate statistical analysis of variance, and Duncan's multiple range test (**Duncan, 1958**) was used to examine the differences across treatments.

RESULTS AND DISCUSSION

Fresh and Dry Weight

Effect of tillage

There were significant differences between using tillage and without on fresh and dry weight of roots, branches and leaves, except fresh weight of roots in the 1st season and soil tillage gave higher fresh weight (12.97 and 11.33 g) and dry weight of branches (5.18 and 4.61 g), fresh weight (46.15 and 47.37 g) and dry weight of leaves (9.23 and 9.53 g) as well as dry weight of roots (5.62 and 6.31 g) in both seasons at 50 days after sowing (Table 1).

The relative increases in fresh weight of shoots (branches and leaves) due to using tillage treatment was about (14.50 and 8.09%) and were about (17.15 and 10.82%) for dry weight of shoots (branches + leaves) than without in the 1st and 2nd seasons, respectively.

Tillage promotes microbial decomposition by altering temperature and moisture levels, enhancing aeration, and stimulating (C) losses. Additionally, tillage exposes previously protected organic matter to decomposition by disrupting soil aggregates. (**Scala *et al*., 2008**) then soil tillage increased fresh and dry weight or roots, branches and leaves/plant compared to without tillage. One of the major objectives of soil tillage is optimal root development. Furthermore, **Khan *et al.* (2001)** came to the conclusion that conventional tillage can be linked to improved soil structure, improved soil moisture preservation, decreased soil penetration resistance, decreased bulk density, improved root-soil contact and improved weed growth suppression—all of which have a positive impact on plant and root development.

Table 1. Effect of tillage on fresh and dry weight of different organs of snap bean cv. Paulista at 50 days from sowing during 2022/2023 and 2023/2024 autumn seasons

Treatments	Fresh weight/ plant (g)			Dry weight/ plant (g)		
	Roots	Branches	Leaves	Roots	Branches	Leaves
				2022/2023 season		
Without tillage	13.61 a	9.92 b	41.71 b	5.44 b	3.96 b	8.34 b
With tillage	14.08 a	12.97 a	46.15 a	5.62 a	5.18 a	9.23 a
LSD at 0.05 level	**NS**	**0.51**	**1.16**	**0.13**	**0.42**	**0.36**
				2023/2024 season		
Without tillage	14.84 b	9.50 b	44.89 b	5.91 b	3.76 b	8.99 b
With tillage	15.80 a	11.33 a	47.57 a	6.31 a	4.61 a	9.53 a
LSD at 0.05 level	**0.82**	**0.57**	**0.45**	**0.15**	**0.39**	**0.24**

Duncan's multiple range test revealed that values with the same alphabetical letter(s) did not substantially differ at the 0.05 level of significance

These results are harmony with those obtained with **Rashidi and Arabsalmani (2016**) on tomato and **Martins *et al*. (2021)** on bean they showed that plant growth promoted with Conventional tillage than without tillage.

Effect of the combinations between mineral and organic fertilization

Increasing fresh weight of roots (18.47 and 19.91 g), branches (14.75 and 9.98 g), fresh weight of leaves (50.90 and 55.06 g), except fresh weight of branches in the 2nd season as well as dry weight of roots (7.41 and 7.96 g), branches (5.88 and 4.64 g), fresh weight of leaves (10.18 and 10.01 g) were obtained from fertilizing snap bean Paulista cultivar with mineral N, P and K at 75% RR in combinations with HA+FA at 6 kg/fed. each as organic, followed by fertilizing with mineral NPK at 100% RR (80 kg N, 37 kg P_2O_5 and 50 kg K_2O/ fed.) in both seasons (Table 2). The combination between mineral NPK at 50% RR and FA at 6 kg/fed., gave the lowest values of fresh and dry weight of roots, branches and leaves in both seasons.

The relative increases in fresh weight of shoots (branches+ leaves) due to the combinations between mineral and organic fertilization at NPK at 75% RR in combinations with HA+FA at 6 kg/fed. were about (6.63 and 5.36%) and were about 7.28 and 6.73% for dry weight of shoots (branches + leaves) than fertilizing with 100%nRR only (control treatment) in the both seasons.

These findings could be explained by the fact that applying HA and FA to soil has a number of beneficial benefits, including increasing the soil's capacity for cation exchange (**Moradi *et al.*, 2017**). Additionally, it has already transformed into known humic compounds when applied to soil, which either directly or indirectly improve plant performance and have a good impact on plant growth (**Lotfi *et al*., 2015**).

Biostimulants based on humic and fulvic acids also improve the fertilization effectiveness of macronutrients including potassium, nitrogen and phosphorus. Humic compounds are important in the soil, particularly for the plant-available mobilization of mineral-fixed phosphates. In the same way, humic materials mobilize vital trace elements like iron, zinc, copper, and manganese.

Table 2. Effect of the combinations between mineral and organic fertilization on fresh and dry weight (g/plant) of different organs of snap bean cv. Paulista at 50 days from sowing during 2022/2023 and 2023/2024 autumn seasons

Treatments	Fresh weight/ plant (g)			Dry weight/ plant (g)		
	Roots	Branches	Leaves	Roots	Branches	Leaves
			2022/2023 season			
100%RR (Control)	16.18 b	13.32 b	48.23 b	6.46 b	5.32 b	9.64 b
50%RR+ HA	11.18 f	10.39 e	39.65 e	4.47 f	4.15 d	7.93 e
50%RR+ FA	10.41 g	8.00 g	38.14 f	4.15 g	3.20 e	7.63 e
75%RR+ HA	14.84 c	11.50 d	45.64 c	5.93 c	4.60 c	9.13 c
75%RR+ FA	13.63 d	12.29 c	42.85 d	5.44 d	4.91 c	8.57 d
50%RR+ HA+FA	12.20 e	9.91 f	42.12 d	4.87 e	3.96 d	8.42 d
75%RR+ HA+FA	18.47 a	14.73 a	50.90 a	7.41 a	5.88 a	10.18 a
LSD at 0.05 level	**0.46**	**0.45**	**1.04**	**0.12**	**0.38**	**0.32**
			2023/2024 season			
100%RR (Control)	18.24 b	10.48 a	51.26 b	7.29 b	4.38 ab	10.32 b
50%RR+ HA	12.41 f	10.43 a	41.21 f	4.95 f	3.77 c	8.24 f
50%RR+ FA	11.57 g	10.56 a	38.74 g	4.62 g	4.21 b	7.81 g
75%RR+ HA	16.70 c	10.88 a	48.30 c	6.67 c	4.05 bc	9.66 c
75%RR+ FA	14.75 d	10.12 b	45.71 d	5.89 d	4.05 bc	9.14 d
50%RR+ HA+FA	13.70 e	10.46 a	43.33 e	5.42 e	4.17 b	8.66 e
75%RR+ HA+FA	19.91 a	9.98 a	55.06 a	7.96 a	4.68 a	11.01 a
LSD at 0.05 level	**0.73**	**NS**	**0.40**	**0.13**	**0.35**	**0.22**

Duncan's multiple range test revealed that values with the same alphabetical letter(s) did not substantially differ at the 0.05 level of significance

that crops would otherwise be unable to absorb directly, particularly in arid soils with low humus levels (**Rose *et al.*, 2014**).

These results are harmony with those obtained with **El-Bassiony *et al*. (2010) and Abou El-Hassan *et al*. (2017)** showed that combined with 50% mineral +50% organic fertilizer produced the highest values of fresh weight and dry weight of shoot as compared to NP and K at 100% of the recommended rate. Also, **Ali *et al*. (2025)** showed that the treatment (ammonium sulphate at rate 200 or 150 kg fed-1 with Compost 6 t fed-1 and 4 kg humic acid/ fed.) gave the highest values of fresh and dry weight of snap bean shoots, but there was no noticeable difference when AS at a rate of 100 kg fed^{-1} was used.

Effect of the interaction

The interaction between using soil tillage and mineral NPK at 75%RR in combinations with HA and FA at 6 kg/fed., each as organic fertilization increased fresh weight of roots (19.14 and 20.53 g), branches (15.05 and 9.74 g) and leaves (52.86 and 55.97 g), also, the same treatment recorded the highest values of dry weight of roots (7.65 and 8.21g), branches (6.01 and 4.89 g) and leaves (10.48 and 11.19 g) at 50 days after sowing in both seasons, followed by the interaction between tillage soil and mineral NPK at 100% RR (Table 3).

Table 3. Effect of the interaction between tillage and the combinations between mineral and organic fertilization on fresh and dry weight (g/plant) of different organs of snap bean cv. Paulista at 50 days from sowing during 2022/2023 and 2023/2024 autumn seasons

Treatments		Fresh weight/ plant (g)			Dry weight/ plant (g)		
		Roots	Branches	Leaves	Roots	Branches	Leaves
				2022/2023 season			
Without tillage	**100%RR (Control)**	16.45 c	12.06 c	45.27 d	6.57 c	4.82 b	9.05 de
	50%RR+ HA	11.24 gh	9.44 d	37.67 h	4.49 i	3.77 c	7.53 hi
	50%RR+ FA	9.89 i	6.63 f	36.38 h	3.95 j	2.65 e	7.28 i
	75%RR+ HA	14.63 d	9.28 d	43.75 e	5.84 e	3.71 cd	8.75 ef
	75%RR+ FA	13.49 e	9.61 d	40.14fg	5.39 f	3.84 c	8.03 g
	50%RR+ HA+FA	11.79 g	8.04 e	39.38 g	4.71 h	3.21 d	7.88 gh
	75%RR+ HA+FA	17.81 b	14.42 ab	49.42 b	7.18 b	5.76 a	9.88 bc
With tillage	**100%RR (Control)**	15.92 c	14.58 a	51.20 a	6.36 d	5.83 a	10.24 ab
	50%RR+ HA	11.13 gh	11.34 c	41.63 f	4.45 i	4.53 b	8.33 fg
	50%RR+ FA	10.93 h	9.38 d	39.91 g	4.36 i	3.75 cd	7.98 gh
	75%RR+ HA	15.06 d	13.73 b	47.53 c	6.02 e	5.49 a	9.51 cd
	75%RR+ FA	13.78 e	14.98 a	45.57 d	5.50 f	5.99 a	9.11 de
	50%RR+ HA+FA	12.61 f	11.78 c	44.86 de	5.04 g	4.71 b	8.97 e
	75%RR+ HA+FA	19.14 a	15.05 a	52.38 a	7.65 a	6.01 a	10.48 a
LSD at 0.05 level		**0.65**	**0.64**	**1.47**	0.17	0.54	0.46
				2023/2024 season			
Without tillage	**100%RR (Control)**	17.32 c	9.88 de	50.34 d	6.92 c	3.94 d-g	10.07 c
	50%RR+ HA	11.91 hi	8.61 g	38.95 k	4.75 h	3.45 gh	7.79 i
	50%RR+ FA	11.45 i	8.92 fg	36.48 l	4.57 h	3.56 fgh	7.43 j
	75%RR+ HA	16.08 d	10.73 bc	47.49 f	6.43 d	3.69 fgh	9.50 de
	75%RR+ FA	14.35 ef	9.57 ef	45.25 h	5.73 f	3.83 e-h	9.05 fg
	50%RR+ HA+FA	13.51 fg	8.60 g	41.58 j	5.30 g	3.43 h	8.31 h
	75%RR+ HA+FA	19.30 b	10.23 cde	54.16 b	7.71 b	4.48 abc	10.83 ab
With tillage	**100%RR (Control)**	19.16 b	11.09 b	52.18 c	7.66 b	4.83 ab	10.57 b
	50%RR+ HA	12.91 gh	12.26a	43.48 i	5.15 g	4.10 c-f	8.69 g
	50%RR+ FA	11.70 i	12.20a	41.01 j	4.67 h	4.87 ab	8.20 h
	75%RR+ HA	17.32 c	11.03 bc	49.12 e	6.92 c	4.41 bcd	9.82 cd
	75%RR+ FA	15.15 de	10.67 bcd	46.18 g	6.05 e	4.27 cde	9.23 ef
	50%RR+ HA+FA	13.89 fg	12.32a	45.09 h	5.55 f	4.92 a	9.02 fg
	75%RR+ HA+FA	20.53 a	9.74 ef	55.97 a	8.21 a	4.89 ab	11.19 a
LSD at 0.05 level		**1.04**	**0.72**	**0.57**	**0.19**	**0.49**	**0.31**

Duncan's multiple range test revealed that values with the same alphabetical letter(s) did not substantially differ at the 0.05 level of significance.

Fertilizing with mineral NPK at 50%RR (40 kg N, 18.5 kg P_2O_5 and 25 kg K_2O/fed.) and FA at 6 kg /fed. without tillage gave the lowest values of fresh and dry weight of roots, branches and leaves plant in both seasons.

The increases in dry weight of shoots (leaves + branches) were about 2.61 and 4.42% for tillage and mineral NPK at 75% RR with organic fertilization with HA and FA at 6 kg /fed. each over the tillage and mineral NPK at 100% RR without organic fertilization and were about 18.89 and 14.78 over mineral NPK at 100% RR without tillage in the 1st and 2nd seasons, respectively.

Leaf Pigments and N, P and K Contents in Shoots

Effect of tillage

Using tillage treatment before sowing snap bean seeds increased the concentrations of chlorophyll a, b and improved contents of N, P and K in shoots in both seasons at 50 days after sowing compared to without tillage (Table 4). The increasing in N, P and K due to tillage treatment were about 14.12 and 8.18%) for N, 15.08 and 10.66%0 for P and (14.14 and 10.14%) for K over without tillage in the both seasons.

Appropriate soil tillage or seedbed type can be a suitable alternative to enhanced nutrient availability to crop and therefore reduce money spend on chemical fertilizers (**Adekiya and Ojeniyi, 2008**). These results are harmony with **Agbede and Adekiya (2011)** they showed that conventional tillage alone resulted in better leaf N, P, K, Ca and Mg concentrations of sweet potato than non tillage.

Effect of the combinations between mineral and organic fertilization

Fertilizing snap bean plants with mineral N, P and K at 75% RR and HA+FA at 6 kg /fed. each enhancing chlorophyll a, b in leaf tissues, N, P and K contents in shoots in both seasons followed by mineral NPK at 100%RR followed by fertilizing with mineral NPK at 100%RR at 50 days after sowing in both seasons (Table 5).

The relative increases in N, P and K contents due to mineral N, P and K at 75% RR and HA+FA at 6 kg/fed. each were about 2.33 and 4.58% for N, 8.54 and 9.34% for P and 4.35 and 2.52% for K content over mineral NPK at 100% RR in the 1st and 2nd seasons, respectively.

It's known that fertilization is important method to all plants by improving soil fertility and quality then increasing crop production. The application of nitrogen, phosphorus and potassium play pivotal roles in plant growth and development. N is major for synthesis of chlorophyll, enzymes and proteins.

HA and FA acids may promote the intake of N and Mg (structural components of chlorophyll), raise the accumulation of chlorophyll, which increases the rate of photosynthesis, and slow down senescence. These findings might be explained by the beneficial properties of fulvic and humic acid, which readily chelate minerals such as calcium, magnesium, iron, zinc, and copper and can supply these elements directly to plants (**Malan , 2015**). Also, humic and fulvic acids are natural organic compounds derived from the decomposition of plant and microbial matter. Applying humic and fulvic acids as soil application increasing nutrient retention, and promoting root growth, improving cation exchange capacity, increasing the availability of essential nutrients such as nitrogen, phosphorus, and potassium, and facilitating better uptake by plants. (**Nardi *et al.*, 2021**).

The obtained results are in accordance with the studies conducted by **Abou El-Hassan *et al*., (2017)** showed that 50% of mineral N, P and K fertilizers combined with 50% of mineral + 50% of organic fertilizer produced the highest concentrations of total chlorophyll, while 100% mineral NP and K produced the highest contents of NP and K in shoots of snap bean.

Effect of the interaction

The interaction between soil tillage and the combinations of mineral NPK at 75% RR and HA + FA at 6 kg/fed., each significant effect on chlorophyll a, b in leaf tissues, N, P and K contents in shoots followed by mineral NPK at 100%RR with or without soil tillage of snap bean at 50 days after sowing, (Table 6).

The increases in N, P and K contents in were about 2.21 and 4.79% for N, 2.47 and 5.02% for P and 5.00 and 3.24% for K from tillage treatment and mineral NPK at 75% RR with HA

Table 4. Effect of tillage on leaf pigments and mineral contents in shoots of snap bean cv. Paulista at 50 days from sowing during 2022/2023 and 2023/2024 autumn seasons

Treatments	Chlorophyll (mg/gDW)		Mineral contents (%)		
	a	b	N	P	K
			2022/2023 season		
Without tillage	2.49 b	1.16 b	2.55 b	0.378 b	1.98 b
With tillage	2.82a	1.34 a	2.91 a	0.435 a	2.26 a
LSD at 0.05 level	**0.09**	**0.04**	**0.17**	**0.017**	**0.07**
			2023/2024 season		
Without tillage	2.61 b	1.21 b	2.69 b	0.394 b	2.07 b
With tillage	2.82 a	1.34 a	2.91 a	0.436 a	2.28 a
LSD at 0.05 level	**0.09**	**0.05**	**0.13**	**0.007**	**0.10**

Duncan's multiple range test revealed that values with the same alphabetical letter(s) did not substantially differ at the 0.05 level of significance

Table 5. Effect of the combinations between mineral and organic fertilization on leaf pigments, mineral contents of snap bean cv. Paulista at 50 days from sowing during 2022/2023 and 2023/2024 autumn seasons

Treatments	Chlorophyll (mg/gDW)		Mineral contents (%)		
	a	b	N	P	K
			2022/2023 season		
100%RR (Control)	2.90 b	1.37 b	3.01 a	0.445 b	2.30 b
50%RR+ HA	2.40 f	1.13 f	2.49 cd	0.369 d	1.94 f
50%RR+ FA	2.26 g	1.04 g	2.35 d	0.340 e	1.82 g
75%RR+ HA	2.74 c	1.29 c	2.85 b	0.421 c	2.22 c
75%RR+ FA	2.64 d	1.25 d	2.75 b	0.406 c	2.14 d
50%RR+ HA+FA	2.49 e	1.17 e	2.59 c	0.383 d	2.02 e
75%RR+ HA+FA	3.14 a	1.48 a	3.08 a	0.483 a	2.40 a
LSD at 0.05 level	**0.08**	**0.03**	**0.15**	**0.015**	**0.06**
			2023/2024 season		
100%RR (Control)	2.95 b	1.37 b	3.06 b	0.447 b	2.38 a
50%RR+ HA	2.43 f	1.14 f	2.53 e	0.373 f	1.97 d
50%RR+ FA	2.38 f	1.09 g	2.47 e	0.356 g	1.91 d
75%RR+ HA	2.80 c	1.32 c	2.91 c	0.430 c	2.27 b
75%RR+ FA	2.67 d	1.26 d	2.78 d	0.411 d	2.17 c
50%RR+ HA+FA	2.58 e	1.21 e	2.68 d	0.396 e	2.09 c
75%RR+ HA+FA	3.20 a	1.51 a	3.20 a	0.491 a	2.44 a
LSD at 0.05 level	**0.08**	**0.04**	**0.12**	**0.006**	**0.09**

Duncan's multiple range test revealed that values with the same alphabetical letter(s) did not substantially differ at the 0.05 level of significance

Table 6. Effect of the interaction between tillage and the combinations between mineral and organic fertilization on leaf pigments , mineral contents of snap bean cv. Paulista at 50 days from sowing during 2022/2023 and 2023/2024 autumn seasons

Treatments		Chlorophyll (mg/gDW)		Mineral contents (%)		
		a	b	N	P	K
				2022/2023 season		
Without tillage	**100%RR (Control)**	2.75 d	1.24 ef	2.86 cde	0.406 de	2.20 d
	50%RR+ HA	2.26 gh	1.06 h	2.35 gh	0.347 g	1.83 g
	50%RR+ FA	2.16 h	0.97 i	2.25 h	0.317 h	1.73 h
	75%RR+ HA	2.54 e	1.20 f	2.65 ef	0.391 e	2.06 e
	75%RR+ FA	2.38 f	1.12 g	2.48 fg	0.367 fg	1.93 f
	50%RR+ HA+FA	2.27 fgh	1.07 gh	2.37 gh	0.349 g	1.84 fg
	75%RR+ HA+FA	3.06 b	1.44 bc	2.93 bcd	0.470 bc	2.28 cd
With tillage	**100%RR (Control)**	3.05 b	1.49 ab	3.17 ab	0.485 ab	2.40 b
	50%RR+ HA	2.54 e	1.20 f	2.64 ef	0.391 ef	2.06 e
	50%RR+ FA	2.36 fg	1.11 gh	2.46 fgh	0.363 g	1.92 fg
	75%RR+ HA	2.94 bc	1.39 cd	3.06 abc	0.452 c	2.38 bc
	75%RR+ FA	2.90 c	1.37 d	3.02 bcd	0.446 c	2.35 bc
	50%RR+ HA+FA	2.71 d	1.28 e	2.82 de	0.417 d	2.20 d
	75%RR+ HA+FA	3.23 a	1.52 a	3.24 a	0.497 a	2.52 a
LSD at 0.05 level		0.11	0.05	**0.21**	**0.022**	**0.09**
				2023/2024 season		
Without tillage	**00%RR (Control)**	2.88 cd	1.28 de	3.00 bc	0.417 d	2.29 cd
	50%RR+ HA	2.28 h	1.07 h	2.38 gh	0.350 h	1.85 ij
	50%RR+ FA	2.20 h	0.98 i	2.30 h	0.321 i	1.76 j
	75%RR+ HA	2.72 e	1.28 de	2.83 cde	0.418 d	2.20 d-g
	75%RR+ FA	2.63 ef	1.24 def	2.73 de	0.404 e	2.13 efg
	50%RR+ HA+FA	2.40 g	1.13 gh	2.50 fg	0.370 g	1.95 hi
	75%RR+ HA+FA	3.13 ab	1.48 ab	3.13 ab	0.481 b	2.34 bc
With tillage	**00%RR (Control)**	3.01 bc	1.47 b	3.13 ab	0.478 b	2.47 ab
	50%RR+ HA	2.57 f	1.21 ef	2.68 ef	0.396 ef	2.09 fgh
	50%RR+ FA	2.55 f	1.20 fg	2.65 ef	0.392 f	2.07 gh
	75%RR+ HA	2.88 d	1.36 c	3.00 bc	0.443 c	2.34 bcd
	75%RR+ FA	2.72 e	1.28 d	2.83 cde	0.419 d	2.21 cdef
	50%RR+ HA+FA	2.75 de	1.30 d	2.86 cd	0.423 d	2.23 cde
	75%RR+ HA+FA	3.27 a	1.54 a	3.28 a	0.502 a	2.55 a
LSD at 0.05 level		0.12	0.06	**0.17**	**0.015**	**0.13**

Duncan's multiple range test revealed that values with the same alphabetical letter(s) did not substantially differ at the 0.05 level of significance

and FA at 6 kg/fed., each over the tillage and mineral NPK at 100% RR without organic fertilization and were about 13.29 and 9.33% for N, 22.41 and 20.38% for P and 14.55 and 22.35% for K over mineral NPK at 100% RR without tillage in the 1st and 2nd seasons, respectively.

These results are harmony with **Agbede and Adekiya (2011)** they showed that Conventional tillage plus 5 t/ha poultry manure (CT+5 PM) resulted in better leaf N, P, K, Ca and Mg concentrations of sweet potato than non tillage.

Yield and its Components and Nitrogen Use Efficiency (NUE)

Effect of tillage

Tillage treatment of the soil before sowing of snap bean seeds gave higher yield/plant (137.71 and 144.8 g), total yield (3.834 and 4.033 ton/fed.) and NUE (72.74 and 76.37 kg pods/ kg N) in both seasons (Table7). The increases in total yield were about 8.95 and 7.35% for tillage treatment over without tillage in both seasons.

The stimulative effect of tillage treatment on total yield of Paulista cultivar may be due to this treatment increased fresh and dry weight of different organs (Table 1) and total chlorophyll and mineral contents (Table 4) and yield/plant (Table 7).

By lowering the soil's mechanical barrier to plant roots penetrating, conventional tillage creates a deeper root system, which boosts the intake of growth supplies, particularly from the deeper soil layers, and ultimately results in a higher yield production (**Gomma and El Naggar, 1995**). Accordingly, **Khan, *et al.* (2001)** came to the conclusion that conventional tillage can be linked to decreased resistance to soil penetration, decreased bulk density, increased moisture retention, improved soil structure, improved root-soil contact, and improved suppression of weed growth. These factors positively impact root development, plant growth, and plant population density, ultimately leading to an increase in yield.

These results are in the same line with those of **Mullins and Straw (1988) Grenoble *et al*. (1989)** on snap bean, **El-Douby and Mohamed (2002) and Nawar *et al.* (2010)** on bean, **Rashidi and Keshavarzpour (2008)** on watermelon**, Rashidi and Arabsalmani (2016)** on tomato and **Martins *et al*., (2021)** on bean, all found that using Conventional tillage produced the highest yield and it components than non tillage.

Effect of the combinations between mineral and organic fertilization

Fertilizing snap bean plants with the combination between mineral N, P and K at 75% RR (60 kg N, 27.75 kg P_2O_5 and 37.5 kg K_2O/fed.) combined with HA+FA at 6 kg /fed. of each as organic fertilization as soil application gave the highest yield/plant and total yield/fed., followed by mineral NPK at 100% RR (80 kg N, 37 kg P_2O_5 and 50 kg K_2O/fed.) in both seasons (Table 8).

Yield/plant and total yield /fed. were about 169.62 and 176.36 g and 4.707 and 4.905 ton/ fed., respectively for mineral N, P and K at 75% RR (60 kg N, 27.75 kg P_2O_5 and 37.5 kg K_2O/ fed.) combined with HA+FA at 6 kg/fed. of each, whereas, were about 153.76 and 164.88 g and 4.285 and 4.594 ton, respectively for mineral N, P and K at 100% RR in both seasons. On the other side, NUE was the highest when fertilizing snap bean plants with NPK at 50% RR+ HA+FA at 6 kg each (83.90 and 88.36 kg pods/one unit of N), followed by mineral 75% RR of NPK combined with HA+FA at 6 kg/fed. which recorded (78.46 and 81.75 kg pods/ kg N) in both seasons, respectively.

The increases in total yield were about 9.84 and 6.76% for mineral N, P and K at 75% RR combined with HA+FA at 6 kg/fed. of each over mineral N, P and K at 100% RR in both seasons.

The stimulative effect of mineral NPK at 75% RR with organic fertilization (HA and FA at 6 kg/fed. each) as organic fertilization on total yield of Paulista cultivar may be due to this treatment increased fresh and dry weight of different organs (Table 2), leaf pigments and mineral contents (Table 5) and yield/plant (Table 8).

The main component of humic substances, such as fulvic acid or humic acid, is utilized in suitable amounts as a fertilizer and soil conditioner to enhance the growth of roots and productivity (**Rady*et al*. 2016**). According to **Selim and Mosa (2012**), humic acid can improve the physical, chemical, and biological

Table 7. Effect of tillage on yield and its components and nitrogen use efficiency (NUE) of snap bean cv. Paulista during 2022/2023 and 2023/2024 autumn seasons

Treatments	Yield / plant (g)	Total yield /fed. (ton)	NUE (kg pods/ kg N)
		2022/2023 season	
Without tillage	126.48 b	3.519 b	66.33 b
With tillage	137.71 a	3.834 a	72.74 a
LSD at 0.05 level	**2.23**	**0.148**	**1.92**
		2023/2024 season	
Without tillage	134.95 b	3.757 b	70.88 b
With tillage	144.87 a	4.033 a	76.37 a
LSD at 0.05 level	**2.13**	**0.145**	**1.46**

Duncan's multiple range test revealed that values with the same alphabetical letter(s) did not substantially differ at the 0.05 level of significance

Table 8. Effect of the combinations between mineral and organic fertilization on yield and its components and nitrogen use efficiency of snap bean cv. Paulista during 2022/2023 and 2023/2024 autumn seasons

Treatments	Yield / plant (g)		Total yield /fed. (ton)		NUE (kg pods/ kg N)	
	2022/2023 season	**2023/2024 season**	**2022/2023 season**	**2023/2024 season**	**2022/2023 season**	**2023/2024 season**
100%RR (Control)	153.76 b	164.88 b	4.285 b	4.594 b	53.56 f	57.43 g
50%RR+ HA	106.88 f	113.60 f	2.982 f	3.170 f	74.56 c	79.25 c
50%RR+ FA	98.63 g	104.31 g	2.741 g	2.899 g	68.52 d	72.48 d
75%RR+ HA	144.35 c	153.12 c	4.021 c	4.265 c	67.02 d	71.09 e
75%RR+ FA	131.02 d	139.88 d	3.645 d	3.901 d	60.76 e	65.02 f
50%RR+ HA+FA	120.80 e	127.23 e	3.356 e	3.534 e	83.90 a	88.36 a
75%RR+ HA+FA	169.26 a	176.36 a	4.707 a	4.905 a	78.46 b	81.75 b
LSD at 0.05 level	**2.00**	**1.91**	**0.132**	**0.130**	**1.72**	**1.31**

Duncan's multiple range test revealed that values with the same alphabetical letter(s) did not substantially differ at the 0.05 level of significance

qualities of soil by increasing the availability of nutrients and then increased the productivity. According to **Hamieh *et al*. (2013**) the effects of humic acid on cell membranes, which enhance nutrient transport, plant activity hormone, protein synthesis, photosynthesis, enzyme activities, macro- and micro-element solubility, lower active levels of toxic minerals, increase microbial populations, and lower optimal productivity, have both direct and indirect positive effects on plant growth and development..

Results are harmony with **Abou El-Hassan *et al*. (2017)** showed that 50% of mineral N, P and K fertilizers combined with 50% mineral + 50% organic fertilizer produced the highest values of yield/plant and total yield kg /m^2. In addition, **Ali *et al*. (2025)** showed that the treatment (ammonium sulphate at rate 200 or 150 kg fed^{-1} with Compost 6 ton/fed. and 4 kg humic acid/fed.) gave the highest values of total yield of snap bean shoots, but there was no noticeable difference when AS at a rate of 100 kg/fed. was used.

Effect of the interaction

Data in Table 9 indicate that the interaction between using tillage and the combinations between mineral NPK at 75%RR and HA + FA at 6 kg/fed. each as organic fertilizers increased yield/plant (175.83 and 182.03 g) and total yield (4.890 and 5.062 ton/fed.) in both seasons followed by mineral NPK at 100% RR with or without soil tillage. Fertilizing with mineral NPK at 50% RR and FA at 6 kg /fed. as organic fertilization without tillage gave the lowest values of yield/plant and total yield /fed. in both seasons.

As for NUE, such data in Table 9 show that, fertilizing snap bean plants with mineral NPK at 50% RR combined with HA+FA at 6 kg /fed. each under tillage practice produced the highest values of NUE (91.08 and 87.90 kg pods/ kg N) in both seasons, respectively. Fertilizing snap bean plants with mineral NPK at 50% RR combined with HA+FA at 6 kg/fed. each with or without tillage produced the highest values of nitrogen use efficiency than mineral NPK at 100% RR with or without tillage.

The increases in total yield/fed. were about 10.70 and 5.89% for tillage treatment and mineral NPK at 75% RR with HA and FA at 6 kg/fed., each over the tillage and mineral NPK at 100% RR in the 1^{st} and 2^{nd} seasons, respectively. The increases in total yield /fed. were about 17.74 and 14.81% due to tillage treatment and mineral NPK at 75% RR with HA and FA at 6 kg /fed. each over mineral NPK at 100% RR without tillage in the 1^{st} and 2^{nd} seasons, respectively.

This means that under tillage treatment, mineral NPK at 75% RR with organic fertilization (HA and FA at 6 kg /fed. each) gave higher total yield of Paulista cultivar than mineral NPK at 100% without organic fertilization.

For all interaction treatments, yield/plant was around from 89.50 to 175.83 ton/fed. in the 1^{st} season and around from 97.26 to 182.03 g in the 2^{nd} season. In addition, for all interaction treatments total yield of Paulista cultivar were around from 2.488 to 4.890 ton/fed. in the 1^{st} season and around from 2.703 to 5.062 ton /fed. in the 2^{nd} season.

The stimulative effect of tillage treatment and mineral NPK at 75% RR with organic fertilization (HA and FA at 6 kg /fed. each) as organic fertilization on total yield of Paulista cultivar may be due to this treatment increased plant growth (Table 3), leaf pigments and N, P and K contents in shoots (Table 6) and yield/ plant (Table 9).

These results are harmony with **Agbede and Adekiya (2011)** they showed that conventional tillage plus 5 t/ha poultry manure (CT+5 PM) improved tuber yield of sweet potato by 117 and 43%.

Pod Quality (N, P, K and Total Protein in Pods)

Effect of tillage

Tillage treatment increased N, P, K contents and total protein in pod (Table 10). There was no significant effect between with and without tillage with respect to P content in both seasons. The increases in total protein in pods were about 6.83 and 1.51% for tillage treatment over without tillage in both seasons.

Theses results are agreement with **Małecka-Jankowia, *et al.* (2025)** they showed that total protein and nitrogen contents in snap bean plants were the best with conventional tillage than non tillage.

Table 9. Effect of the interaction between tillage and the combinations between mineral and organic fertilization on yield and its components and nitrogen use efficiency of snap bean cv. Paulista during 2022/2023 and 2023/2024 autumn seasons

Treatments		Yield / plant (g)		Total yield /fed. (ton)		NUE (kg pods/ kg N)	
		2022/2023 season	2023/2024 season	2022/2023 season	2023/2024 season	2022/2023 season	2023/2024 season
Without tillage	**100%RR (Control)**	148.89 d	158.08 c	4.153 c	4.409 c	55.11 k	51.91 k
	50%RR+ HA	101.62 j	107.76 k	2.837 h	3.008 i	75.20 e	70.93 f
	50%RR+ FA	89.50 k	97.26 l	2.488 i	2.703 j	67.58 h	62.20 h
	75%RR+ HA	140.75 e	149.97 d	3.915 de	4.171 de	69.52 g	65.25 g
	75%RR+ FA	126.65 g	137.25 f	3.525 f	3.839 fg	63.98 i	58.75 i
	50%RR+ HA+FA	115.29 h	123.60 h	3.196 g	3.426 h	85.65 b	79.90 bc
	75%RR+ HA+FA	162.69 b	170.70 b	4.525 b	4.748 b	79.13 d	75.42 de
With tillage	**100%RR (Control)**	158.63 c	171.67 b	4.417 b	4.780 b	59.75 j	55.21 j
	50%RR+ HA	112.13 h	119.43 i	3.128 g	3.332 h	83.30 c	78.20 cd
	50%RR+ FA	107.76 i	111.36 j	2.994 gh	3.095 i	77.38 d	74.85 e
	75%RR+ HA	147.95 d	156.26 c	4.128 cd	4.360 cd	72.67 f	68.80 f
	75%RR+ FA	135.39 f	142.50 e	3.766 e	3.964 ef	66.07 hi	62.77 gh
	50%RR+ HA+FA	126.30 g	130.86 g	3.516 f	3.643 g	91.08 a	87.90 a
	75%RR+ HA+FA	175.83 a	182.03 a	4.890 a	5.062 a	84.37 bc	81.50 b
LSD at 0.05 level		**2.83**	**2.71**	**0.187**	**0.184**	**1.86**	**2.44**

Duncan's multiple range test revealed that values with the same alphabetical letter(s) did not substantially differ at the 0.05 level of significance

Table 10. Effect of tillage on N, P and K contents and total protein (%) in pods of snap bean cv. Paulista at harvesting time during 2022/2023 and 2023/2024 autumn seasons

Treatments	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Total protein (%)
		2022/2023 season		
Without tillage	1.95 b	0.440 a	1.39 b	12.16 b
With tillage	2.07 a	0.445 a	1.51 a	12.99 a
LSD at 0.05 level	**0.02**	**NS**	**0.04**	**0.40**
		2023/2024 season		
Without tillage	2.01 b	0.454 a	1.43 b	12.58 b
With tillage	2.04 a	0.461 a	1.55 a	12.77 a
LSD at 0.05 level	**0.02**	**NS**	**0.05**	**0.08**

Duncan's multiple range test revealed that values with the same alphabetical letter(s) did not substantially differ at the 0.05 level of significance

Effect of the combinations between mineral and organic fertilization

Data in Table 11 indicate that fertilizing mineral N, P and K at 75% RR combined with HA + FA at 6 kg/fed. of each significantly increased N, P and K contents as well as total protein in pod in both seasons, followed by mineral NPK at 100%RR without organic fertilization (HA+FA) in both seasons.

The increases in total protein in pods were about 1.18 and 1.16% for mineral N, P and K at 75% RR combined with HA+FA at 6 kg /fed. of each over mineral N, P and K at 100% RR in both seasons.

In this reared, **Zaki *et al*. (2006),** support the beneficial effect of adding the treatment HA + mineral fertilizers recommendation on N and protein percentage in common bean dry seeds.

Results are harmony with **Ali, *et al.* (2025)** showed that adding of humic acid (4 kg/fed.) and compost (6 ton/fed.) and ammonium sulphate at 100% RRN, and humic acid (4 kg / fed.) and compost (3 ton /fed.) and 100% RRN produced the highest values of N% and protein % in the average of both season respectively. While, the humic acid (4 kg /fed.) and compost (6 ton /fed.) and 150 kg ammonium sulphate (75% RR) produced the maximum P and K% in seeds of snap bean.

Effect of the interaction

The interaction between using tillage and the combinations between mineral NPK at 75% RR and HA + FA at 6 kg/fed. Each as organic fertilizers significantly increased N, P and K contents and total protein in pods in both seasons (Table 12) .

The increases in total protein in pods were about 12.58 and 2.41% due to tillage treatment and mineral NPK at 75% RR with HA and FA at 6 kg /fed. each over mineral NPK at 100% RR without tillage in the 1st and 2nd seasons, respectively.

Table 11. Effect of the combinations between mineral and organic fertilization on N, P and K contents total protein (%) in pods of snap bean cv. Paulista at harvesting time during 2022/2023 and 2023/2024 autumn seasons

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)		Total protein (%)	
	2022/2023 season	2023/2024 season	2022/2023 season	2023/2024 season	2022/2023 season	2023/2024 season	2022/2023 season	2023/2024 season
100%RR (Control)	2.20 a	2.07 b	0.490 b	0.500 b	1.66 b	1.71 b	13.56 a	12.97 b
50%RR+ HA	2.00 c	1.98 d	0.400 f	0.410 f	1.31 e	1.30 e	12.50bc	12.40 e
50%RR+ FA	1.77 e	1.96 e	0.385 g	0.395 g	1.16 f	1.20 f	11.09 e	12.25 f
75%RR+ HA	2.04 b	2.05 c	0.465 c	0.480 c	1.48 c	1.53 c	12.78 b	12.81 c
75%RR+ FA	1.91 d	2.03 c	0.435 d	0.465 d	1.40 d	1.45 d	11.97 d	12.72 d
50%RR+ HA+FA	1.98 c	1.99 d	0.410 e	0.435 e	1.42 d	1.45 d	12.41 c	12.47 e
75%RR+ HA+FA	2.19 a	2.10 a	0.515 a	0.520 a	1.72 a	1.83 a	13.72 a	13.12 a
LSD at 0.05 level	**0.02**	**0.02**	**0.006**	**0.009**	**0.04**	**0.04**	**0.35**	**0.07**

Duncan's multiple range test revealed that values with the same alphabetical letter(s) did not substantially differ at the 0.05 level of significance

Table 12. Effect of the interaction between tillage and the combinations between mineral and organic fertilization on N, P and K contents and total protein (%) in pods of snap bean cv. Paulista at harvesting time during 2022/2023 and 2023/2024 autumn seasons

Treatments		Nitrogen (%)	Phosphorus (%)	Potassium (%)	Total protein (%)
		2022/2023 season	2023/2024 season	2022/2023 season	2023/2024 season
Without tillage	**100%RR (Control)**	2.12 c	0.480a	1.58 cd	12.88 b
	50%RR+ HA	2.00 fg	0.400a	1.23 g	12.50bc
	50%RR+ FA	1.67 j	0.390 a	1.09 h	10.44 f
	75%RR+ HA	2.03 ef	0.460 a	1.45 e	12.69 b
	75%RR+ FA	1.85 i	0.430 a	1.35 f	11.56 e
	50%RR+ HA+FA	1.94 h	0.410 a	1.43 e	12.13cd
	75%RR+ HA+FA	2.07 d	0.510 a	1.63 c	12.94 b
With tillage	**100%RR (Control)**	2.28 b	0.500 a	1.75 b	14.25 a
	50%RR+ HA	2.00 fg	0.400 a	1.39 ef	12.50bc
	50%RR+ FA	1.88 i	0.380 a	1.23 g	11.75de
	75%RR+ HA	2.06 de	0.470 a	1.52 d	12.88 b
	75%RR+ FA	1.98 g	0.440 a	1.45 e	12.38bc
	50%RR+ HA+FA	2.03 ef	0.410 a	1.42 e	12.69bc
	75%RR+ HA+FA	2.32 a	0.520 a	1.82 a	14.50 a
LSD at 0.05 level		**0.03**	**NS**	**0.05**	**0.58**
Without tillage	**100%RR (Control)**	2.06 b	0.500 b	1.62 c	12.88 c
	50%RR+ HA	1.96 ef	0.400 g	1.25 i	12.25 g
	50%RR+ FA	1.94 f	0.390 g	1.13 j	12.13 h
	75%RR+ HA	2.04 bc	0.480 c	1.48 ef	12.75 d
	75%RR+ FA	2.02 cd	0.460 d	1.39 gh	12.63 e
	50%RR+ HA+FA	1.98 e	0.430 ef	1.45 efg	12.38 f
	75%RR+ HA+FA	2.09 a	0.520 a	1.74 b	13.06ab
With tillage	**100%RR (Control)**	2.09 a	0.500 b	1.80 b	13.06 b
	50%RR+ HA	2.01 d	0.420 f	1.35 h	12.56 e
	50%RR+ FA	1.98 e	0.400 g	1.27 i	12.38 fg
	75%RR+ HA	2.06 b	0.480 c	1.58 cd	12.88cd
	75%RR+ FA	2.05 b	0.470 cd	1.52 de	12.81cd
	50%RR+ HA+FA	2.01 d	0.440 e	1.45 fg	12.56 e
	75%RR+ HA+FA	2.11 a	0.520 a	1.93 a	13.19 a
LSD at 0.05 level		**0.02**	**0.013**	**0.06**	**0.11**

Duncan's multiple range test revealed that values with the same alphabetical letter(s) did not substantially differ at the 0.05 level of significance

Conclusion

Soil tillage and fertilization with mineral NPK at 75% of recommended rate (80 kg N, 37 kg P_2O_5 and 50 kg K_2O/fed) in combinations with humic acid and fulvic acid at 6 kg /fed. of each as organic fertilization was the best treatment for enhancing the productivity of snap bean Paulista cultivar grown in sandy soil during autumn plantations. Fertilizing snap bean plants with mineral NPK at 50% RR combined with HA+FA at 6 kg /fed. each under tillage practice produced the highest values of nitrogen use efficiency.

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تقييم تاثير حرث التربة والتسميد المعدنى بالنيتروجين والفوسفور والبوتاسيوم مع توليفات من احماض الهيوميك والفولفيك على تحسين انتاجية وكفاءه استخدام النيتروجين فى الفاصوليا الخضراء

إيمان عبد العزيز ابراهيم محمد[1] - داليا احمد سامى نوار[1]- هانى جمال زياده[1] - شعبان دسوقي ابو حسين[2] - ايناس عبدالله برديسى[1]

1- قسم البساتين -كلية الزراعة -جامعة الزقازيق- مصر

2- معهد البحوث الزراعية والبيولوجية - المركز القومى للبحوث - مصر

أجريت هذه الدراسة خلال الخريف لعامى 2023/2022 و 2024/2023 في محطة بحوث البستانين بالقصاصين بمحافظة الإسماعيلية بمصر، لتقييم تأثير بعض الممارسات الزراعية مثل الحرث واستخدام بعض البدائل العضوية لاستبدال الأسمدة المعدنية جزئيًا مثل حمض الهيوميك وحمض الفولفيك كمادة مضافة للتربة بهدف تحسين مقاييس النمو والمحصول الأخضر وكفاءه استخدام النيتروجين وجودة القرون لنباتات الفاصوليا الخضراء. أدى حرث التربة والتسميد بالسماد المعدني (النيتروجين والفوسفور والبوتاسيوم) بنسبة 75% من المعدل الموصى به (60 كجم نيتروجين و 27.75 كجم فوسفور و 37.5 كجم بوتاسيوم / فدان) مع حمض الهيوميك وحمض الفولفيك بمعدل 6 كجم/فدان من كل منهما كتسميد عضوي إلى زيادة الوزن الطازج والجاف للجذور والأفرع والأوراق والكلوروفيل أ و ب في أنسجة الأوراق ومحتوى النيتروجين والفوسفور والبوتاسيوم في العرش، محصول النبات والفدان، وكذلك محتوى القرون من النيتروجين والفوسفور والبوتاسيوم والبروتين الكلي، في حين أن تسميد نباتات الفاصوليا الخضراء بالسماد المعدني من النيتروجين والفوسفور والبوتاسيوم بنسبة 50% من المعدل الموصى به مع حمض الهيومك + حمض الفولفيك بمعدل 6 كجم / فدان لكل منهما تحت ممارسة الحرث أنتجت أعلى قيم لكفاءة استخدام نباتات الفاصوليا الخضراء صنف بوليستا النامى فى الارض الرملية للنيتروجين.

المحكمـــــون:

1- أ.د. الســـــيد الســـــيد أبو الخير	أستاذ الخضر- معهد بحوث البساتين- مركز البحوث الزراعيه.
2- أ.د. أحمد عبد الله محمود محسن	استاذ الخضر-قسم البساتين- كليه الزراعه – جامعه الزقازيق