Annals of R.S.C.B., ISSN: 1583-6258, Vol. 26, Issue 1, 2022, Pages. 15 - 32
Received 08 November 2021; Accepted 15 December 2021.

# Nitrogen Sources and Foliar Spray with Some Stimulants Affect Dry Weight, Yield and Fruit Quality of Sweet Pepper under Plastic Houses Conditions

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## ABSTRACT

This work was carried out during 2019/2020 and 2020/2021 winter seasons in a private unheated plastic houses, Kom Haleen, Menia El Qamh city, Sharkia Governorate, Egypt, to evaluate the effect of different sources of nitrogen fertilizers and some growth stimulants as foliar application on growth, yield and fruit quality of sweet pepper (Lirica RZ *cv.*) grown in clay soil using drip irrigation system**.**

Results indicated that, the interaction between fertilization sweet pepper plants with vermicompost at 1.226 kg /$m^2$ (as organic nitrogen 100% ) and foliar spray with compost tea at 10 ml/l increased dry weight of shoots/ plant, number of fruits/ plant , yield / plant and TSS contents in fruits followed by the interaction between vermicompost and spraying with vermicompost tea at 7.5 ml/l at 100 days after transplanting in both seasons. The interaction between fertilization plants with vermicompost +FYM at (0.613+2.100 kg /$m^2$ ) as organic nitrogen (50% +50 % of each ) and spraying with compost tea at 10 ml/l increased N,P and K uptake by shoots, total sugars in fruits (%) and vitamin C in fruits , whereas spraying with vermicompost at 7.5 ml/l with the same fertilizer increase average fruit weight ( kg) , on the other hand, the interaction between fertilizing with ammonium nitrate at 0.085 kg /$m^2$ and spraying with compost tea at 10 ml/l gave the highest values of fruits DM (%).

**Keywords:**
Sweet pepper; nitrogen sources; compost tea; vermicompost tea; nano-micronutrients; yield and quality

## Introduction

In Egypt, sweet pepper (Capsicum annuum L.) is one of the most popular and favorite vegetable crop cultivated for local market and exportation. High cash crops such as sweet pepper have occupied an important rank in Egyptian and world agriculture due to its high profit and nutritional values for human health [1].

Nutrition plays an important role in the growth and development of any crop including capsicum, because it is known to exhibit positive response to the application of nitrogenous fertilizers particularly in light soils. Nitrogen fertilizer is an essential component of any system in which the aim is to maintain good yield [2]. The productivity of pepper is highly responsive to N fertilizer. Application of inorganic fertilizer to agriculture is now common practice, using composts derived from various green wastes in agriculture is tardily coming back. Compost, vermicompost and farmyard manure (FYM) contains variable amounts of N, P and K and it is a valuable source of plant nutrients. Cost of inorganic fertilizers is very high and sometimes it is not available in the market right time it leads to the farmers fail to apply the inorganic fertilizers to the crop field in optimum

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time. In simple words, organic farming is the cultivation of crops through organic inputs with intensity to minimize the use of chemical fertilizers and pesticides that is hazardous to the environment. Organic materials can substitute for inorganic fertilizers to maintain productivity and environmental quality [3].

Many investigators found that about sweet pepper, addition of organic fertilizer had a major effect on dry weight [4, 5, 6, 7], N,P and K total uptake [8, 9, 10, 11, 12], yield and its components [12, 13, 14, 15] and quality of sweet pepper fruits [16].

Compost or vermicompost tea is a highly concentrated microorganisms solution produced by extracting beneficial microbes from compost. It can use it as foliar or soil inoculation as organic nutrients, contain cheated micronutrients for easy plant absorption and the nutrients are in a biologically available form for both plant uptake. Compost tea is gaining importance as an alternative to chemical fertilizers and pesticides. The microbial population in the compost tea contributes toward its beneficial effectiveness. It has beneficial effects on plant growth and considered as a valuable soil amendment [17].

Vermicompost is a nutrient-rich, microbiologically active organic amendment which results from the interactions between earthworms and microorganisms in the breakdown of organic matter. It is a stabilized, finely divided peat-like material with a low C/N ratio and high porosity and water-holding capacity that contains most nutrients in forms that are readily taken up by plants [18]. Nutrients in vermicompost are present in readily available forms for plant uptake; e.g. nitrates, exchangeable P, K, Ca and Mg [19].

In the last years, the development of new products derived from compost or vermicompost are increasing, due to their positive effects on the crops. CT is organic product obtained through a liquid-phase of compost and its extraction period ranging from few hours to two weeks, with or without active aeration with the addition of some active nutrients, i. e., molasses, casein, etc. [20].

Some authors showed that spraying sweet pepper plants with compost tea , vermicompost tea or nano micronutrients significantly enhanced dry weight [21, 22, 23, 24] mineral uptake [25] (on snap bean), yield and its components [26, 27, 28, 29] and fruit quality [23, 30, 31].

Thus, the main aims of this experiment were to find the best nitrogen fertilizer sources and suitable foliar stimulants such as compost, vermicompost tea and nano micronutrients to obtained high dry weight , yield and quality of sweet pepper grown under plastic houses conditions.

## Materials and Methods

This experimental was carried out during winter seasons of 2019/2020 and 2020/2021 in a private unheated plastic houses,, Kom Haleen, Menia El Qamh Distract, Sharkia Governorate, Egypt to study the effect of different sources of nitrogen fertilizers and some growth stimulants as foliar application on dry weight ,N,P and K total uptake, yield and fruit quality of sweet pepper (Lirica RZ cv.) grown in clay soil using drip irrigation system .

The used soil properties were: Clay loam soil in texture for the average two seasons, while it had 1.27% organic matter, 8.08 pH, 0.45 mmhos/cm EC, 0.17, 2 , ,2 , 0.87 , 0 , 1, 2.23 and 1.8 meq /l K2O, Mg, Ca, Na, CO3, HCO3, SO4 and Cl, respectively .

Chemical analysis of the farmyard manure ( average two seasons ) it had 7.8, 71.47, 3.79, 6.98, 0.71, 0.032 and 0.025 for moisture (%), ash (%) , EC dS/m, pH, N (%),P (%) and K (%),respectively.

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Chemical analysis of the compost ( average two seasons ), it had, 780 kg, 17%, 7.14, 12.94 dS/m, 0.79%, 25.31 %, 1:18, 0.40 % and 0.80% for weight of m3, moisture content , pH , EC, total N, organic matter, C/N ratio, total P and total K, respectively.
Chemical analysis of the vermicompost ( average two seasons ), it had, 760 kg, 51%, 6.99, 1.37 dS/m, 2.33%, 52.31 %, 1:12.89, 1.39 % and 0.99% for weight of m3, moisture content , pH , EC, total N, organic matter, C/N ratio, total P and total K, respectively.
All Chemical analysis were carried to in the water and environment Res. Intst., (SWERI), ARC, Egypt.
This experiment includes 20 treatments which were the combinations between five different sources of soil nitrogen fertilizers i.e., mineral nitrogen , compost fertilizer, vermicompost fertilizer, farmyard manure (FYM) and vermicompost + FYM and and foliar spraying with four growth stimulants i.e., compost tea at 10 ml/l, vermicompost tea at 7.5 ml/l, mixture of nano micronutrients (Magro Nano Mix at 0.5g/l) and spraying with water ( control ).
The quantities of different sources of nitrogen as shown in Schedule 1.

**Schedule 1.**Quantities of different sources of nitrogen

| Fertilizers | N % | Kg/fad. | Kg/m2 |
|---|---|---|---|
| Ammonium nitrate | 33.5 | 358.209 | 0.085 |
| Compost | 0.79 | 15190 | 3.617 |
| Vermicompost | 2.33 | 5150 | 1.225 |
| FYM | 0.68 | 17647 | 4.202 |
| Vermicompost +FYM | 2.33+0.68 | 2575+8823 | 0.613+2.100 |

The recommended rate of mineral nitrogen was 120 kg N /fad. ( 0.0286 kg N/m2)
These treatments were arranged in a split plot design with three replicates. The sources of nitrogen fertilizers were arranged in main plots and the foliar application of growth stimulants were randomly distributed in the sub plots.
Sweet pepper seeds were sown in seedling from trays ( 84 eyes) filled with a mixture of peat moss: vermiculite ( 1:1 v/v), supplemented with 300 g ammonium sulphate ( 20.5 % N) 400 g calcium super phosphate (15 % P2O5), 150 g of potassium sulphate (48 % K2O) for each, 50 kg of the mixture under nursery of plastic house on the 1st of August during both seasons of study. Seedlings of 31 days old were transplanted on the 1st of September in clay soil under unheated plastic house at 40 cm apart and 1 ml width of row.
This experiment included three unheated plastic house. The total area of plastic house were 240 m2 ( 40 m long and 6 m width) , 50 cm from both sides of plastic house ( 40 m2) were left without planting . So, the total number of plants of plastic house were 500 plants ( 2.5 plants/m2) .
The plastic house contained 5 rows ( 40 m long and 1 m width ) as main plot ( five sources of nitrogen fertilizers ) and each row divided into four equal divisions (10 m long and 1 m width) as sub plots ( four growth stimulants ).
The experimentalunitarea was 10.0 m2 .It contained one row 10 m long and 1 m width. Each plot area included 25 plants.
All quantities of different nitrogen fertilizers were about 0.085, 3.617, 1.226, 4.202 and 0.613+2.100 kg /m2 from ammonium nitrate, compost, vermicompost, FYM and vermicompost + FYM,

respectively. Organic fertilizer were incorporated into ridge at once before one week of transplanting.

The source of vermicompost was central laboratory for agriculture climate (CLAM) Giza, Egypt. The source of farmyard manure was a private of animal farm, Kom Haleen, Menia El-Qamh Distract and the source of compost was Barakah Company for Organic fertilizer, Belbeis Distract. The source of mixture of nano micro nutrients was Modern Agric Company of Pesticides, Belbeis Distract.

Magro Nano Mix as source mixture of nano micronutrients contained 6 % Fe, 6 % Zn, 5%Mn, 1%Cu, 2%B,0.1% Mo and 4 % citric acid. The source of seeds of Lirica RZ cultivar was RZ Egypt for importing LLc, producer: Rijk Zwaon, Holland.

Different growth stimulants applications were foliar three times beginning 45 days from transplanting and 15 days intervals. The normal agricultural practices in both experiments will be carried out as commonly followed in the district.

**Data Recorded**

Dry weight:A random sample of three plants from each plot was taken at 100 days after transplanting and dried at 70 Cº till constant weight and the dry weight of shoots ( leaves + stem ) were determined .

Plant Chemical Composition: the uptake of N,P and K (mg) by shoot were computed at 100 days after transplanting in the 2nd season after determined of nitrogen, phosphorus and potassium contents in leaves and stems according to the methods described by [32].

**Fruit yield and its characteristics**

Total yield: all harvesting were picked all over the season for all plots and the following data were calculated, number of fruits/ plant, average fruit weight (kg) , total yield / plant (kg) were estimated .

Fruit quality

Dry matter (%): One hundred grams of fruits were dried at 1050C till the constant weight and DM (%) was recorded. Total soluble solids contents (TSS ) as brixo: Samples of fruits were chosen randomly from each experimental plot to measure the percentage of total soluble solids content using the hand refractometer. Total soluble sugar; it was determined according to the method [33]. Ascorbic acid: (Vitamin C mg/100g fresh weight) content was determined using 2, 6 dichlorophenol indophenols, method [34].

**Statistical analysis**

Collected data were subjected to proper statistical analysis of variance according to Snedecor and Cochran [35] and the differences among treatments were compared using Duncans' multiple range test[36], where means had the different letter were statistically significant, while those means followed by the same letter were statistically insignificant.

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 26, Issue 1, 2022, Pages. 15 - 32
Received 08 November 2021; Accepted 15 December 2021.

## Results and discussion

### Total dry weight of shoots

Concerning the effect of nitrogen fertilization sources , fertilizing sweet pepper plants grown in plastic house with vermicompost at 1.226 kg /$m^2$ increased dry weight of shoots/ plant, followed by fertilizing with vermicompost +FYM at 0.613+2.100 kg /$m^2$ at 100 days after transplanting in both seasons ( Table 1). Fertilizing with FYM at 4.202 kg /$m^2$ gave the lowest values of dry weight of shoots/ plant. Such increments in dry weight parameters in case of using vermicompost in fertilization may be due to its highest content of nutrient elements and organic matter , which may be improved both soil fertility and physical soil characteristics. In addition, vermicompost +FYM considered slow release organic fertilizer lasting long period in the soil and positively affect vegetative growth.

These results agreement with those of [5, 6, 7, 37] on sweet pepper. They indicated that fertilized plants with organic fertilizer significantly higher dry weight per plant in comparison to mineral fertilizers.

As for foliar spray with some stimulants , foliar spray with some stimulants increased dry weight of shoots/ plant compared to control treatment (spraying with water) at 100 days after transplanting in both seasons ( Table 1). Spraying with compost tea at 10 ml/l increased dry weight of shoots/ plant, followed by spraying with vermicompost tea at 7.5 ml/l in both seasons. The favourable effect of compost tea treatments on dry weight might be attributed to the beneficial effects of compost tea that contains many macro and micro nutrients in available form, natural hormones such as cytokinens, gibberellins, indoleacetic acid, vitamins and antioxidants that be available for plant and so reflect on plant growth and its composition [38].

These results are in accordance with those obtained [29] on tomato concerning the effect of compost tea and [24] on chili plants regarding nano-micronutrient. They indicated that spraying with compost tea, or nano micronutrient gave the highest values of different dry weight parts / plant as compared to un spraying plants.

Regarding the interaction treatments, data in the same Table show that the interaction between fertilization with vermicompost at 1.226 kg /$m^2$ and foliar spray with compost tea at 10 ml/l increased dry weight of shoots/ plant, followed by the interaction between vermicompost and spraying with vermicompost tea at 7.5 ml/l at 100 days after transplanting in both seasons.

From the foregoing results , it could be concluded that , fertilizing sweet pepper grown in plastic house conditions with vermicompost at 1.226 kg /$m^2$ as organic nitrogen (100%) and foliar spray with compost tea at 10 ml/l increased dry weight of shoots (leaves and stems) / plant.

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Received 08 November 2021; Accepted 15 December 2021.

**Table 1.Effect of the interaction between nitrogen fertilization sources and foliar spray with some stimulants on shoot dry weight of sweet pepper under plastic houses conditions at 100 days after transplanting during 2019/2020 season.**

| Treatments | Compost tea | Vermicompost tea | Nano micronutrient | Water ( control) | Mean ( nitrogen sources (A) |
|---|---|---|---|---|---|
| | 2019/2020 season | | | | |
| **Mineral nitrogen** | 73.85cd | 68.96ef | 65.53 gh | 53.74k | **65.52 C** |
| **Compost** | 77.97 ab | 72.88 d | 71.04de | 62.74 hi | **71.15 B** |
| **Vermicompost** | 79.87 a | 76.99 ab | 71.40 de | 66.60 fg | **73.71 A** |
| **FYM** | 65.40 gh | 61.04 ij | 58.88j | 51.59 k | **59.22 D** |
| **Vermicompost+FYM** | 76.17 bc | 73.42 cd | 67.88 fg | 65.19 gh | **70.66 B** |
| **Mean (stimulants) B** | **74.65 A** | **70.65 B** | **66.94 C** | **59.97 D** | - |
| | 2020/2021 season | | | | |
| **Mineral nitrogen** | 74.65 a-c | 70.56 d | 63.97e | 55.76f | **66.23 C** |
| **Compost** | 74.56 a-c | 74.42 a-c | 72.95 b-d | 63.75 e | **71.42 AB** |
| **Vermicompost** | 78.00 a | 75.88 ab | 72.80 b-d | 65.34 e | **73.00 A** |
| **FYM** | 66.59 e | 64.25 e | 59.40 f | 50.76 g | **60.25 D** |
| **Vermicompost+FYM** | 74.04 b-d | 71.35 cd | 70.48 d | 63.77 e | **69.91 B** |
| **Mean (stimulants) B** | **73.56A** | **71.29B** | **67.92C** | **59.87D** | |

-Mineral nitrogen as ammonium nitrate = 0.085 kg /$m^2$, compost at 3.617 kg/$m^2$, vermicompost at 1.226 kg /$m^2$ , FYM at 4.202 kg /$m^2$ and FYM at 2.100 + vermicompost at 0.613 kg /$m^2$.
-Compost tea at 10 ml/l, Vermicompost tea at 7.5 ml/l and mixture of nano micronutrients ( Magro Nano Mix) at 0.5 g/l .

**N,P and K uptake**

The obtained results in Table 2 show that , fertilizing sweet pepper plants with vermicompost +FYM at 0.613+2.100 kg /$m^2$ increased total uptake of N,P and K by shoots at 100 days after transplanting, followed by fertilizing with vermicompost at 1.226 kg /$m^2$ in the 2$^{nd}$ season only. The superiority of NPK uptake by pepper plants by vermicompost +FYM treatment may be due to that vermicompost +FYM is usually applied at much greater rates; therefore, it can have a significant cumulative effect on nutrient availability. The great rates of vermicompost +FYM also increases activity of beneficial microorganisms in soil, which help in promotion of nutrient availability by atmospheric nitrogen fixation, phosphate dissolving and potassium releasing [39]. All these led to increment NPK uptake by pepper plants. These results coincide with those of [10, 11, 12]whoindicated that under plastic house, adding chicken manure at 20 $m^3$ / fed. with 150 or 100 Kg. mineral N /fed. to sweet pepper gave the highest concentration of N,P and K in leaves as compared to the other treatments.

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 26, Issue 1, 2022, Pages. 15 - 32
Received 08 November 2021; Accepted 15 December 2021.

Foliar spray with compost tea at 10 ml/l, followed by vermicompost tea at 7.5 ml/l increased uptake of N,P and K by shoots at100 days after transplanting in the 2nd season only ( Table 2). Such increases in chemical constituents as a result of foliar spray with compost tea and vermicompost teamay be due to its stimulants from high macronutrients which affect positively on nutrient absorption and accumulation in plant cells.

These results are in accordance with those obtained by [21]showed that spraying sweet pepper plants with mixture of Fe 1 g/L + Mn 1 g/L + Zn 1 g/L treatment gave the highest values N, P and K contents than unsprayed plants of sweep pepper.Also, **[25]** on snap bean plantsfound that spraying plant with compost tea gave the highest values of N,P and K contents in plant foliage than unsprayed plants .

The interaction between fertilization with vermicompost +FYM at 0.613+2.100 kg /$m^2$ and foliar spray with compost tea at 10 ml/l , followed by the interaction between vermicompost at 1.226 kg /$m^2$ and spraying with compost tea at 10 ml/l increased total uptake of N,P and K by shoots at 100 days after transplanting in the 2nd season only ( Table 2).

From the foregoing results , it could be concluded that , fertilizing sweet pepper plants grown in plastic house conditions with vermicompost +FYM at 0.613+2.100 kg /$m^2$ as organic nitrogen (50% +50 % of each ) and foliar spray with compost tea at 10 ml/l increased N ,P and K uptake by shoots.

Increasing N uptake in fruits of sweet pepper may be due to the more availability of nitrogen which release from compost and compost tea by mineralization process in paddy soil that is due to conversion of organic forms of N to inorganic N as ammonium ($NH_4^+$) as available form of N to uptake by pepper plant [40]. Also Compost and compost tea application leads to enhanced enrichment of organic nitrogen in the soil [41].

In this regard, [25]on snap bean plantsmentioned that using mineral nitrogen at 60 kg /fad. and spraying plant with compost tea gave the highest values of N,P and K contents in plant foliage than using chicken manure and unsprayed plants.

**Table 3.Effect of the interaction between nitrogen fertilization sources and foliar spray with some stimulants on N,P and K uptake by shoots ( mg) at 100 days after transplanting of sweet pepper under plastic houses conditions during 2019/2020 season.**

| Treatments | Compost tea | Vermicompost tea | Nano micronutrient | Water ( control) | Mean ( nitrogen sources (A) |
|---|---|---|---|---|---|
| | Nitrogen | | | | |
| **Mineral nitrogen** | 1266.1 a | 1206.5 b | 1114.7 de | 948.5 g | **1093.1 C** |
| **Compost** | 1019.7 f | 949.2 g | 859.3 h | 685.0 i | **1086.4 C** |
| **Vermicompost** | 1192.3 b | 1141.9 cd | 1086.9 e | 924.8 g | **1134.0 B** |
| **FYM** | 1282.5 a | 1214.3 b | 1182.7 b | 1027.6 f | **878.3 D** |

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| | | | | | |
|---|---|---|---|---|---|
| **Vermicompost+FYM** | 1266.1 a | 1206.5 b | 1114.7 de | 948.5 g | **1176.8 A** |
| **Mean (stimulants) B** | **1206.6 A** | **1137.9 B** | **1057.3 C** | **893.1 D** | |
| | **Phosphorus** | | | | |
| **Mineral nitrogen** | 274.95 ab | 254.61 de | 227.73 g | 186.19 k | **235.87 B** |
| **Compost** | 263.88 cd | 259.10 de | 242.96 f | 200.49 j | **241.61 B** |
| **Vermicompost** | 283.68 a | 270.89 bc | 251.17 ef | 211.93 i | **254.42 A** |
| **FYM** | 229.36 g | 217.82 hi | 190.77 k | 154.56 l | **198.13 C** |
| **Vermicompost+FYM** | 280.71 a | 258.64 de | 253.26 e | 221.48 gh | **253.52 A** |
| **Mean (stimulants) B** | **266.51 A** | **252.21 B** | **233.18 C** | **194.93 D** | |
| | **Potassium** | | | | |
| **Mineral nitrogen** | 1498.9 a | 1355.6 cd | 1127.6 g | 945.1 i | **1231.8 C** |
| **Compost** | 1394.8 bc | 1339.1 d | 1200.8 f | 1028.3 h | **1240.7 C** |
| **Vermicompost** | 1493.5 a | 1391.8 bc | 1224.0 f | 1055.3 h | **1291.1 B** |
| **FYM** | 1220.5 f | 1113.2 g | 959.3 i | 736.7 j | **1007.4 D** |
| **Vermicompost+FYM** | 1520.0 a | 1418.7 b | 1273.0 e | 1124.6 g | **1334.1 A** |
| **Mean (stimulants) B** | **1425.5 A** | **1323.7 B** | **1156.9 C** | **978.0 D** | |

-Mineral nitrogen as ammonium nitrate = 0.085 kg /$m^2$, compost at 3.617 kg/$m^2$, vermicompost at 1.226 kg /$m^2$ , FYM at 4.202 kg /$m^2$ and FYM at 2.100 + vermicompost at 0.613 kg /$m^2$. -Compost tea at 10 ml/l, Vermicompost tea at 7.5 ml/l and mixture of nano micronutrients ( Magro Nano Mix) at 0.5 g/l .

**Yield and its components**

Data in Tables 4 to 6 showed that , fertilizing with vermicompost at 1.226 kg /$m^2$ increased number of fruits / plant ( 23.53 and 24.69 fruits/ plant) , while fertilizing with vermicompost +FYM at 0.613+2.100 kg /$m^2$ increased average fruit weight (0.209 and 0.182 kg/fruit) and total yield / plant ( 4.018 and 3.622 kg / plant) with no significant differences with vermicompost at 1.226 kg /$m^2$ with respect to total yield / plant in both seasons ( Table 6).

This means that fertilizing with vermicompost at 1.226 kg /$m^2$ and vermicompost +FYM at 0.613+2.100 kg /$m^2$ increased total yield in both seasons. As for number of fruits/plant, data show

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 26, Issue 1, 2022, Pages. 15 - 32
Received 08 November 2021; Accepted 15 December 2021.

that fertilizing with vermicompost at 1.226 kg /$m^2$ increased number of fruits/ plant in both seasons. Fertilizing sweet pepper with FYM at 4.202 kg /$m^2$ gave the lowest values of number of fruits/ plant, average fruit weight and yield per plant and per meter square compared to other treatments.

The stimulative effect of vermicompost +FYM on yield / plant may be due to that vermicompost +FYM increased average fruit weight of sweet pepper.

Vermicompost contains 2.33% N, 1.39% P and 0.99 K (show materials), in addition to these, it is, also, contains micro nutrients. It is a good source of organic matter (52.31%) which acts as a store house of all plant nutrients including trace elements might have released them gradually and steadily and this contributed towards the balanced nutrition of crop which resulted in maximum fruit yield. Also, the positive response of vermicompost in different growth parameters of sweet pepper is due to fact that it increases the microbial population and also provides the source of energy to sustain them and remain active [42]. It increases the plant growth and yield by providing nutrients in the available form as compared to other organic manures and conventional inorganic fertilizers.

Similar results were reported by [11, 37, 43, 44, 45]all on sweet pepper. They found that fertilizing plants with organic fertilizers such as compost and vermicompost gave the best results for yield and its components than that fertilized with mineral nitrogen.

Spraying sweet pepper grown in plastic house with compost tea at 10 ml/l, significantly increased number of fruits/ plant ( 23.42 and 24.33 fruit / plant) and total yield per plant ( 4.120 and 3.879 kg / plant ), whereas spraying with vermicompost tea at 7.5 ml/l increased average fruit weight ( 0.184 and 0.167 kg / fruit) in both seasons ( Tables 4 to 6).

**Table 4.Effect of the interaction between nitrogen fertilization sources and foliar spray with some stimulants on number of fruits / plant of sweet pepper under plastic houses conditions during 2019/2020 and 2020/2021 seasons**

| | **Compost tea** | **Vermicompost tea** | **Nano micronutrient** | **Water ( control)** | **Mean ( nitrogen sources (A)** |
|---|---|---|---|---|---|
| | **2019/2020 season** | | | | |
| **Mineral nitrogen** | 22.51 c | 15.64g-i | 15.43 hi | 15.78 gh | **17.34 D** |
| **Compost** | 23.16 c | 20.40de | 18.10 f | 16.20 gh | **19.46 B** |
| **Vermicompost** | 26.48 a | 25.61 ab | 25.27 b | 16.76 g | **23.53 A** |
| **FYM** | 22.37 c | 16.73g | 19.20 ef | 15.90 gh | **18.55 C** |
| **Vermicompost+FYM** | 22.58 c | 20.80 d | 18.73 f | 14.50 i | **19.15 BC** |
| **Mean (stimulants) B** | **23.42 A** | **19.83 B** | **19.34 B** | **15.82 C** | |
| | **2020/2021 season** | | | | |
| **Mineral nitrogen** | 19.99 i | 17.51 j | 15.48 kl | 15.00 l | **16.99 D** |

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Received 08 November 2021; Accepted 15 December 2021.

| | | | | | |
|---|---|---|---|---|---|
| **Compost** | 27.00 a | 22.38 d-f | 22.02 e-g | 20.39 g-i | **22.94 B** |
| **Vermicompost** | 26.52 ab | 23.83 cd | 23.40 c-e | 25.01 bc | **24.69 A** |
| **FYM** | 24.18 c | 21.73 e-h | 21.12 f-i | 21.07 f-i | **22.02 B** |
| **Vermicompost+FYM** | 24.00cd | 20.29 hi | 16.87 jk | 18.13j | **19.82 C** |
| **Mean (stimulants) B** | **24.33 A** | **21.14 B** | **19.92 C** | **19.77 C** | |

-Mineral nitrogen as ammonium nitrate = 0.085 kg /$m^2$, compost at 3.617 kg/$m^2$, vermicompost at 1.226 kg /$m^2$ , FYM at 4.202 kg /$m^2$ and FYM at 2.100 + vermicompost at 0.613 kg /$m^2$. -Compost tea at 10 ml/l, Vermicompost tea at 7.5 ml/l and mixture of nano micronutrients ( Magro Nano Mix) at 0.5 g/l .

**Table 5.Effect of the interaction between nitrogen fertilization sources and foliar spray with some stimulants on average fruit weight ( kg) of sweet pepper under plastic houses conditions during 2019/2020 and 2020/2021 seasons**

| **Treatments** | **Compost tea** | **Vermicompost tea** | **Nano micronutrient** | **Water ( control)** | **Mean ( nitrogen sources (A)** |
|---|---|---|---|---|---|
| | **2019/2020 season** | | | | |
| **Mineral nitrogen** | 0.174 hi | 0.200 cd | 0.184 fg | 0.160 j | **0.179B** |
| **Compost** | 0.175 g-i | 0.145 k | 0.176 gh | 0.167ij | **0.165D** |
| **Vermicompost** | 0.187 ef | 0.166 ij | 0.163j | 0.178 gh | **0.173C** |
| **FYM** | 0.132 l | 0.195 de | 0.132 l | 0.149 k | **0.152E** |
| **Vermicompost+FYM** | 0.209 bc | 0.218 a | 0.210 ab | 0.199 d | **0.209A** |
| **Mean (stimulants) B** | **0.175B** | **0.184A** | **0.173BC** | **0.170C** | -- |
| | **2020/2021 season** | | | | |
| **Mineral nitrogen** | 0.185 bc | 0.162 de | 0.174 cd | 0.154 e-g | **0.168B** |
| **Compost** | 0.151 e-g | 0.144 g-i | 0.148 f-h | 0.132 i-k | **0.143D** |
| **Vermicompost** | 0.160 ef | 0.176 c | 0.150 e-h | 0.123 k | **0.152C** |
| **FYM** | 0.130 jk | 0.150 e-h | 0.137 h-j | 0.128 jk | **0.136E** |
| **Vermicompost+FYM** | 0.176 c | 0.203 a | 0.192 ab | 0.160 ef | **0.182A** |
| **Mean (stimulants) B** | **0.160B** | **0.167A** | **0.160B** | **0.139C** | -- |

-Mineral nitrogen as ammonium nitrate = 0.085 kg /$m^2$, compost at 3.617 kg/$m^2$, vermicompost at 1.226 kg /$m^2$ , FYM at 4.202 kg /$m^2$ and FYM at 2.100 + vermicompost at 0.613 kg /$m^2$. -Compost tea at 10 ml/l, Vermicompost tea at 7.5 ml/l and mixture of nano micronutrients ( Magro Nano Mix) at 0.5 g/l .

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Received 08 November 2021; Accepted 15 December 2021.

**Table 6.Effect of the interaction between nitrogen fertilization sources and foliar spray with some stimulants on fruit yield / plant ( kg) of sweet pepper under plastic houses conditions during 2019/2020 and 2020/2021 seasons**

| Treatments | Compost tea | Vermicompost tea | Nano micronutrient | Water ( control) | Mean ( nitrogen sources (A) |
|---|---|---|---|---|---|
| | 2019/2020 season | | | | |
| **Mineral nitrogen** | 3.920 c | 3.135 de | 2.839 d-g | 2.527 f-h | **3.105 B** |
| **Compost** | 4.073 c | 2.952d-g | 3.189 d | 2.705e-h | **3.229 B** |
| **Vermicompost** | 4.941 a | 4.259 bc | 4.116 bc | 2.990 de | **4.076 A** |
| **FYM** | 2.957 d-f | 3.260 d | 2.526gh | 2.363 h | **2.776 C** |
| **Vermicompost+FYM** | 4.711 a | 4.540 ab | 3.932 c | 2.890 d-g | **4.018 A** |
| **Mean (stimulants) B** | **4.120A** | **3.629B** | **3.320C** | **2.695D** | |
| | 2020/2021 season | | | | |
| **Mineral nitrogen** | 3.694 b | 2.839 fg | 2.696 g | 2.648 g | **2.969 C** |
| **Compost** | 4.076 a | 3.219 c-e | 3.259 cd | 2.689 g | **3.310 B** |
| **Vermicompost** | 4.239 a | 4.203 a | 3.504 bc | 3.076 d-f | **3.755 A** |
| **FYM** | 3.154 d-f | 3.261 cd | 2.891 e-g | 2.692 g | **2.999 C** |
| **Vermicompost+FYM** | 4.233 a | 4.123 a | 3.234 cd | 2.900e-g | **3.622 A** |
| **Mean (stimulants) B** | **3.879A** | **3.529B** | **3.116C** | **2.801D** | |

-Mineral nitrogen as ammonium nitrate = 0.085 kg /$m^2$, compost at 3.617 kg/$m^2$, vermicompost at 1.225 kg /$m^2$ , FYM at 4.20 kg /$m^2$ and FYM at 2.100 + vermicompost at 0.613 kg /$m^2$. -Compost tea at 10 ml/l, Vermicompost tea at 7.5 ml/l and mixture of nano micronutrients ( Magro Nano Mix) at 0.5 g/l .

Spraying sweet pepper plants with compost tea at 10 ml/l and vermicompost tea at 7.5 ml/l increased number of fruits/ plant , average fruit weight and total yield per plant compared to control ( spraying with water).

The increases in total yield were about 52.9 and 38.5 % for compost tea, 34.7 and 26.0 % for vermicompost tea and 23.2 and 11.2 % for mixture of nano micronutrients over the control ( water) in the 1$^{st}$ and 2$^{nd}$ seasons, respectively.

The stimulative effect of compost tea on total yield / plant may be due to that compost tea increased number of fruits/ plant from 15.82 and 19.77 fruits/ plant for control ( water) to 23.42 and 24.33 fruit / plant in the 1$^{st}$ and 2$^{nd}$ seasons, respectively ( Table 4 ).

The favourable effect of compost tea on total yield might be attributed to positive effects to compost tea on the crops because contains many macro and micro nutrients in available form, natural hormones and the highest number of microorganisms that be available for plant and so reflect on plant growth and its composition [38] that led to improve yield. Moreover, the highest yield was recorded with compost tea. This was probably due to increase in the number of fruits /plant, average fruit weight, yield/plant which might contribute to the increase in production.

These results agreed with [46] indicated that spraying pepper plants with compost tea at 5 ml/l under green house significantly increased total yield by 21.9% and 16.3%. in the 1st and 2nd seasons, respectively than unsprayed plants. Also, they added that , the increment of the yields was related to an increase of the number of fruits *per* plant, whereas the weight of the single fruit was not affected by treatment. also, [24] showed that, fruit length, fruit diameter and average fruit weight , number of fruits/ plant, fruit yield / plant and total yield / feddan of chilli were the highest with spraying chili plants with nano micronutrients at 0.25 or 0.50 g/l as compared to control treatment. however, [7] tested the effect of some nitrogen sources on cucumber, i.e., control (without any fertilizer), control with chemical fertilizer (20-20-20), vermicompost in two levels (20 and 30%), and chicken manure tea (25, 50, and 75%). They showed that increasing the amount of chicken manure tea (up to 50%) significantly increased days until flowering, yield (40, 65, and 90 days after culturing), marketable fruit ratio to second degree fruit, and total fruit weight of cucumber by enhancement in content of chicken manure tea (75%) all traits showed the same result as treatment with chemical fertilizer.

The interaction between vermicompost at 1.226 kg /$m^2$ and spraying with compost tea at 10 ml/ gave the highest values of number of fruits / plant ( 26.48 in the 1st season ) and total yield per plant ( 4.941 and 4.239 kg / plant in both seasons (Tables 4 and 6). Whereas, the interaction between vermicompost +FYM at 0.613+2.100 kg/$m^2$ and foliar spray with vermicompost tea at 7.5 ml/l gave the highest values of average fruit weight ( 0.218 and 0.203 kg/ fruit) in both seasons. The stimulative effect on the interaction between vermicompost +FYM and compost tea on total yield , may be due to that vermicompost +FYM and compost tea increased N,P and K uptake by sweet pepper plants ( Table 3) which resulted in increased dry weight of shoots. From the foregoing results , it could be concluded that , fertilization sweet pepper plants in plastic house with vermicompost +FYM at 0.613 + 2.100 kg /$m^2$ as organic nitrogen (50% +50 % of each ) and spraying with vermicompost tea at 7.5 ml/l increased average fruit weight, whereas fertilization with vermicompost at 1.226 kg /$m^2$ as organic nitrogen (100%) and spraying with compost tea at 10 ml/l increased number of fruits/ plant and total yield per plant.

It may be due to the direct effect of vermicompost application and foliar spray with liquid manure on plant growth, which provides a source of plant macro and micronutrients. Although some of these nutrients are present in inorganic forms and are readily available to plants, most are released gradually through mineralization of the organic matter, thus comprising a gradual-release fertilizer that contributes the plant with a dynamic and stable source of nutrients[22].

These results are harmony with those reported by [37] showed that fertilizing with vermicompost at 20 % gave the highest values of fruit yield of pepper as compared to using urea as chemical fertilizer. Also, [22] indicated that application of vermicompost at 7 t/ha along with Jeevamrut (liquid manure at 3 % as foliar spray ) recorded the highest values of yield attributes (number of fruits per plant , average fruit weight , fruit yield /plot) and fruit yield/ha. of pepper and recorded (82.4) per cent increase in yield over control along.

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 26, Issue 1, 2022, Pages. 15 - 32
Received 08 November 2021; Accepted 15 December 2021.

**Fruit quality**

Fertilizing with vermicompost +FYM at 0.613+2.100 kg /$m^2$ and ammonium nitrate at 0.085 kg /$m^2$ increased total sugars (%) , vitamin C content and dry matter in fruits, compost at 3.617 kg /$m^2$ increased total soluble solids (TSS) in fruits ( Tables 7 to 10). Improvement in ascorbic acid content in pepper fruits with organic manure may be because of slow but continuous supply of all major and micro-nutrients, which might have helped in the assimilation of carbohydrates and in turn synthesis of ascorbic acid [47].Also, [27] showed that , the highest fruit quality parameters such as total soluble solids and vitamin-C in fruits were the obtained by 50% organic fertilizers + 50% mineral fertilizers + biofertilizers as comported to other treatments.

Spraying sweet pepper with compost tea at 10 ml/l significantly increased dry matter (%), TSS, total sugars (%) and vitamin C content in fruit ( Tables 7 to 10). DM%, TSS, total sugars and vitamin C in fruits increased with compost tea, vermicompost tea and mixture of nano micronutrients compared to control treatment.

The obtained results are in agreement with those reported by [27] spraying pepper plants with mixture of micronutrient gave the best results for TSS and ascorbic acid contents in fruits as compared to untreated plants. The best results for increasing TSS and total protein were recorded byzinc, Fe or Mn nano-fertilizer than without nano-fertilizer addition[23]. Also, [24] showed that TSS and ascorbic acid in fruits of chilli significantly increased with spraying plants by nano micronutrients at 0.50 g/l as compared to control treatment.

**Table 7.Effect of the interaction between nitrogen fertilization sources and foliar spray with some stimulants on DM(%) in fruits of sweet pepper under plastic houses conditions during 2020/2021 season**

| | **Compost tea** | **Vermicompost tea** | **Nano micronutrient** | **Water ( control)** | **Mean ( nitrogen sources (A)** |
|---|---|---|---|---|---|
| **Mineral nitrogen** | 19.70 a | 18.20 b-e | 15.30 h-k | 14.70 jk | 16.97 AB |
| **Compost** | 16.10 g-i | 18.33 b-d | 16.40 f-h | 15.07 i-k | 16.47 B |
| **Vermicompost** | 18.83 a-c | 18.23 b-d | 15.80 g-j | 14.23 k | 16.77 AB |
| **FYM** | 16.97 e-g | 14.50 k | 14.70 jk | 14.23 k | 15.10 C |
| **Vermicompost+FYM** | 19.40 ab | 17.77 c-e | 17.47 d-f | 14.57 jk | 17.30 A |
| **Mean (stimulants) B** | 18.20A | 17.40B | 15.93C | 14.56D | |

-Mineral nitrogen as ammonium nitrate = 0.085 kg /$m^2$, compost at 3.617 kg/$m^2$, vermicompost at 1.226 kg /$m^2$ , FYM at 4.202 kg /$m^2$ and FYM at 2.100 + vermicompost at 0.613 kg /$m^2$. -Compost tea at 10 ml/l, Vermicompost tea at 7.5 ml/l and mixture of nano micronutrients ( Magro Nano Mix) at 0.5 g/l .

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 26, Issue 1, 2022, Pages. 15 - 32
Received 08 November 2021; Accepted 15 December 2021.

**Table 8.Effect of the interaction between nitrogen fertilization sources and foliar spray with some stimulants on TSS (%) in fruits of sweet pepper under plastic houses conditions during 2020/2021 season**

| | Compost tea | Vermicompost tea | Nano micronutrient | Water ( control) | Mean ( nitrogen sources (A) |
|---|---|---|---|---|---|
| **Mineral nitrogen** | 12.80 b-f | 12.73 c-f | 12.35 ef | 11.40 h | **12.32 B** |
| **Compost** | 13.45 ab | 12.17 fg | 13.33 a-c | 12.55 d-f | **12.87 A** |
| **Vermicompost** | 13.55 a | 13.20 a-d | 12.80 b-f | 11.25 h | **12.70 A** |
| **FYM** | 12.98 a-e | 12.28 fg | 11.65 gh | 11.23 h | **12.03 B** |
| **Vermicompost+FYM** | 13.28 a-c | 12.45 ef | 12.17 fg | 11.03 h | **12.23 B** |
| **Mean (stimulants) B** | **13.21A** | **12.56B** | **12.46B** | **11.49C** | |

-Mineral nitrogen as ammonium nitrate = 0.085 kg /$m^2$, compost at 3.617 kg/$m^2$, vermicompost at 1.226 kg /$m^2$ , FYM at 4.202 kg /$m^2$ and FYM at 2.100 + vermicompost at 0.613 kg /$m^2$. -Compost tea at 10 ml/l, Vermicompost tea at 7.5 ml/l and mixture of nano micronutrients ( Magro Nano Mix) at 0.5 g/l .

The interaction between ammonium nitrate at 0.085 kg /$m^2$ and spraying with compost tea at 10 ml/l gave the highest values of DM (%), the interaction between vermicompost at 1.226 kg /$m^2$ and spraying with compost tea at 10 ml/l increased TSS contents , the interaction between vermicompost +FYM at 0.613+2.100 kg /$m^2$ and spraying with compost tea at 10 ml/l increased total sugars and vitamin C in fruits ( Tables 7 to 10). Obtained results may be due to the mineral nutrient and growth stimulants which positively affected on plant growth vigor and in turn increased fruit quality parameters.

These results are agreed with [22] indicated that fertilizing plants with vermicompost at 3.5 t/ha + FYM at 10 t/ha + spraying with vermicompost at 3 % gave the highest values of TSS and ascorbic acid content in sweet pepper fruits.

**Table 9.Effect of the interaction between nitrogen fertilization sources and foliar spray with some stimulants on total sugars (%) in fruits of sweet pepper under plastic houses conditions during 2020/2021 season**

| | Compost tea | Vermicompost tea | Nano micronutrient | Water ( control) | Mean ( nitrogen sources (A) |
|---|---|---|---|---|---|
| **Mineral nitrogen** | 6.27 a | 6.13 a | 5.93 ab | 5.43 c | **5.94 A** |
| **Compost** | 5.93 ab | 5.64 bc | 5.39 c | 4.84 de | **5.45 B** |
| **Vermicompost** | 5.62 bc | 5.35 c | 4.87 d | 4.69 de | **5.13 C** |
| **FYM** | 4.82 de | 4.36 ef | 4.09 f | 3.94 f | **4.30 D** |

| | | | | | |
|---|---|---|---|---|---|
| **Vermicompost+FYM** | 6.32 a | 6.17 a | 5.93 ab | 5.48 bc | **5.97 A** |
| **Mean (stimulants) B** | **5.79A** | **5.53B** | **5.24C** | **4.87D** | |

-Mineral nitrogen as ammonium nitrate = 0.085 kg /$m^2$, compost at 3.617 kg/$m^2$, vermicompost at 1.225 kg /$m^2$ , FYM at 4.20 kg /$m^2$ and FYM at 2.100 + vermicompost at 0.613 kg /$m^2$. -Compost tea at 10 ml/l, Vermicompost tea at 7.5 ml/l and mixture of nano micronutrients ( Magro Nano Mix) at 0.5 g/l .

**Table 10.Effect of the interaction between nitrogen fertilization sources and foliar spray with some stimulants on vitamin C ( mg/100 g juice) in fruits of sweet pepper under plastic houses conditions during 2020/2021 season**

| **Treatments** | **Compost tea** | **Vermicompost tea** | **Nano micronutrient** | **Water ( control)** | **Mean ( nitrogen sources (A)** |
|---|---|---|---|---|---|
| **Mineral nitrogen** | 159.30 ab | 156.53 a-d | 155.17 a-d | 132.57 f | **150.89 A** |
| **Compost** | 157.27 a-c | 155.07 a-d | 150.53 c-e | 133.83 f | **149.17 A** |
| **Vermicompost** | 152.10 b-d | 149.43 de | 143.27 e | 119.40 g | **141.05 B** |
| **FYM** | 96.37 h | 94.83 h | 93.87 h | 81.67 i | **91.69 C** |
| **Vermicompost+FYM** | 160.27 a | 158.03 ab | 155.07 a-d | 134.07 f | **151.86 A** |
| **Mean (stimulants) B** | **145.06A** | **142.78AB** | **139.58B** | **120.31C** | |

-Mineral nitrogen as ammonium nitrate = 0.085 kg /$m^2$, compost at 3.617 kg/$m^2$, vermicompost at 1.225 kg /$m^2$ , FYM at 4.20 kg /$m^2$ and FYM at 2.100 + vermicompost at 0.613 kg /$m^2$. -Compost tea at 10 ml/l, Vermicompost tea at 7.5 ml/l and mixture of nano micronutrients ( Magro Nano Mix) at 0.5 g/l .

## Conclusion

In conclusion, this work showed that satisfactory sweet pepper yield and quality, could be obtained in organic production systems under plastic house conditions using vermicompost as (100%) or vermicompost +FYM (50+50%) recommended rate of nitrogen and spraying with compost tea or vermicompost tea to reduce environment pollution caused by application of mineral fertilizers and sustain soil fertility.

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