Response of Zucchini Plants to Nano and Organic Fertilizers Application Grown in Sandy Soil

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Authors’ contributions
This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Nanotechnology and organic fertilization are represented the most important tools for agriculture and anticipated to become a driving economic force in the near future. Two field experiments were carried out on sandy soil at El Ismailia Research Station, Agriculture Research Center Egypt, to study the effects of application of nitrogen fertilizer, as black urea, Nano black urea and organic fertilizer FMY, nutrients and productivity of Cucurbita pepo L. Two rates of FMY at 50 and 100 m³ ha⁻¹ was applied to the soil with soil application of black urea and Nano black urea) with applied both as foliar application on plants. A split-plot design with four replications for each treatment was used, during the two summer seasons of 2019 and 2020. Results obtained showed that yield components of plants increased with applied Nano black urea and black urea accompanied with application both rates of FMY. The Nano black urea accompanied with FMY applied at a rate of 100 m³ ha⁻¹ give the highest yield values. However, effective treatment was foliar Nano black urea application with a rate of 0.5 ppm with organic fertilizer FMY at rate of 100 m³ ha⁻¹ and gave the highest significant values of fruits yield (300, 327, 342, 356 and 373 g plant⁻¹ for five times picked, respectively. On the other hands, in foliar application, fruits weight yield was higher than the first cut. Nutrients contents showed almost a trend as all parameters under study the superior treatment was at Nano black urea foliar application a rate of 0.5 ppm with 100 m³ ha⁻¹ of FMY with high availability of nutrients at the studied soil.
Keywords: Black urea; nano black urea; organic fertilizer; Zucchini plants and sandy soil.

1. INTRODUCTION

Regarding Nano fertilizer's effect on release nutrients and yield parameters of sage plants, Subbaiya et al. [1] indicated that the urea-modified (Nano) have been used in agriculture, because of their larger nitrogen use competence and slow availability of nitrogen to the soil, and perfect reutilization of nitrogen sources. So it has a good yield than other traditional fertilizers; Urea modified humic acid particle treated seed of plants showed a good germination of 100% across the yield while urea alone gives only 70% of seed germination. Nitrogen release was predestined by using nitrate estimation. Nitrate assessment of HA particle was calculated as 100 µg m⁻¹ whereas urea treated was calculated as 50µgµm⁻¹. Abyaneh and Maryam Varkeshi [2] indicated that the soil nitrate during the growing season of potato in Nano- Nitrogen Chelate (NNC), Sulphur Coated Nano- Nitrogen Chelate (SNNC), and Sulphur Coated Urea (SCU) fertilizers was 10.36%, 29.92%, and 23.95 % increased than Urea (U) fertilizer, respectively. Ekinci et al. [3] stated that the foliar application of nano fertilizers (Nanonat and Fer-banat) significantly improved the yield compared to control. The foliar applications of fertilizer solution maybe advance the plant growth and yield of plants.Use of 0.3% Humestim after soil fertilization with N, P, K increased the rate of photosynthesis, transpiration intensity, and content of photosynthetic pigments [4]. Foliar application is an integral part of root-feeding that one of the important factors in minimizing losses and rationalizing the high quantities of chemical fertilizers, so increasing the efficiency of the use of fertilizer that applied to the soil additional to its direct and rapid effect, [5].

Sanchary and Huq [6] black urea is proved as a better N fertilizer than white urea as far as the growth of yield, content of nutrient and cost-effectiveness in fertilizer application are concerned. As black urea is evidenced to show the best result if applied by following proper management practices and to fulfill the target of improved benefits and reduced costs. Reduction cost or farm inputs may be ensured by cutting off the usual application rate by 15-35%, a more effective source of N for crops at the same time more economical too.

Humic compounds have the potential back to increase the soil population potential, especially in the top layer of the root rhizosphere that creates substances that stimulate plant growth. Humic acid is a product of many elements which improve soil fertility and increase the 57 potential of nutrient elements by holding them on mineral surfaces and, consequently, affect Plant growth and yield. Richness, plant physiology, and ecological sciences, as the many roles played by these substances, can greatly develop plant growth and nutrient absorption [7,8]. Complete replacement of mineral nitrogen fertilization by chicken manure was associated with slow plant growth and early flowering which reflected in smaller fruit and lower production. Under conditions of this study, additional treatments of soaking squash seed in garlic extract and spraying squash seedlings with ethrel as sex ratio modulating treatments stimulate plant growth increased female flowers ratio. That, resulted in improving mean fruit weight and yield production [9]. Additions of organic matter for improving soil quality and supplying the soil properties, nutrition, and microbiology needed for enhanced crop performance and yield in organic vegetable production. They provide information on specific management practices and approaches to help improve the sustainability and productivity of organic vegetable production [10].

The objectives of this investigation to study the levels effect of organic fertilization as farm yard manure and black urea NPs on sandy soil, on growth and yield in Zucchini plants by foliar spraying and soil application.

2. MATERIALS AND METHODS

These field experiments carried out on sandy soil during the two successive summer seasons of 2019 and 2020 at El Ismailia Agric. Res. Farm Agric. Res. Center El Ismailia Governorate, Egypt.

The main physical and chemical soil properties of the experimental field were determined according to the methods described by Klute [11] and Page et al. [12], and data are given showed in Table 1.

For preparation of nano-particles, black urea was ground to fine powder and passed through a sieve 0.25 mm and the passing powder was re-ground to obtain the desirable sized nano-particles. Nano-materials are commonly referred to as small objects with one or more external dimensions in the size range of 1-100 nm. Materials with these nano-sized dimensions, exhibit a distinctive behavior in comparison to larger sized particles of same composition [13]. black urea powders as mono
pantiles were examined for size characterization under transmission electron microscopy (TEM) HRTEM, JEOL 3010.

The main chemical properties of farmyard manure applied used in the experimental field were found in Table 2.

2.1 Layout of Experiment

The experiment was laid-out on area of 409.5 m$^2$, (with an area of each plot was 10.5 m$^2$) in factorial randomized complete block design in split-plot arrangement with four replications. The studied treatments, as detailed below, included foliar spraying and soil applications in addition to recommended NPK rates, as control.

The total number of Zucchini plants (*Cucurbita pepo* L.) was 20,000 ha$^{-1}$. The plants were fertilized by 200 kg ha$^{-1}$ N as Urea (46% N), 200 kg ha$^{-1}$ N as Black-Urea (46% N), 150 kg ha$^{-1}$ K$_2$O as potassium sulfate (50% K$_2$O) 100 kg ha$^{-1}$ P$_2$O$_5$ as superphosphate according (15% P$_2$O$_5$), and based on the Ministry of Agriculture and Land Reclamation (Egypt). Data in Table (2) recorded the main chemical properties of the FYM while applied at two rates 50 and 100 m$^2$ ha$^{-1}$. All the amount of P and organic manure fertilizers was added before cultivation, nitrogen fertilizer urea of control treatment was applied in the same times of added the 75% black urea at150 kg ha$^{-1}$ and 75% of black urea NPs at 2.8125 kg ha$^{-1}$ for soil application were added at three equal doses (2 weeks after germination, 30 and 45 days after cultivation. All other recommended agriculture practices were taken according to the recommendations. On the other hand, foliar treatments were applied at four times at 2 weeks after germination, 30, 45 and 60 days after cultivation with a rates of 2 gm L$^{-1}$ black urea and 0.5 gm l$^{-1}$ of black urea NPs.

**Table 1. Some physical and chemical properties of Ismailia soil**

| Soil characteristics       | Value | Soil characteristics       | Value |
|---------------------------|-------|---------------------------|-------|
| Particle size distribution |       | Soluble cations (soil paste mmol$^{-1}$ l$^{-1}$) |       |
| Coarse sand               | 62.79 | Ca$^{2+}$                  | 3.20  |
| Fine sand                 | 29.68 | Mg$^{2+}$                  | 2.20  |
| Silt                      | 3.40  | Na$^+$                     | 1.70  |
| Clay                      | 4.22  | K$^+$                      | 2.10  |
| Textural class            | Sandy |                           |       |
| pH (1:2.5 soil: water suspension) | 7.58 | Soluble anions (soil paste, mmol$^{-1}$ l$^{-1}$) |       |
| ECE (dSm$^{-1}$, soil paste extract) | 0.92 | CO$_3^{2-}$                | 0.00  |
| CaCO$_3$ %                | 0.28  | HCO$_3^{-}$                | 2.20  |
| Organic matter %          | 0.28  | Cl$^-$                     | 4.00  |
|                           |       | SO$_4^{2-}$                 | 3.00  |

**Table 2. Some chemical properties of farmyard manure fertilizer**

| Soil application                  | Foliar application                  |
|-----------------------------------|-------------------------------------|
| NPK (control treatment)           | NPK (control treatment)             |
| Black U +PK                       | Foliar Black U +PK                  |
| Black U-NPs PK                    | Foliar Black U-NPs PK               |
| 75% Black U-NPs PK + FYM 50 m$^2$ ha$^{-1}$ | Foliar **Black U-NPs PK + FYM 50 m$^2$ ha$^{-1}$ |
| 75% Black U-NPs PK + FYM 50 m$^2$ ha$^{-1}$ | Foliar Black U-NPs PK + 50 m$^2$ ha$^{-1}$ |
| 75% Black U- PK + FYM 100 m$^2$ ha$^{-1}$ | Foliar Black U- PK + FYM 100 m$^2$ ha$^{-1}$ |
| 75% Black U-NPs PK + FYM 100 m$^2$ ha$^{-1}$ | Foliar Black U-NPs PK + FYM 100 m$^2$ ha$^{-1}$ |

*Black U means black urea, **NPs means nanoparticles*
2.2 Plant Growth Parameters and Methods of Analysis

Fruit weight plant$^{-1}$ and harvested fruit ton ha$^{-1}$ were recorded according to Bremner and Taha [14]. Samples of leaves and fruits were dried, ground and wet digested; and the digested product was used for determining N content using micro-Kjeldahl according method described by Chapman and Pratt. [15] Phosphorus was calorimetrically determined according to Watanabe and Olsen, [16] and potassium was determined using flame photometer according for AOAC [17] and micronutrients were determined according to method described by Jackson (1973) and AOAC [18] using Atomic Absorption Spectrophotometer (Analytikjena nova 350).

2.3 Soil Analysis

Soil samples were collected, air-dried, gently ground and passed through a 2 mm sieve to determine particle size distribution, organic matter, pH using electrodes pH-meter, electrical conductivity of the saturated extract of soil paste, water soluble cations and anions were determined in the extract of the saturated soil paste and available N, P and K according to methods described by Page et al. [12]. Fe, Mn, and Zn were extracted by DTPA according to Soltanpour and Schwab [19] and were determined by using Atomic Absorption Spectrophotometer.

2.4 Statistical Analysis

All data were subjected to the analysis of variance (ANOVA) using CoStat version 6.3.11. Comparison of treatment means was using the Duncan's test at 0.05 level of significance [20].

3. RESULTS AND DISCUSSION

3.1 Some Soil Characteristics and Available Nutrients

The effect of nitrogen sources, as farm yard manure (FYM) applied at two rates and foliar nitrogen sources on soil properties and the detectable nutrients at the maximum growth stage are given in Table 3. Results showed that soil pH values were slightly decreased due to the application of either Black U or Black U NPs as foliar without organic manure in comparison with control. On the other hand, high rate of FYM with Black U NPs as soil addition was superior effect in decreasing soil pH values at both studied seasons may be due to the organic components, acid compounds as humic, amino and fulvic acids most stable organic compounds, contain a relatively large number of functional groups (OH, COOH, SH) [21], that released true in the two seasons of growth. Data depicted in Table (3) showed that the soil organic matter was significantly increased by the addition of different treatments under study, being the high values due to may be applied FYM and low application of foliar Black U + PK treatment. While the control was lowest one. The increase in soil organic matter associated with the added farm yard manure at rate of 100 m$^3$ha$^{-1}$ and accompanied with black urea as soil addition reached to 0.56 and 0.42 as soil treatment and 0.49 and 0.38 % as foliar one in at 60 days and last cut in both of two seasons, respectively. On the other hand, the average was increasing reached 56.67, 23.33% with soil application and to 33.33, 10.0% with foliar application compared with control, at the two seasons, respectively and the reason may be due to increases the solubility and mobility of metal ions.

When manure is applied to soil, the plant-availability of nutrients may increase due to mineralization or decrease due to immobilization, depending on the soil and manure properties, included soil textured and soil organic matter content. Data presented in Table 3 and 4 showed significant increasing of available macro and micronutrients in soil by applied treatments (as soil application or foliar application) in compared to control treatment). The results in Table 3 investigated that after 60 days of cultivation the available nitrogen, phosphorus, potassium, Iron, Manganese and Zinc were recorded 132.67, 6.32, 463.20, 2.67, 0.90 and 0.65 mg.kg$^{-1}$ soil by the treatment 75% of black urea NPs + FYM at rate of 100 m$^3$ ha$^{-1}$ that was significantly higher as compared to other treatment combination. On the other hand, the applied black urea NPs a rate 0.5 gm L$^{-1}$ foliar with FMY a rate 100 m$^3$ ha$^{-1}$ showed efficacy clearly comparing for experiment followed treatments, in soil at layer 0-30 cm increased available of N, P, K, Fe, Mn and Zn values of 96.33, 3.81, 306.00, 2.10, 078 and 0.63, mg.kg$^{-1}$ soil respectively, at 60 days of plants cultivation in the two seasons respectively, the inference of this finding is that the N supply from Nano source available for a longer time compared with the conventional N-fertilizers. The previous results seem to be supported by those obtained by [22,23].

Regard to nutritional status, data showed in Table 3 that the available nitrogen, phosphorus, potassium, iron, Manganese and Zinc increased
may be due to increase in applied rates of FYM fertilizer and nitrogen source, which is increased the residues into soil and may be concluded from trial that the various level from different sources in the experiment, the treatment combination 75% of black urea NPs + FYM at rate 100 m³ ha⁻¹ was found to be more effect to improvement the chemical properties of soil.

3.2 Post-harvest Soil Nutritional Status of Soils

After harvest, the contents of available N, P, K, Fe, Mn, Zn, and content of organic matter for mixed fertilizer treatments all was significantly higher than of the control treatment. Data present in Table 4 showed that the application of black urea with FYM led to decreasing in soil pH values compared with the same treatments at 60 days of cultivation as affected by factors i.e. micro-organisms activities and acids which, release from decomposition of manure and black urea. Also, data in Table 4 demonstrated organic matter content in soil showed decreased value compared with the same treatments at 60 days for cultivation, this may be back to organic manure was break down and its decomposition. On the other hand, data in Table 4 showed significant increasing in available all nutrients under studied, also, results observed that the black urea NPs and farm yard manure led to more increasing soil nutrients availability, may be due to the decomposition of organic manure, which affected the solubility and mobility of nutrient to plants. The increasing of available N, P, K, Fe, Mn and Zn in soil at post-harvest was recorded by applied treatment a rate of 75% of black urea NPs + FYM at rate of 100 m³ ha⁻¹ and recorded values of 89.00, 4.37, 259.70, 1.67, 70 and 0.65 mg.kg⁻¹ soil, respectively of soil application and 60, 3.71, 242.90, 1.26, 0.57 and 0.51 mg.kg⁻¹ soil. As foliar application in the two seasons continuous application fertilizer led to increase the content of soil organic carbon, nitrogen and other nutrients compared with no application and improve soil productivity Rengel, Z. 2015, [24,25,26,27].

Faintly, the experiment data showed positive effects of organic manure on available contents of nutrients in soil and followed a descending order organic manure at rate FYM 100 m³ ha⁻¹ + Black U or Black U NPs as soil application > organic manure at rate of FYM 50 m³ ha⁻¹ + Black U or Black U NPs as soil application > FYM a rate of 100 m³ ha⁻¹ + Black U or Black U NPs as foliar application > organic manure at rate of FYM 50 m³ ha⁻¹ + Black U or Black U NPs as soil application > FYM a rate of 100 m³ ha⁻¹ + Black U or Black U NPs as foliar application > control. This may be ascribed to decompositions activation which increased the released nutrients from organic substances in soil into available forms. Simple organic compounds such as amino acids, hydroxy acids and also phosphoric acids are effective in complexing metals, thus increasing its mobility and solubility in soils [28].

3.3 Yield Parameters of Plant

Data in Table 5 showed that yield of plants increased with the increasing of Nano black urea and application rates during cuts. The mineral treatments with organic fertilizer gave greater yield values than that without applying organic fertilizer. Also, data revealed that foliar application treatments gave high yield than applied treatments as soil. On the other, illustrated data shown highly significant effect with applied foliar treatments. The most effective treatment foliar Nano black urea with organic one FYM and gave highest significant values of yield reached to 255, 269, 278, 320 and 344 gm. plant⁻¹ for soil addendum 300, 327, 342, 356 and 373 gm. Plant⁻¹ with foliar applied (gm plant⁻¹), respectively. The highest yield of last cut was 71.1% was obtained with high application foliar treatment 0.5gL⁻¹ Black U-NPs PK + FYM 100 m³ ha⁻¹. In comparison between the control and last cutting of fruits yield of plant was higher in the next cut than the first cut. This result may be due to the residual effect of treatments used in the next cut and the probable due to utilization of N in the form of N urea as N released slowly for the entire growth period leading to higher photosynthetic rate and finally more accumulation of biomass yield. also, yield cut gm plant⁻¹ increased with increased in foliar spraying number on plants. ([29,30,31].

3.4 Nutrient Contents of Plant Leaves and Fruits Cuts

Data in Table 6 showed that the increased values of N content of zucchini plants during the fruits cuts increased with increasing the application rates of Nano black urea, black urea and FYM application rates. The P and K content showed increases with rates of Nano black urea and black urea fertilizers compared with N content. The treatment of Nano black urea with organic fertilizer at FYM 100 m³ ha⁻¹ recorded significant effect on nutrient content of N, P, K, Fe, Mn and Zn when compared with other studied treatments.
Table 3. Soil pH, organic matter and available nutrients content affected by fertilizers application after 60 days

| Treatments                      | pH  | MO  | NO$_3$ | NH$_4$ | P    | K    | Fe   | Mn   | Zn   |
|---------------------------------|-----|-----|--------|--------|------|------|------|------|------|
| **Soil application**            |     |     |        |        |      |      |      |      |      |
| NPK                             | 7.57| 0.30a| 36.78a | 26.67a | 2.65a| 189.40a | 0.62a | 0.42a | 0.34a|
| Black U+PK                      | 7.46| 0.34a| 40.76b | 30.23b | 4.29b| 284.50b | 0.70b | 0.50b | 0.36a|
| Black U-NPs +PK                | 7.42| 0.37b| 44.33c | 33.10c | 4.73c| 307.40c | 0.77c | 0.55c | 0.40b|
| 75% Black U PK +FYM 50 m$^3$ha$^{-1}$ | 7.29| 0.49c| 56.83d | 36.66d | 5.76d| 418.40d | 1.43d | 0.70d | 0.48c|
| 75% Black UNPs PK+FYM 50 m$^3$ha$^{-1}$ | 7.25| 0.54d| 67.00e | 40.67e | 5.89e| 436.10e | 1.67e | 0.77e | 0.55e|
| 75% Black UPK + FYM 100 m$^3$ha$^{-1}$ | 7.20| 0.51c| 72.67f | 46.67f | 6.07f| 436.40f | 2.13f | 0.84f | 0.60f|
| 75% Black UNPs PK + FYM 100 m$^3$ha$^{-1}$ | 6.90| 0.56e| 80.67g | 52.00g | 6.32g| 463.20g | 2.67g | 0.90g | 0.65g|
| **Foliar application**         |     |     |        |        |      |      |      |      |      |
| NPK                             | 7.57| 0.30a| 36.78a | 26.67a | 2.65a| 189.40a | 0.62a | 0.42a | 0.34a|
| Black U +PK                     | 7.55| 0.30a| 30.50b | 26.88a | 2.97b| 190.40b | 0.63a | 0.43a | 0.36a|
| Black U-NPs +PK                | 7.54| 0.32a| 34.33c | 29.14b | 3.42c| 217.40c | 0.65a | 0.44a | 0.37a|
| Black U- PK + FYM 50 m$^3$ha$^{-1}$ | 7.50| 0.40d| 37.00d | 31.00d | 3.71d| 268.54d | 1.05b | 0.60b | 0.46b|
| Black UNPs PK + FYM 50 m$^3$ha$^{-1}$ | 7.48| 0.43e| 42.00e | 33.33c | 3.94e| 272.10e | 1.16c | 0.67c | 0.53c|
| Black U PK + FYM 100 m$^3$ha$^{-1}$ | 7.45| 0.47f| 50.67f | 36.67d | 3.65f| 297.40f | 1.89e | 0.72d | 0.57d|
| Black UNPs PK + FYM 100 m$^3$ha$^{-1}$ | 7.41| 0.49f| 56.33g | 40.00e | 3.81g| 306.00g | 2.10f | 0.78e | 0.63e|
| **Mean**                        | 0.44| 38.00| 5.10   | 362.20 | 1.43 | 0.67  | 0.48 |

Means in a column followed by the same letter(s) are not significantly different at LSD ≤ 0.05 based on Duncan’s.
Table 4. Soil pH, organic matter and available nutrients content in different treatments after fruit at harvest

| Treatments                        | pH    | MO % | NO₃⁻ | NH₄⁺ | P     | K     | Fe     | Mn     | Zn     |
|-----------------------------------|-------|------|-------|-------|-------|-------|--------|--------|--------|
| Soil application                  |       |      |       |       |       |       |        |        |        |
| NPK                              | 7.53  | 0.27a| 20.00a| 10.33a| 2.75a | 176.54a| 0.64a  | 0.34a  | 0.34a  |
| Black U +PK                      | 7.44  | 0.30b| 36.27b| 16.16b| 2.09b | 200.20b| 0.70b  | 0.38b  | 0.36b  |
| Black U-NPs + PK                 | 7.40  | 0.32b| 41.12c| 16.22c| 3.12c | 224.60c| 0.85c  | 0.41c  | 0.40c  |
| 75 % Black U PK + FYM 50 m⁻ha⁻¹  | 7.15  | 0.38c| 51.67d| 20.00d| 4.00d | 245.50d| 0.93d  | 0.50d  | 0.48d  |
| 75 % Black UNPs PK + FYM 50 m⁻ha⁻¹| 7.00  | 0.40d| 57.33e| 24.67e| 4.24e | 238.40e| 1.17e  | 0.57e  | 0.55e  |
| 75 % Black UPK + FYM 100 m⁻ha⁻¹ | 6.89  | 0.39c| 61.00f| 26.67f| 4.19f | 241.00f| 1.13f  | 0.64f  | 0.60f  |
| 75 % Black UNPs PK + FYM 100 m⁻ha⁻¹| 6.82  | 0.42e| 60.33g| 28.67g| 4.37g | 259.70g| 1.67g  | 0.70g  | 0.65g  |
| Mean                             | 0.35  | 45.82| 20.39 | 3.54  | 226.56| 0.91   | 0.50   | 0.48   |
| Foliar application               |       |      |       |       |       |       |        |        |        |
| NPK                              | 7.53  | 0.27a| 20.00a| 10.33a| 2.75a | 176.54a| 0.64a  | 0.34a  | 0.34a  |
| Black U +PK                      | 7.53  | 0.28a| 10.00b| 16.33b| 2.97b | 179.87a| 0.67b  | 0.35a  | 0.35a  |
| Black U-NPs + PK                 | 7.53  | 0.29a| 26.67c| 16.67c| 3.07c | 207.00b| 0.69b  | 0.36a  | 0.37a  |
| Black U- PK + FYM 50 m⁻ha⁻¹      | 7.49  | 0.32b| 23.33d| 20.00c| 3.51d | 216.00c| 0.85c  | 0.42d  | 0.40b  |
| Black UNPs PK + FYM 50 m⁻ha⁻¹    | 7.46  | 0.35c| 26.33e| 24.67d| 3.94e | 228.20d| 0.96d  | 0.49e  | 0.44c  |
| Black U PK + FYM 100 m⁻ha⁻¹      | 7.45  | 0.36c| 28.00f| 26.67e| 3.65f | 235.80e| 1.19e  | 0.51f  | 0.47d  |
| Black UNPs PK + FYM 100 m⁻ha⁻¹   | 7.41  | 0.38d| 32.00g| 28.00f| 3.71g | 242.90f| 1.26f  | 0.57g  | 0.51f  |
| Mean                             | 0.32  | 23.76| 20.38 | 3.37  | 212.33| 0.89   | 0.43   | 0.41   |

Means in a column followed by the same letter(s) are not significantly different at LSD ≤ 0.05 based on Duncan's.
| Treatments                              | Weight cuts fruits (gm plant⁻¹) | Weight cuts fruits (t ha⁻¹) |
|----------------------------------------|---------------------------------|-----------------------------|
|                                        | No. of cuts                      |                            |
|                                        | 1 | 2 | 3 | 4 | 5 | Mean | 1  | 2 | 3 | 4 | 5 | mean |
| **Soil application**                   |   |   |   |   |   |      |    |   |   |   |   |      |
| NPK                                    | 168a | 176a | 205a | 212a | 218a | 195.8 | 3.36a | 3.58a | 4.10a | 4.24a | 4.36a | 3.93 |
| Black U +PK                            | 189b | 200b | 212b | 266b | 274b | 228.2 | 3.78b | 4.00b | 4.24b | 5.32b | 5.48b | 4.56 |
| Black U-NPs + PK                       | 200c | 217c | 228c | 270c | 280c | 239.0 | 4.00c | 4.34c | 4.56c | 5.40c | 5.60c | 4.78 |
| 75 % Black U- PK + FYM 50 m⁻¹ha⁻¹      | 215d | 223d | 244d | 287d | 300d | 253.8 | 4.30d | 4.46d | 4.88d | 5.74d | 6.00d | 5.08 |
| 75% Black U-NPs PK + FYM 50 m⁻¹ha⁻¹    | 244e | 251e | 262e | 301e | 326e | 276.8 | 4.88e | 5.02e | 5.24e | 6.02e | 6.52e | 5.54 |
| 75 %Black U.PK + FYM 100 m⁻¹ha⁻¹       | 239f | 247f | 256f | 300f | 319f | 272.2 | 4.78f | 5.02e | 5.40e | 6.02e | 6.52e | 5.54 |
| 75% Black U.NPs PK+ FYM 100 m⁻¹ha⁻¹    | 255g | 269g | 278g | 320f | 344g | 293.2 | 5.10g | 5.38g | 5.56g | 6.40f | 6.88g | 5.86 |
| Mean                                   | 215.71 | 226.14 | 240.7 | 279.4 | 294.4 | 218.0 | 4.314 | 4.531 | 4.814 | 5.59  | 5.89  |      |
| **Foliar application**                |   |   |   |   |   |      |    |   |   |   |   |      |
| NPK                                    | 168a | 176a | 205a | 212a | 218a | 195.8 | 3.36a | 3.58a | 4.10a | 4.24a | 4.36a | 3.93 |
| Black U +PK                            | 191b | 215b | 225b | 238b | 250b | 223.8 | 3.82b | 4.30b | 4.50b | 4.76b | 5.00b | 4.48 |
| Black U-NPs + PK                       | 223c | 234c | 254c | 293c | 310c | 262.8 | 4.46c | 4.68c | 5.08c | 5.86c | 6.20c | 5.23 |
| Black U- PK + FYM 50 m⁻¹ha⁻¹           | 250d | 260d | 276d | 315d | 334d | 287.0 | 5.00d | 5.20d | 5.52d | 6.30d | 6.88d | 5.74 |
| Black U-NPs PK + FYM 50 m⁻¹ha⁻¹        | 283e | 308e | 330e | 348e | 361e | 326.0 | 5.66e | 6.16e | 6.60e | 6.96e | 7.22e | 6.52 |
| Black U- PK + FYM 100 m⁻¹ha⁻¹           | 276f | 296f | 326e | 344e | 357e | 319.8 | 5.52f | 5.92f | 6.52f | 6.88e | 7.14e | 6.40 |
| Black U-NPs PK + FYM m⁻¹ha⁻¹           | 300g | 327g | 342f | 356f | 373f | 339.6 | 6.00g | 6.54g | 6.84g | 7.12f | 7.46f | 6.79 |
| Mean                                   | 218 | 234 | 250 | 271 | 284 | 4.83 | 5.20 | 5.59 | 6.02 | 6.29 |      |

Means in a column followed by the same letter(s) are not significantly different at LSD ≤ 0.05 based on Duncan's.
Table 6. Macro and micro-nutrients content of fruits and leaves affected by fertilizers and application methods

| Treatments                  | Leaves   | Fruits   |
|-----------------------------|----------|----------|
|                            | N        | P        | K        | Fe       | Mn       | Zn       | N        | P        | K        | Fe       | Mn       | Zn       |
|                            | %        | mg kg⁻¹ (D.W) | %        | mg kg⁻¹ (D.W) |
| Soil application            |          |          |          |          |          |          |          |          |          |          |          |          |
| NPK                         | 2.86a    | 0.30a    | 2.58a    | 197a     | 28a      | 20a      | 2.84a    | 0.23a    | 1.19a    | 181a     | 31a      | 18a      |
| Black U +PK                 | 3.71b    | 0.32a    | 3.12b    | 215b     | 31b      | 23b      | 2.88a    | 0.24a    | 1.22b    | 188b     | 40b      | 21b      |
| Black U-NPs + PK            | 3.82c    | 0.37b    | 3.28c    | 225c     | 34c      | 27c      | 3.21b    | 0.28b    | 1.92c    | 204c     | 45c      | 24c      |
| 75 % Black U- PK + FYM 50 mha⁻¹ | 4.92d  | 0.43c    | 3.82d    | 231d     | 41d      | 31d      | 4.88c    | 0.39c    | 3.49d    | 222d     | 45c      | 28d      |
| 75 % Black U-NPs PK + FYM 50 mha⁻¹ | 5.44e | 0.49d    | 4.17e    | 245e     | 45d      | 33d      | 4.97d    | 0.41d    | 3.50d    | 238e     | 47d      | 32e      |
| 75 % Black U- PK + FYM 100 mha⁻¹ | 5.49e  | 0.51d    | 4.31f    | 237d     | 43d      | 28c      | 3.87e    | 0.39c    | 3.15e    | 232f     | 48d      | 31e      |
| 75 % Black U-NPs PK + FYM 100 mha⁻¹ | 5.64f | 0.57e    | 4.66g    | 248e     | 48e      | 35g      | 5.26f    | 0.44e    | 4.24f    | 242g     | 53e      | 33e      |
| Mean                        | 4.55     | 0.43     | 3.71     | 228.29   | 38.57    | 28.14    | 3.99     | 0.34     | 2.67     | 215.29   | 44.14    | 26.71    |
| Foliar application          |          |          |          |          |          |          |          |          |          |          |          |          |
| NPK                         | 2.86a    | 0.30a    | 2.58a    | 197a     | 28a      | 20a      | 2.84a    | 0.23a    | 1.19a    | 181a     | 31a      | 18a      |
| Black U +PK                 | 3.91b    | 0.35b    | 3.22b    | 210b     | 27a      | 24b      | 3.81b    | 0.35b    | 2.85b    | 190b     | 43b      | 20b      |
| Black U-NPs + PK            | 4.11c    | 0.42c    | 3.54c    | 228c     | 29a      | 29c      | 3.94c    | 0.39c    | 3.02c    | 203c     | 46c      | 24c      |
| Black U- PK + FYM 50 mha⁻¹ | 5.22d    | 0.48d    | 4.19d    | 237d     | 35b      | 34d      | 5.23d    | 0.44d    | 4.21d    | 219d     | 48c      | 27d      |
| Black U-NPs PK + FYM 50 mha⁻¹ | 5.53e  | 0.50e    | 4.37e    | 245e     | 38c      | 37e      | 5.45e    | 0.45e    | 4.32e    | 231e     | 51d      | 33e      |
| Black U- PK + FYM 100 mha⁻¹ | 5.52e    | 0.49f    | 4.59f    | 241e     | 39c      | 38e      | 5.53f    | 0.49f    | 4.33f    | 242f     | 54e      | 31f      |
| Black U-NPs PK + FYM 100 mha⁻¹ | 5.74f | 0.53g    | 4.91g    | 255f     | 43e      | 41f      | 5.77g    | 0.52g    | 4.46g    | 237g     | 57f      | 35e      |
| mean                        | 4.70     | 0.44     | 3.91     | 230.43   | 34.14    | 31.86    | 4.67     | 0.41     | 3.48     | 214.71   | 47.14    | 26.86    |

Means in a column followed by the same letter(s) are not significantly different at LSD ≤ 0.05 based on Duncan’s
The application of organic N fertilizer gave higher nutrients content in leaves of zucchini plants and black urea with organic N fertilizer treatment was the next effect on nutrient content. The comparison effect between the first and next cutting on nutrient content of leaves, the next cutting was the best content. These results could due to the Nano particles can be adsorbed by soil colloids, thereby reducing losses and there releasing into the soil solution slowly. The above results agreed with those obtained by [28,32].

Concerning the data in Table (6) showed that the high nutrients content in zucchini leaves and fruits by applied foliar spraying fertilization treatments on the leaves of plants comparison with soil fertilization, the increased in leaves were obtained reached to 56.64, 40, 41.09, 23.84, 36.36 and 17.31% for N, P, K, Fe, Mn and Zn with soil applications, and 75.17, 76.67, 58.91, 38.43, 50, 26.92% for N, P, K, Fe, Mn and Zn with applied foliar spraying, respectively. While, fruits nutrients N, P, K, Fe, Mn and Zn content by soil applications reached at (44.89, 47.83, 124.37, 28.88, 41.94 and 29.31%) and 69.34, 78.26, 192.44, 31.61, 51.61 and 32.76% for applied foliar spraying fertilization treatments, respectively. These results are in harmony with investigate of (33).

Regard to fruits nutrients content of N, P, K, Fe, Mn and Zn the value was reached to 44.89, 47.83, 124.37, 28.88, 41.94 and 29.31 mg.kg⁻¹ by soil applications, and 69.34, 78.26, 192.44, 31.61, 51.61 and 32.76 mg.kg⁻¹ for applied foliar spraying. These results are in harmony with investigate of (34).

4. CONCLUSIONS

FMV manure influenced many factors, on some soil properties, as pH, O.M% and nutrients content and manure characteristics, also, mixed black urea NPs + manure increased the effectivity of manure application and foliar application increased zucchini fruits crop and nutrients content. Foliar 0.5 gm L⁻¹ Black U-NPs PK + FYM 100 m⁻² treatment recorded a high yield of zucchini fruits compared with all treatments used under conditions of soil experiment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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