Residual Effects of Organic Manure on Onion Varieties’ Mineral Content

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A B S T R A C T

This study was conducted to determine the residual effects of chicken manure applications on nutrients in leaves and bulbs of second crop onion that grown after lettuce in greenhouse conditions. In the study, residual effects of chicken manure in 4 different doses (control, 20 t ha⁻¹, 40 t ha⁻¹, 60 t ha⁻¹) and chemical fertilizers applied in the recommended amounts are investigated. Three onion varieties, called Burgaz, Snow white, Champion, were used. In the study, the lowest nutrient uptake was observed in control. However, the highest mineral content in leaves and bulbs were determined in the plots, that on average 40 t ha⁻¹ chicken manure was applied to. In terms of leaf nutrient content, when the varieties were compared to each other, Ca, Mg, and Cu contents were found to be the highest in the Burgaz variety. Phosphorus, Zn, Mn contents were analyzed to be the highest in Snow white while N values determined maximum in Champion. The Champion variety contained higher nutrient values in bulbs.

Introduction

Organic manure is essential for the sustainability of crop production and soil fertility. At the same time, its agricultural input is used in organic farming, which is preferred for a healthy life and environmental awareness (Eleroglu and Korkmaz, 2016). Organic material such as chicken manure improves soil’s physical, chemical, and biological properties that are important for plant growth (Snyman et al., 1998). The decomposition of materials would provide additional nutrients to the growing medium, which may lead to higher uptake of nutrients by the crop and subsequently to high yield. Besides, organic manures have a positive effect on root growth by improving the root rhizosphere conditions (such as structure and humidity), and also plant growth is encouraged by increasing the population of microorganisms (Shaheen et al., 2007; Kidanu, 2017). The organic fertilizers hold plant nutrients that promote enzymes and hormones, besides plant nutrients make them necessary for the enhancement of soil fertility and production (Bhuma, 2001). Organic manure added to soil leaves a substantial amount of residual nutrients to succeed crop. Besides, it is supplying nutrients to the current crop (Suthamathy and Seran, 2013). Some studies have reported that organic manures have significant residual effects on the soil and preceding crop (Yoldaş et al., 2019; Yoldaş et al., 2020). According to Aydeniz et al. (1977), Aydeniz and Brohi (1991), 65% of N, 50% of P, and 75% of K in poultry manure have become available within the first year application. In another study, Whitmore (2007) found that 40% of the total N from composted chicken manure was available in the first year, with the remainder available in subsequent years at a rate of 6% to 12% per year.

A residual effect of manure application study has reported where excessive rates of manure are applied (Lund and Doss, 1980). Ginting et al. (2003) did not find increased emission of greenhouse gasses (CO₂, CH₄, and N₂O) as a result of residual manure and compost applications that ceased 4 year earlier.

Onion bulb is a rich source of minerals like P, Ca, Mg, Fe, Mn, and carbohydrates. It also contains protein, Vitamin C, Vitamin B6, and antioxidants.

Onions are produced in our country as widely as possible According to the statistics; Turkey’s bulb onion production is 1930695 tons over 53000 hectare area (Anonymous, 2018).

The objective of this study is to evaluate the residual effects of different doses of chicken manure on second crop onion (Allium cepa L.) varieties’ mineral and sucrose, fructose, glucose content in the in the greenhouse condition.
Materials and Methods

The study was carried out in the greenhouse condition at the Ödemiş Vocational School of the Ege University, in İzmir (38°16’N, 27°59’E) during the year 2017. The experimental designs were split plot with three replications. Before sowing of lettuce, the chicken manure was applied to the soil at the rates of 0 – 20 – 40 - 60 t ha⁻¹ and also recommended dose of NPK (150:100:150 kg ha⁻¹). Five different treatments with control and three replications were conducted in 15 plots. Lolla Rossa variety of lettuce was sown and harvested at the end of vegetation. After harvesting the lettuce plant, onion varieties were sown in order to determine the residual effects of chicken manure and chemical fertilizer in the greenhouse conditions. No nutrient addition was made to chicken manure was applied to plots. In this study, during the growth period, weeds were removed by hand hoeing, and irrigation was done regularly.

Three onion varieties called Burgaz, Snow white, Champion were used. *Allium cepa* L., was planted in each plot with 30 cm between rows and 15 cm above the rows. The total plot length is 11.5 m, and the plot width is 6.2 m.

Soil samples (0-20 cm) were collected from the individual experimental plots (15 samples) at the beginning of onion vegetation. The sample was air-dried, ground and passed through a 2 mm sieve for the determination of chemical parameters (Kacak, 1984).

Some physical and chemical characteristics of soils, determined by standard analytical methods specified in Klute (1986) and Page et al. (1982). Available K, Ca, Na, flame photometer (Eppendorf) and Mg, Fe, Zn, Mn, Cu by atomic absorption spectrophotometer (AAS; Varian AA 240 FS) (Lindsay and Norvell, 1978; Atalay et al., 1986). Leaf samples were taken before the onion bulbs became not to the stage of maturity as the youngest leaves for chemical analyses (Jones et al., 1991). After the leaf and bulb samples were taken from plots, and dried in 70°C, ready for analyses (Kacak, 1972). In the study, total nitrogen was analyzed according to the modified method of Kjeldahl (Bremner, 1965). After the wet digestion of samples, the phosphorus content was determined by the colorimetric method (Lott et al., 1956). Potassium, calcium, and sodium contents were analyzed by flame fotometer; Mg, Fe, Zn, Mn, and Cu amount were measured by the AAS (Munoz, 1968; Kacak, 1972). The trial statistical evaluation result of data was done using software package TARIST (Acikgoz et al., 1993).

Results and Discussion

**Soil Properties**

The physical and chemical properties of soils before onion sowing are presented in Tables 2 and 3. Chicken manure and mineral fertilizer applications significantly improved the total N percentage of the soils (P<0.01). The maximum N content of greenhouse soils was determined in the plots in which the chicken manure was applied as 40 t ha⁻¹. Similar the results Ayed (2002); Adenawoola and Adejoro (2005); Davis et al., (2006); Dikinya (2010), explained that N content in the soil was significantly increased by chicken manure application because of the nitrogenous compounds that are found in the chicken manure which is released during decomposition.

On the contrary, pH, organic matter, lime, P, K, Ca, Mg, Na, Fe, Zn, Mn, Cu values in the soil did not show any statistical difference between applications at the beginning of vegetation. However, Eghball et al. (2004), no residual effects of manure and compost treatments on pH, total C and N concentration were observed in the 15-30 cm soil depth.

The composition of chicken manure that residual effect investigated was analyzed according to Kacak (1995) and is presented in Table 1.

**Table 1. Some properties of chicken manure.**

| Properties | Value |
|------------|-------|
| pH         | 8.55  |
| Total Salt (ms/cm) | 2.47 |
| Ash 550°C (%) | 79  |
| Organic Matter (%) | 19.8 |
| Organic Carbon (%) | 11.51 |
| Total N (%) | 0.95  |
| C/N       | 12.1  |
| P (%)     | 0.70  |
| K (%)     | 1.02  |
| Ca (%)    | 1.37  |
| Mg (ppm)  | 3729  |
| Na (ppm)  | 1248  |

**Table 2. Some properties of greenhouse soils at the beginning of onion vegetation.**

| Treatment | pH     | O.M. (%) | CaCO₃ (%) |
|-----------|--------|----------|-----------|
| 0         | 7.24   | 1.57     | 0.92      |
| NPK       | 7.25   | 1.47     | 0.43      |
| 20 t ha⁻¹ | 7.44   | 1.61     | 0.86      |
| 40 t ha⁻¹ | 7.29   | 1.33     | 0.42      |
| 60 t ha⁻¹ | 7.15   | 1.47     | 0.36      |
| LSD       | n.s.   | n.s.     | n.s.      |

*: P<0.01, #: P<0.05, n.s.: not significant

**Mineral Contents of Onion Leaves**

Residue effects of chicken manure doses on the nutrient content of onion leaf as the second crop after the lettuce production are given in Table 4. Nitrogen, P, Ca, Mg, Fe, Zn, Cu contents in onion leaves increased significantly depending on the residue effects of the chicken manure doses and chemical fertilizer compared to control plot (P<0.01). Lowest nutrients uptake was observed in control. However, the highest mineral content in leaves was determined in the plots, in which the chicken manure was applied as 40 t ha⁻¹ generally. These results could be explained by the positive effect of chicken manure on improving the nutritional status of the soil, also, due to the rapid mineralization of organic matter (Yassen and Khalid, 2009). Also, Eghball et al. (2003) found that the increased plant-available P level in soil following N-based manure or compost application can contribute to crop P uptake for up to 10 yrs. without any additional P addition.

Similarly, Shaymaa et al. (2014) reported that organic matter represented in cattle manure was important to obtain the highest, chemical constituent and mineral composition that will lead to the best quality in onion plants. Ceylan et al. (2017) stated that P, K, Ca, Mg, Fe, Cu, Zn and Mn contents in lettuce increased significantly with chicken manure applications.
Bergmann (1993) gave sufficient values as percentages for onion leaves as N: 2.0 to 3.0, P: 0.25 to 0.40, K: 2.5 to 3.0, Ca: 0.6 to 1.5 and Mg: 0.25 to 0.50, and according to this, the leaves in the experiment indicated sufficient levels of N, Ca, Mg elements (Table 4). However, although the nitrogen is insufficient in the soil before planting, it is noteworthy that the leaves are at a sufficient level. This result may be due to the slow release of organic fertilizers and their effects on the following products. Similarly, Murphy (2014) explained that soil organic matter influences a range of functional soil physical, chemical, and biological properties and plays a vital role in nutrient cycling. In the study, although the soils are rich in phosphorus, the leaves are insufficient. Sometimes it may be due to the organic materials in soils that cause negative effects, and also it may create an organo-mineral complex that reduces the availability of some minerals (Sezen, 1995).

Table 3. Nutrient contents of greenhouse soils at the beginning of vegetation.

| Treatment | Total N (%) | P (mg kg⁻¹) | K (mg kg⁻¹) | Ca (mg kg⁻¹) | Mg (mg kg⁻¹) |
|-----------|-------------|-------------|-------------|-------------|-------------|
| 0         | 0.056c      | 51.30       | 104.4       | 1386        | 323         |
| NPK       | 0.078abc    | 56.35       | 133.5       | 1023        | 305         |
| 20 t ha⁻¹ | 0.067bc     | 60.51       | 133.4       | 1254        | 303         |
| 40 t ha⁻¹ | 0.084a      | 63.45       | 136.4       | 1188        | 318         |
| 60 t ha⁻¹ | 0.081abc    | 62.05       | 146.5       | 1221        | 308         |
| LSD       | 0.015**     | n.s.        | n.s         | n.s         | n.s         |

Table 4. Residual effects of chicken manure on nutrient content of onion leaf

| Treatment | Total N (%) | P (mg kg⁻¹) | K (mg kg⁻¹) | Ca (mg kg⁻¹) | Mg (mg kg⁻¹) |
|-----------|-------------|-------------|-------------|-------------|-------------|
| 0         | 0.056c      | 51.30       | 104.4       | 1386        | 323         |
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| 60 t ha⁻¹ | 0.081abc    | 62.05       | 146.5       | 1221        | 308         |
| LSD       | 0.015**     | n.s.        | n.s         | n.s         | n.s         |

Table 5. Effect of variety on nutrient content of onion leaf as second crop depending on residue effect of chicken manure

| Variety | N (%) | P (%) | K (%) | Ca (%) | Mg (%) |
|---------|-------|-------|-------|--------|--------|
| Burgaz  | 2.35b | 0.18b | 2.32  | 1.43b  | 0.59a  |
| Kar Beyazı | 2.38ab | 0.21a | 2.40  | 1.11b  | 0.57ab |
| Şampiyon | 2.42a  | 0.16b | 2.15  | 1.03b  | 0.52b  |
| LSD     | 0.059**| 0.026**| n.s. | 0.164**| 0.049**|

| Variety | Fe (mg kg⁻¹) | Zn (mg kg⁻¹) | Mn (mg kg⁻¹) | Cu (mg kg⁻¹) | Na (mg kg⁻¹) |
|---------|--------------|--------------|--------------|--------------|--------------|
| Burgaz  | 86.8         | 19.45b       | 21.17ab      | 4.51b        | 979.5        |
| Kar Beyazı | 85.5   | 21.37a       | 24.17a       | 3.24b        | 1031.2       |
| Şampiyon | 91.0         | 19.93ab      | 20.88b       | 3.08b        | 870.8        |
| LSD     | n.s.         | 1.858*       | 3.185*       | 0.928**      | n.s.         |

**P<0.01, *P<0.05, n.s.: not significant
In the study, it was determined that leaf nutrient content varies significantly according to the varieties of onion (Table 5). Calcium, Mg, and Cu content in leaves were found to be the highest in the Burgaz variety (P<0.01). Phosphorus, Zn, Mn contents in leaves was found to be the highest in Snow white while N values determined in maximum in Champion variety.

**Table 6.** Residual effects of chicken manure on nutrient content of onion bulb

| Treatment | Total N (%) | P (mg kg\(^{-1}\)) | K (mg kg\(^{-1}\)) | Ca (mg kg\(^{-1}\)) | Mg (mg kg\(^{-1}\)) |
|-----------|-------------|-----------------|-----------------|-----------------|-----------------|
| 0         | 1.63        | 0.17            | 0.98            | 0.097           | 0.160           |
| NPK       | 2.08        | 0.25            | 1.25            | 0.134           | 0.187           |
| 20 t ha\(^{-1}\) | 1.73        | 0.20            | 1.24            | 0.128           | 0.190           |
| 40 t ha\(^{-1}\) | 1.86        | 0.23            | 1.25            | 0.149           | 0.202           |
| 60 t ha\(^{-1}\) | 1.98        | 0.27            | 1.35            | 0.152           | 0.199           |
| LSD       | 0.072**     | 0.059**         | 0.015**         | 0.031**         | 0.032**         |

| Treatment | Na (mg kg\(^{-1}\)) | Fe (mg kg\(^{-1}\)) | Zn (mg kg\(^{-1}\)) | Mn (mg kg\(^{-1}\)) | Cu (mg kg\(^{-1}\)) |
|-----------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 0         | 186.3           | 28.31           | 16.20           | 16.37           | 2.80            |
| NPK       | 217.3           | 37.15           | 21.77           | 18.42           | 3.89            |
| 20 t ha\(^{-1}\) | 247.5         | 34.28           | 19.56           | 18.86           | 3.60            |
| 40 t ha\(^{-1}\) | 301.3         | 37.64           | 23.45           | 19.51           | 3.75            |
| 60 t ha\(^{-1}\) | 353.6         | 34.47           | 22.23           | 19.28           | 3.92            |
| LSD       | 62.743**       | 6.366**         | 4.828**         | 2.20**          | ns.              |

**: P<0.01, *: P<0.05, n.s.: not significant

**Table 7.** Effect of variety on nutrient content of onion bulb as second crop

| Variety   | Total N (%) | P (mg kg\(^{-1}\)) | K (mg kg\(^{-1}\)) | Ca (mg kg\(^{-1}\)) | Mg (mg kg\(^{-1}\)) |
|-----------|-------------|-----------------|-----------------|-----------------|-----------------|
| Burgaz    | 1.65c       | 0.16b           | 1.28            | 0.12            | 0.18            |
| Snow White| 1.83b       | 0.23a           | 1.19            | 0.14            | 0.18            |
| Champion  | 2.08a       | 0.23a           | 1.17            | 0.13            | 0.19            |
| LSD       | 0.072**     | 0.036**         | n.s.            | n.s.            | n.s.            |

| Variety   | Na (mg kg\(^{-1}\)) | Fe (mg kg\(^{-1}\)) | Zn (mg kg\(^{-1}\)) | Mn (mg kg\(^{-1}\)) | Cu (mg kg\(^{-1}\)) |
|-----------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Burgaz    | 244.5           | 29.23           | 19.29           | 18.39           | 3.85a           |
| Snow White| 260.0           | 39.12           | 21.85           | 18.18           | 4.04a           |
| Champion  | 278.9           | 34.77           | 20.79           | 18.89           | 2.89b           |
| LSD       | n.s.            | 5.541**         | ns.             | n.s.            | 0.718**         |

**: P<0.01, *: P<0.05, n.s.: not significant
The nutrient content of Burgaz variety is lower than Cu. No significant difference was found among the cultivars in terms of K and Fe content. The different mineral composition of onion varieties grown in the same conditions may result from genotypic variations between varieties (Chope and Terry, 2009).

In the study, generally, the highest nutrient contents on leaves and bulbs were obtained with the residual effect of 40 t ha\(^{-1}\) doses of chicken manure. Champion varieties had more response to the organic manure compared to the other onion varieties about nutrient content in bulbs. The Champion varieties contained higher nutrient values in bulbs.

In terms of the leaf nutrient content, when the varieties compared to each other, Ca, Mg, and Cu content is found to be the highest in the Burgaz variety. Phosphorus, Zn, Mn content is analyzed to be the highest in the Burgaz variety. Phosphorus, Zn, Mn, and Cu contents were found to be the highest in Champion variety. Phosphorus, Zn, Mn, and Cu contents were found to be the highest in Champion variety.

Organic fertilizers are slow-release fertilizers, and their effects on soil fertility are seen in the following years and N values determined maximum in Champion variety.

As observed in our study, considering their effects on soil fertility are seen in the following years and N values determined maximum in Champion variety. Phosphorus, Zn, Mn, and Cu contents were found to be the highest in Champion variety. Phosphorus, Zn, Mn, and Cu contents were found to be the highest in Champion variety.

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In terms of the leaf nutrient content, when the varieties compared to each other, Ca, Mg, and Cu content is found to be the highest in the Burgaz variety. Phosphorus, Zn, Mn content is analyzed to be the highest in Snow white, while, N values determined maximum in Champion variety.

Organic fertilizers are slow-release fertilizers, and their effects on soil fertility are seen in the following years and N values determined maximum in Champion variety.

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