**AGRICULTURAL ACADEMY**

**Research Institute of Mountain Stockbreeding and Agriculture, Troyan**

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# UPDATE OF SOME TECHNOLOGICAL ELEMENTS IN THE PRODUCTION OF PLUM FRUIT

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The experimental work was performed during the period 2016-2018. in demonstration fruit plantations of the Research Institute of Mountain Stockbreeding and Agriculture- Troyan.

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## I. INTRODUCTION

Plum is a perspective crop. Its great economic significance is determined by the varied use of its fruits. Plums are consumed fresh and dried, as well as processed into various products. Plum fruit is considered to be healthy food because of their low fat content and essential nutrients, such as carbohydrates, vitamins, minerals etc. Their consumption is useful for a number of diseases and their prevention. Due to the abundance of bioactive compounds, plums are a valuable component in terms of their nutritional and dietary value.

The advantages are the relatively low investment in the establishment of plantations, early entry into fruit bearing, an unlimited market for fruits and their products. An important element in the cultivation of trees is the right choice of planting site, including analysis of soil profile, selection of cultivars appropriate for the particular area. Currently, there cultivars with various ripening period available, which leads to an increase in the duration of the harvesting period, to supply of fresh fruit for the market and to reduce labour tensions, regarding harvesting.

## II. OBJECTIVE AND TASKS

**The purpose of the research** is to investigate the prospects for controlling the nutritional deficiency in fruit-bearing plum plantations created through organic stockpile fertilizing and grown using biological and conventional technology.

**To fulfill this objective, the following tasks were accomplished:**

- ✓ Analysis of the content of the basic nutrients (N, P, K), humus and pH in the different soil layers: 0-20, 20-40 and 40-60 cm of the plum cultivars, such as 'Tegera', 'Elena' and 'Stanley' after stockpile fertilizing in trenches and local organic fertilization;
- ✓ to determine the fertilizer need of 'Tegera', 'Elena' and 'Stanley' cultivars, after a long period of organic stockpile fertilizing;
- ✓ to determine fertilization stages, based on soil stockpile with nitrogen, phosphorus and potassium reserves;
- ✓ to observe the impact of innovative conventional fertilizers, such as Yara Mila Complex (soil), YaraVita Frutrel (foliar) and Yara Vita Universal Bio (foliar), organic fertilizers (Agriful (soil), Tecamin Flower (foliar) and Tecnocel Amino Ca (foliar) and granulated chicken manure, on the vegetative and reproductive characteristics of trees;
- ✓ to determine the values of the elemental composition and the pigments in the leaf samples to characterize the specificity of the cultivars;
- ✓ to determine the degree of impact of fertilization on the biochemical composition of fresh and dried fruits;
- ✓ to determine colour parameters for fresh and dried fruits from fertilization variants.
- ✓ to analyze the effect of fertilization on the density (firmness) of fruits, fruit flesh and their storage.
- ✓ to determine the correlation and regression dependencies between different indicators in the cultivars.

## III. MATERIAL AND METHODS

### 1. Material

The research work on the topic was carried out in the period of 2016-2018 in demonstrative fruit plantations of the Institute of Mountain Stockbreeding and Agriculture-Troyan. The objectives of the present study are plum cultivars 'Stanley', 'Tegera' and 'Elena'. An innovative solution in the experiment is that the three cultivars differ in their period of ripening. 'Tegera' is characterized by the earliest period of fruit ripening, 'Stanley' is a mid-ripening and Elena is a late-ripening cultivar.

To solve the tasks, two experiments were made:

**I$^{st}$ experiment - includes 'Tegera' and 'Elena' cultivars;**

The plantation of these cultivars was created in the spring of 2001. The trees were planted in trenches with organic stockpile fertilizing with manure (130 kg/1 linear meter). The planting distances are 4/2.5 m. The row spacing is vovered with tall fescue and the intra row spacing is kept in black fallow. During the vegetation period, the necessary mowing in the row spacings and digging in the intra-row lines are carried out, as well as other agrotechnical events such as pruning, plant protection, etc.

**II$^{nd}$ experiment includes - 'Stanley' cultivar;**

The plantation of the experiment was created in the spring of 2003. The preparation for planting of trees involves opening three pits along the row. The stockpile fertilizing is applied in all three pits, as the trees are planted in the middle one. The purpose is the tree root system to use the nutrients from the manure in the three locations. Tree planting distances is 5/4 m. The area is maintained in black fallow, with the application of the necessary agro-technology, according to the crop.

The experiment of both trials involved four trees of a variant of all the three plum cultivars.

Variants of the experiment:

**I variant -** Bio-fertilization - including fertilizers: Agriful (soil) - 5 l/da, Tecamin Flower (foliar) - 0.3%, Tecnocel Amino Ca (foliar) - 0.4%;

**II variant** - Conventional fertilizing - Yara Mila Complex (soil) - 0.500 kg/tree, YaraVita Frutrel (foliar) – 0.500 ml/da, Yara Vita Universal Bio (foliar) – 0.500 ml/da

**III variant** - Granulated chicken Manure - 0.500 kg/tree

**IV variant** - Control

### 2. Methodology of study

**2.1. Determination of soil stockpile with essential nutrients:**

- The soil reaction is determined by potentiometric analysis in water and in KCl. pH of the soil show the equilibrium concentration of hydrogen ions in the soil-water suspension;
- nitrogen according to Bremner and Keeney ((mg/kg)
- phosphorus according to P. Ivanov (mg/100g)
- potassium according to P. Ivanov (mg/100g)
- humus according to Turin (%)

- Soil layers - Soil samples are taken from soil depths: 0-20 cm; 20-40 cm and 40-60 cm, using probe. Formed samples with an amount of 0.5 to 1 kg were placed and transported for analysis in labeled polyethylene bags.

From each soil profile, three replicate samples obtained from the intra row spacing and row spacing of the plum orchards were analyzed.

**2.2. Phenological phases**

- beginning of vegetation;
- white button;
- beginning of flowering - 5% of flowers are open;
- full flowering - 75% of the flowers are open;
- end of flowering - about 5% of the flowers are not faded;
- harvesting of fruits;
- end of vegetation - 75% of leaves have fallen.

**2.3. Vegetative indicators**

- trunk circumference (cm) - measured on a marked ring 40 cm high from the soil surface after the end of vegetation;
- crown height (m) - measured from the level of the first skeletal branch of the lowest branches to the top of the tree;
- crown width (m) - recorded in two directions - towards the row spacing and along the row;
- crown volume (m3) - calculated by the formula $V = \pi*d^2*h/12$, including: $\pi$ - 3.14; d is the diameter, on the average, of the two mutually perpendicular directions, excluding the individual projecting branches; h - crown height (m) (excluding stem) measured from the level of the first skeletal branch of the lowest branches to the top of the tree;
- annual growth - the indicator includes, average length (cm) of branches above 5 cm and total annual growth on marked branches after the end of vegetation;

**2.4. Reproductive characteristics**

- percentage of useful fruit-set, thirty days after mass flowering, on marked branches;
- fruit weight and stone (g) - a technical balance was used to measure 25 randomly selected fruits and their stones;
- average yield kg/tree;
- yield per unit crown volume (kg per $m^3$);
- yield ($g/cm^2$) from the trunk section.

**2.5. Biochemical composition of fresh and dried fruits:**

- dry matter (measured by refractometer, %);
- dry weight (%);
- total and reduced sugars (%) - according to Schoorl and Regenbogen;
- titratable acids (%) - by titration with 0.1N NaOH;
- ascorbic acid content (mg%) - according to Fialkov;
- anthocyanins (mg%) - according to Fuleki and Franciss;
- pectin (%) - according to Meliz;
- tanning substances (%) - according to Levental;

- total polyphenols (mgGAE/100);
- antioxidant activity (µmolTE/100g);
- the colour was determined according to Gardner;
- determination of the acedimetric factor.

**2.6. Fruit quality**

- fruit density (firmness) (kgf/cm$^2$) - determined by the FHT-15 (3.5 mm) digital penetrometer by measuring on both sides of 25 randomly selected fruits.
- fruit flesh density (firmness) (kgf/cm$^2$) - determined with a FHT-15 (3.5 mm) digital penetrometer by measuring on both sides of 25 randomly selected fruits. Fruit skin was removed with a scalpel to measure the fruit.
- fruit storage period at 4$^O$C - 5 kg of fruit of each variant were stored in the crates for storage. Rotten and non-edible fruits were reported every 7 days.

**2.7. Drying of fruit**

- Drying by heat pump;
- Drying with an alternative energy source dryer.

**2.8. Leaf diagnosis**

- plant analysis - according to the method of Mincheva-Brashnarova
- chlorophyll "a" and "в" - spectrophotometrically

**2.9 Economical analysis**

Economic estimation of the income and expenses of the fertilizers applied and the production received.

**3.0. Statistical data processing**

To process data obtained from the experimental work of the studied cultivars the following statistical analyzes were used: variance analysis, one-way ANOVA, followed by multiple comparisons of Duncan test results and least significant difference test (LSD test), at a significance level of $P \leq 0.05$, correlation and regression analysis.

## V. RESULTS AND DISCUSSION

Determining the agrochemical composition of soil profiles is crucial in the cultivation of the crops concerned. Every crop needs an optimal balance of nutrients in the soil in order for the plants to develop properly.

**1. Agrochemical analysis of soil in plum plantation with 'Tegera'**

The composition of the agrochemical indicators recorded in three soil layers, before the applied fertilization from the intra-row spacing in the plum plantation withg cultivar 'Tegera' for 2016 is presented in **Table 1**, and from the row spacing in **Table 2**.

In 2016, inside intra-row, the soil reaction in a solution of KCl in the soil layer of 0-20 cm ranged from 4.5 to 5.4, with an average value of 4.80, which is characterized as a medium to highly acidic reaction. At a depth of 20-40 cm, with an average pH of 5.00, the acid reaction of the medium is maintained.

**Table 1. Composition of agrochemical parameters of soil layers in the intra-row space with 'Tegera' cultivar in 2016**

| Soil layers cm | | pH | | ∑ N- $NH_4$+$NO_3$ | $P_2O_5$ | $K_2O$ | Humus |
|---|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | mg/kg | mg/100 g | | % |
| 0-20 cm | Minimum | 4.7 | 4.5 | 14.4 | 9.9 | 28.5 | 2.46 |
| | Maximum | 5.9 | 5.4 | 37.4 | 15.8 | 51.2 | 3.06 |
| | Mean | 5.10 | 4.80 | 24.60 | 13.23 | 41.63 | 2.74 |
| | St error | 0.38 | 0.30 | 6.77 | 1.74 | 6.79 | 0.17 |
| | St Dev | 0.66 | 0.52 | 11.73 | 3.02 | 11.76 | 0.30 |
| | CV% | 12.94 | 10.83 | 47.68 | 22.83 | 28.25 | 10.95 |
| 20-40 cm | Minimum | 4.8 | 4.6 | 21.9 | 9.3 | 26.5 | 1.93 |
| | Maximum | 5.4 | 5.3 | 37.4 | 79.6 | 49.1 | 5.08 |
| | Mean | 5.20 | 5.00 | 32.07 | 43.03 | 39.90 | 3.53 |
| | St error | 0.20 | 0.22 | 5.08 | 20.34 | 6.85 | 0.91 |
| | St Dev | 0.35 | 0.38 | 8.8 | 35.23 | 11.87 | 1.57 |
| | CV% | 6.73 | 7.6 | 27.44 | 81.87 | 29.75 | 44.47 |
| 40-60 cm | Minimum | 6.9 | 6.1 | 10.9 | 23.1 | 14.0 | 0.60 |
| | Maximum | 7.5 | 6.8 | 20.7 | 51.7 | 120.8 | 3.38 |
| | Mean | 7.23 | 6.57 | 14.43 | 39.2 | 45.23 | 1.42 |
| | St error | 0.06 | 0.08 | 1.02 | 2.99 | 13.09 | 0.30 |
| | St Dev | 0.19 | 0.24 | 3.07 | 8.98 | 39.28 | 0.91 |
| | CV% | 2.63 | 3.65 | 21.27 | 22.90 | 86.84 | 64.08 |

Row spacing of the three layers were determined by the acidity degree from acidic to slightly acidic, ranging from 3.9 (20-40 cm) to 5.9 (40-60 cm). Variability of values in all three soil layers was low.

The nitrogen content recorded within the intra-row space at the surface layer (0-20 cm) was in the range of 14.4-37.4 mg/kg, which indicated the wide range in variation of the element. The average nitrogen content was 24.60 mg/kg, which defined the layer as relatively well-preserved. At a depth of 20-40 cm, the nitrogen content was higher and reached 32.07 mg/kg, values indicating very good stockpile. At 40-60 cm was found the lowest amount of the element - 14.43mg/kg with an average degree of variation.

In the row spacing, the nitrogen content of the three depths was in the range 8.1-41.5 mg/kg. The highest average values were found at 0-20 cm (21.82 mg/kg), which defines the layer as low to medium stockpile. Decreases in nitrogen content in depth can be reported, probably due to the high mobility of the element in the soil or as a result of its absorption by the crop.

Phosphorus values within the intra-row space at 0-20 cm ranged from 9.9 to 15.8 mg/100g. The average for the layer is 13.23 mg/100g, which defines it as well-preserved. The phosphorus content of the next soil layer (20-40 cm), where it averages 43.03 mg/100g, was significantly higher. The high variation in the content of the element and its larger values in some samples, probably, are due to the quantities of manure in this sector.

There is a strong variation of phosphorus in the row spacing, which shows significant differences in the phosphorus amount in the individual samples. At a soil depth of 20-40 cm, the minimum value was 0.1 mg/100g and the maximum was 10.1 mg/100g. The highest average phosphorus content was reported at 0-20 cm - 12.20 mg/100g.

For the other two depths, the average phosphorus values were almost equal, respectively: 1.98 mg/100g and 1.90 mg/100g. Based on the data obtained, the surface 0-20 cm layer can be defined as medium-stored and the other two as poorly stocked.

**Table 2. Composition of agrochemical indicators of soil layers in the row spacing of 'Tegera' for 2016**

| Soil layers cm | | pH | | ∑ N- $NH_4$+$NO_3$ | $P_2O_5$ | $K_2O$ | Humus |
|---|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | mg/kg | mg/100 g | | % |
| 0-20 cm | Minimum | 4.6 | 4.5 | 13.8 | 2.6 | 15.0 | 1.88 |
| | Maximum | 6.0 | 5.5 | 41.5 | 35.0 | 44.7 | 2.94 |
| | Mean | 5.39 | 5.02 | 21.82 | 12.20 | 23.93 | 2.33 |
| | St error | 0.16 | 0.12 | 3.01 | 3.94 | 3.68 | 0.11 |
| | St Dev | 0.48 | 0.36 | 9.04 | 11.83 | 11.03 | 0.34 |
| | CV % | 8.90 | 7.17 | 41.43 | 96.97 | 46.09 | 14.59 |
| 20-40 cm | Minimum | 4.5 | 3.9 | 12.7 | 0.1 | 11.4 | 0.43 |
| | Maximum | 6.0 | 5.3 | 20.2 | 10.1 | 39.6 | 1.59 |
| | Mean | 5.12 | 4.52 | 17.23 | 1.98 | 17.90 | 1.12 |
| | St error | 0.18 | 0.18 | 0.75 | 1.04 | 3.05 | 0.13 |
| | St Dev | 0.55 | 0.54 | 2.26 | 3.13 | 9.15 | 0.38 |
| | CV % | 10.74 | 11.95 | 13.11 | 158.08 | 51.12 | 33.93 |
| 40-60 cm | Minimum | 5.0 | 4.5 | 8.1 | 0.9 | 11.6 | 0.76 |
| | Maximum | 6.6 | 5.9 | 17.8 | 3.5 | 18.0 | 1.63 |
| | Mean | 6.00 | 5.27 | 14.67 | 1.90 | 14.42 | 1.13 |
| | St error | 0.35 | 0.29 | 2.22 | 0.58 | 1.54 | 0.19 |
| | St Dev | 0.7 | 0.59 | 4.44 | 1.16 | 3.09 | 0.38 |
| | CV % | 11.67 | 11.19 | 30.26 | 61.05 | 21.42 | 33.63 |

Regarding the soil content of potassium, the results show that these soils are naturally very well stocked with this nutrient, which is characteristic of the soils of the area.

In the intra-row spacing, potassium values at 0-20 cm ranged from 28.5 to 51.2 mg/100g. On average, it was 41.63 mg/100g, which records the very good storage of the element in this soil layer. At a depth of 20-40 cm, the potassium averaged 39.90 mg/100g. The reported average values at 40-60 cm depth were high - 45.23 mg/100g, probably due to the basic amount of manure in this soil layer. The variation coefficient was high at all three soil depths.

High potassium values were also observed in the row spacing, ranging from 11.4 mg/100g (at 20-40 cm) to 44.7 mg/100g (0-20 cm). Variability in the content of the element in the layers is considerable. On average, the amount at 0-20 cm was 23.93 mg/100g, which defines the layer as well-preserved. Its content decreased in descending depth, at 20-40 cm it was 17.90 mg/100g and at 40-60 cm it was 14.42 mg/100g.

Reported results in humus content indicate that its soil profile values were low. From a depth of 0-20 cm in order, the humus content was average - 2.74%. In the next layer (20-40 cm), it was more - 3.53%, probably from the degree of mineralization of the manure, while at 40-60 cm it was 1.42%. Variability in organic matter values was medium to high at all three depths.

The highest humus content in the intra-row spacing was found at 0-20 cm (average - 2.33%), which defines the layer as poorly stockpiled. At the other two depths, humus content values were very low and almost equal, respectively: 1.12% and 1.13%. Variability in organic matter values for the soil under cultivation was medium and high for the other two depths.

**Table 3. Composition of agrochemical indicators of soil layers in the intra-row spacing of 'Tegera' cultivar in 2017**

| Variant | Soil variant cm | pH | | ∑ N- NH4+NO3 | $P_2O_5$ | $K_2O$ | Humus |
|---|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | mg/kg | mg/100 g | | % |
| I Bio-fertilization | 0-20 | 6.6 | 5.8 | 11.5 | 8.5 | 30.9 | 2.39 |
| | 20-40 | 6.1 | 5.6 | 12.1 | 5.4 | 17.7 | 1.43 |
| | 40-60 | 7.1 | 6.4 | 18.4 | 90.0 | 22.3 | 4.30 |
| II Conventional fertilizer | 0-20 | 6.6 | 5.7 | 15.0 | 37.9 | 76.7 | 4.44 |
| | 20-40 | 6.9 | 6.2 | 10.9 | 81.9 | 41.7 | 3.52 |
| | 40-60 | 7.6 | 6.8 | 20.2 | 120.2 | 42.5 | 4.26 |
| III Chicken manure | 0-20 | 6.7 | 5.9 | 11.5 | 16.9 | 51.7 | 2.91 |
| | 20-40 | 6.6 | 5.8 | 17.3 | 25.4 | 38.1 | 3.18 |
| | 40-60 | 6.7 | 5.9 | 12.1 | 13.5 | 36.1 | 1.64 |
| IV Control | 0-20 | 6.7 | 5.9 | 16.1 | 35.6 | 32.3 | 2.50 |
| | 20-40 | 7.3 | 6.5 | 22.5 | 40.5 | 20.1 | 3.90 |
| | 40-60 | 7.5 | 6.7 | 16.1 | 120.8 | 27.1 | 5.46 |

In the second year (2017), an analysis of the agrochemical soil status in the intra-row space of the fruit trees of 'Tegera' cultivar was carried out again in order to observe the impact on it after the fertilization variants applied.

From the results obtained, it was found that in all soil layers of the four fertilization variants, the acidic reaction of the medium (pH in $H_2O$ and KCl) decreased and its neutrality increased with increasing soil depth (**Table 3**).

Reported amount of nitrogen for 2017 at the surface 0-20 cm and the next 20-40 cm soil layer, in all experimental variants was lower than the average value of the same profiles analyzed in 2016. At a soil depth of 20-40 cm, the highest and lowest nutrient content were found, respectively 22.5 mg/kg in the control (IV variant) of the experiment and 10.9 mg/kg in conventional fertilization.

The analysis shows, that during the second experimental year 2017 compared to the previous 2016, the phosphorus amount was significantly higher in the conventional fertilizer variants (probably due to the quality of fertilizer applied) and the control for soil layers of 0-20 cm and 20-40 cm. In both variants, phosphorus content increased with increasing the soil depth, reaching a soil layer of 40-60 cm to 120.2 mg/100g (II variant) and 120.8 mg/100g (IV variant).

In the second year there was an increase in the amount of potassium in conventional fertilization and in the three soil layers of the variant. At 0-20 cm - 76.7 mg/100g, 20-40 cm - 41.7 mg/100g and 40-60 cm - 42.5 mg/ 100g.

The higher amounts of phosphorus and potassium in soil depths are probably due to the increased pH values.

As a result of the analyzed agrochemical parameters, it was found that the humus content has different results from the soil layers. Its values are in the range from 1.43% (I variant of profile 20-40 cm) to 5.46% (IV variant of profile 40-60 cm).

In the third experimental year, the acidic reaction of the medium (pH in $H_2O$ and KCl) continued to decrease in all soil layers from the four fertilization variants applied. It has been reported that as soil depth increased, so did its neutrality (**Table 4**).

For 2018, higher values were also found in the amount of nitrogen from the applied fertilization variants, except for the control, where the indicator remains low. It is observed that the soil depth and the nitrogen values were in a proportional relation. High amounts, at all three depths, were reported for the first variant (bio fertilization), and the highest value of 37.4 mg/kg was analyzed for the soil layer 40-60 cm in the third variant (chicken fertilizer).

**Table 4. Composition of agrochemical indicators of soil layers in the intra-row spacing of 'Tegera' in 2018**

| Variant | Soil layer cm | pH | | ∑ N- NH4+NO3 | $P_2O_5$ | $K_2O$ | Humus |
|---|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | mg / kg | mg / 100 g | | % |
| I Bio-fertilization | 0-20 | 6.6 | 5.8 | 22.5 | 23.4 | 33.3 | 3.44 |
| | 20-40 | 7.1 | 6.6 | 31.7 | 53.0 | 23.2 | 2.99 |
| | 40-60 | 6.6 | 5.7 | 34.6 | 21.8 | 31.3 | 2.82 |
| II Conventional fertilizer | 0-20 | 6.9 | 6.2 | 20.2 | 30.0 | 50.3 | 2.93 |
| | 20-40 | 6.9 | 6.2 | 27.1 | 34.8 | 35.3 | 3.26 |
| | 40-60 | 7.2 | 6.7 | 30.5 | 69.2 | 36.5 | 3.61 |
| III Chicken manure | 0-20 | 7.3 | 6.7 | 19.6 | 55.8 | 50.7 | 3.43 |
| | 20-40 | 7.4 | 6.8 | 28.8 | 104.7 | 41.5 | 5.40 |
| | 40-60 | 7.3 | 6.8 | 37.4 | 76.0 | 34.1 | 2.71 |
| IV Control | 0-20 | 7.2 | 6.3 | 15.6 | 20.5 | 56.3 | 2.33 |
| | 20-40 | 7.4 | 6.8 | 16.7 | 69.0 | 44.5 | 3.06 |
| | 40-60 | 7.5 | 6.8 | 27.1 | 62.0 | 33.5 | 3.10 |

The three-year soil analysis shows that during the third year of the experiment (2018) compared to the previous two (2016 and 2017), the phosphorus amount had a significantly higher content at soil depth from 0 to 40 cm in the variant with bio fertilization. The chicken manure gives the highest results in 2018, with soil layers of 20-40 cm (104.7 mg/100g) and 40-60 cm (76.0 mg/100g).

The quantification analysis of potassium in 2018 shows it is well-preserved in all three fertilization variants, including the controls. There was a slight variation in the analyzed values between the variants compared to the experimental 2016-2017 years. Closer results for the four variants were also reported for humus content ranging from 2.33% (IV variant of profile 0-20 cm) to 5.40% (III variant of profile 20-40 cm).

**2. Agrochemical analysis of soil in plum plantation with 'Elena' cultivar**

For the proper course of physiological and biochemical processes in fruit trees, an optimal balance of nutrients in the soil is required.

The composition of the agrochemical parameters of the soil layers 0-20 cm. 20-40 cm. and 40-60 cm in the intra-row space of 'Elena' in 2016 is presented in **Table 5**.

Row spacing of the three soil depths were determined with an average acidity, ranging from 4.0 (20-40 cm) to 5.9 (40-60 cm) (**Table 6**).

The nitrogen content, measured in the intra-row space, presented in ammonia and nitrate form at the soil layer 0-20 cm was in the range 22.5-34.0 mg/kg. The average nitrogen content was 28.60 mg/kg, which defines the layer as well-preserved. The depth of 20-40 cm is also characterized by good stockpile, however, the nitrogen content decreased to 25.13 mg/kg. In the analysis of 40-60 cm, the lowest average quantity is observed - 17.37 mg/kg, with a high degree of variation.

**Table 5. Composition of agrochemical parameters of soil layers in the intra-row space of 'Elena' cultivar in 2016**

| Soil layers cm | | pH | | ∑ N- $NH_4$+$NO_3$ | $P_2O_5$ | $K_2O$ | Humus |
|---|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | mg/kg | mg/100 g | | % |
| 0-20 cm | Minimum | 5.2 | 4.7 | 11.5 | 1.6 | 13.5 | 1.53 |
| | Maximum | 6.2 | 5.9 | 25.3 | 25.4 | 50.6 | 2.57 |
| | Mean | 5.71 | 5.30 | 15.15 | 8.25 | 29.29 | 2.13 |
| | St error | 0.13 | 0.14 | 1.48 | 2.40 | 4.61 | 0.11 |
| | St Dev | 0.39 | 0.42 | 4.44 | 7.20 | 13.83 | 0.34 |
| | CV% | 6.83 | 7.92 | 29.30 | 87.27 | 47.22 | 15.96 |
| 20-40 cm | Minimum | 4.5 | 4.0 | 15.6 | 0.1 | 10.6 | 0.98 |
| | Maximum | 6.3 | 5.9 | 20.2 | 10.7 | 37.0 | 0.82 |
| | Mean | 5.55 | 4.97 | 18.12 | 2.92 | 18.10 | 1.36 |
| | St error | 0.21 | 0.23 | 0.50 | 1.22 | 2.78 | 0.11 |
| | St Dev | 0.65 | 0.71 | 1.49 | 3.67 | 8.33 | 0.33 |
| | CV% | 11.71 | 14.28 | 8.22 | 125.68 | 46.02 | 24.26 |
| 40-60 cm | Minimum | 4.7 | 4.1 | 11.5 | 2.0 | 14.9 | 1.06 |
| | Maximum | 6.7 | 5.9 | 24.8 | 8.4 | 23.7 | 1.85 |
| | Mean | 6.07 | 5.30 | 17.15 | 5.05 | 17.42 | 1.32 |
| | St error | 0.47 | 0.41 | 2.87 | 1.31 | 2.10 | 0.18 |
| | St Dev | 0.93 | 0.82 | 5.73 | 2.62 | 4.22 | 0.37 |
| | CV% | 15.32 | 15.47 | 33.41 | 51.88 | 24.22 | 28.03 |

In the row spacing, the nitrogen content of the three depths was in the range 11.5-25.3 mg/kg. The highest average values were at 20-40 cm (18.12 mg/kg).

**Table 6. Composition of agrochemical indicators of soil layers in the row spacings of 'Elena' cultivar in 2016**

| Soil layers cm | | pH | | ∑ N- $NH_4$+$NO_3$ | $P_2O_5$ | $K_2O$ | Humus |
|---|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | mg/kg | mg/100 g | | % |
| 0-20 cm | Minimum | 5.2 | 4.7 | 11.5 | 1.6 | 13.5 | 1.53 |
| | Maximum | 6.2 | 5.9 | 25.3 | 25.4 | 50.6 | 2.57 |
| | Mean | 5.71 | 5.30 | 15.15 | 8.25 | 29.29 | 2.13 |
| | St error | 0.13 | 0.14 | 1.48 | 2.40 | 4.61 | 0.11 |
| | St Dev | 0.39 | 0.42 | 4.44 | 7.20 | 13.83 | 0.34 |
| | CV% | 6.83 | 7.92 | 29.30 | 87.27 | 47.22 | 15.96 |
| 20-40 cm | Minimum | 4.5 | 4.0 | 15.6 | 0.1 | 10.6 | 0.98 |
| | Maximum | 6.3 | 5.9 | 20.2 | 10.7 | 37.0 | 0.82 |
| | Mean | 5.55 | 4.97 | 18.12 | 2.92 | 18.10 | 1.36 |
| | St error | 0.21 | 0.23 | 0.50 | 1.22 | 2.78 | 0.11 |
| | St Dev | 0.65 | 0.71 | 1.49 | 3.67 | 8.33 | 0.33 |
| | CV% | 11.71 | 14.28 | 8.22 | 125.68 | 46.02 | 24.26 |
| 40-60 cm | Minimum | 4.7 | 4.1 | 11.5 | 2.0 | 14.9 | 1.06 |
| | Maximum | 6.7 | 5.9 | 24.8 | 8.4 | 23.7 | 1.85 |
| | Mean | 6.07 | 5.30 | 17.15 | 5.05 | 17.42 | 1.32 |
| | St error | 0.47 | 0.41 | 2.87 | 1.31 | 2.10 | 0.18 |
| | St Dev | 0.93 | 0.82 | 5.73 | 2.62 | 4.22 | 0.37 |
| | CV% | 15.32 | 15.47 | 33.41 | 51.88 | 24.22 | 28.03 |

Significant variation in the phosphorus values in the intra-row spacing was observed at all three depths. Its amount, for the soil layer 0-20 cm, was in the range from 8.7 to 120.2 mg/100g, at 20-40 cm from 14.8 to 137.3 mg/100g and at 40-60 cm from 54.5 to 126.6 mg/100g. The average values for the layers increased with increasing profile depth,

respectively: 57.80; 76.83 and 98.46 mg/100g, which defined the depths as highly conserved. The high variations in its content and its higher values in some samples probably were due to the mineralization and quantities of manure in this sector.

In the row spacing, a strong variation of phosphorous was observed, which showed significant differences in its amounts in the individual samples. For a soil layer of 20-40 cm, the minimum value was 0.1 mg/100g and the maximum value was 10.7 mg/100g. The highest average phosphorus content was reported at a depth of 0-20 cm - 8.25 mg/100g. Variability of the indicator is extremely high. At a depth of 20-40 cm, the variation coefficient was 125.7%, at 0-20 cm - 87.27% and at 40-60 cm - 51.88%. On the basis of the data obtained, it can be determined that the three soil layers are poorly and highly phosphorus-rich nutrient.

Within the intra-row, potassium values ranged from 31.3 to 50.6 mg/100g at a depth of 0-20 cm. On average, it was 40.40 mg/100g, which records a very good stockpile of macronutrients in the soil layer. At a depth of 20-40 cm, its amount was high with an average value of 34.17 mg/100g. In the analysis of the third soil layer (40-60 cm), the reported average values were also high - 44.29 mg/100g. The variation coefficient at all three soil depths was high.

Significant values of potassium were reported in the row spacing. On average, the highest amount was from 0-20 cm - 29.29 mg/100g. Its content decreased in descending line in depth.

Humus content indicate that its soil depth values are low, which is characteristic of that soil type. In the layers of 0-20 cm and 20-40 cm in the row, the humus content averaged 4.64%. It decreased to 3.92% in the next layer 40-60 cm. The variation in organic matter values was high at all three depths.

The highest humus content in the intra-row spacing was in the surface soil layer of 0-20 cm (average - 2.13%), which defines the layer as poorly stockpiled. For the other two depths, the humus values were the same, 1.36% at 20-40 cm and 1.32% at 40-60 cm, respectively. The variation in organic matter values for the first layer was medium and high for the other two.

**Table 7. Composition of agrochemical indicators of soil layers in the intra-row space of 'Elena' cultivar in 2017**

| Variant | Soil layer cm | pH | | ∑ N- NH4+NO3 | $P_2O_5$ | $K_2O$ | Humus |
|---|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | mg / kg | mg / 100 g | | % |
| I Bio-fertilization | 0-20 | 6.6 | 5.9 | 6.3 | 36.2 | 71.7 | 3.00 |
| | 20-40 | 7.1 | 6.5 | 22.5 | 124.7 | 44.7 | 8.89 |
| | 40-60 | 7.1 | 6.3 | 12.7 | 60.3 | 36.1 | 3. 02 |
| II Conventional fertilizer | 0-20 | 6.7 | 5.9 | 9.2 | 16.8 | 51.0 | 2.32 |
| | 20-40 | 6.9 | 6.2 | 9.8 | 33.5 | 37.9 | 1.64 |
| | 40-60 | 7.3 | 6.8 | 8.6 | 89.2 | 64.0 | 3.65 |
| III Chicken manure | 0-20 | 7.1 | 6.7 | 16.7 | 107.6 | 52.5 | 5.62 |
| | 20-40 | 7.1 | 6.6 | 9.8 | 78.5 | 41.6 | 3.84 |
| | 40-60 | 7.1 | 6.7 | 14.4 | 127.8 | 32.0 | 5.39 |
| IV Control | 0-20 | 7.1 | 6.7 | 12.7 | 65.3 | 40.9 | 2.37 |
| | 20-40 | 7.1 | 6.6 | 15.6 | 92.7 | 29.8 | 5.01 |
| | 40-60 | 7.1 | 6.7 | 24.2 | 171.3 | 21.9 | 7.45 |

The second analysis of the agrochemical soil status within the intra-row space, for 'Elena' cultivar conducted in 2017, determined the transition of the soil reaction of the medium in all three soil layers tested from the four test variants to neutral (pH in $H_2O$) retaining its slightly acidic reaction in KCl solution (**Table 7**).

Identical to 'Tegera' and 'Elena' cultivars, the nitrogen amount decreased in all three

soil layers in the second experimental year. At the first layer of 0-20 cm, the highest values were reported from fertilization with chicken manure - 16.7 mg/kg. The next depth is bio-fertilization variant - 22.5 mg/kg and the third layer is the control variant - 24.2 mg/kg. That is, there is variation in the values in the different variants, compared to the previous year.

Compared to 2016, in 2017 the phosphorous and potassium content was high, maintaining good soil stockpile at all depths of fertilization variants studied. There is a tendency for higher phosphorus values with increasing soil depth in conventional fertilization and the control. Significant amounts of the indicator were reported from 0-20 cm surface layer in the chicken manure variant - 107.6 mg/100g, 20-40 cm, for bio fertilizing - 124.7 mg/100g and the highest in 40-60 cm soil layer in the control variant - 171.3 mg/100g. The high potassium amount was found at a soil depth of 0-20 cm in the bio fertilizer variants - 71.7 mg/100g, chicken manure - 52.5 mg/100g and the control - 40.9 mg/100g.

Significant humus content was registered at 20-40 cm and 40-60 cm soil layer, reaching 8.89% for bio fertilization (20-40 cm) and 7.45% for control (40-60 cm).

**Table 8. Composition of agrochemical indicators of soil layers in the intra-row space of 'Elena' cultivar in 2018**

| Variant | Soil layer cm | pH | | ∑ N- NH4+NO3 | $P_2O_5$ | $K_2O$ | Humus |
|---|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | mg / kg | mg / 100 g | | % |
| I Bio-fertilization | 0-20 | 7.3 | 6.7 | 28.2 | 55.4 | 55.0 | 3.43 |
| | 20-40 | 7.4 | 6.8 | 26.0 | 101.1 | 46.5 | 5.86 |
| | 40-60 | 7.3 | 6.8 | 20.3 | 103.3 | 37.7 | 6.94 |
| II Conventional fertilizer | 0-20 | 7.3 | 6.8 | 17.9 | 54.9 | 112.0 | 3.96 |
| | 20-40 | 7.2 | 6.8 | 20.3 | 34.0 | 47.9 | 2.55 |
| | 40-60 | 7.4 | 6.8 | 27.1 | 89.2 | 51.2 | 3.37 |
| III Chicken manure | 0-20 | 7.3 | 6.7 | 21.3 | 70.2 | 40.4 | 3.55 |
| | 20-40 | 7.0 | 6.3 | 27.1 | 32.2 | 38.4 | 2.58 |
| | 40-60 | 7.3 | 6.7 | 19.0 | 67.8 | 37.9 | 3.71 |
| IV Control | 0-20 | 7.6 | 6.9 | 25.9 | 48.4 | 32.7 | 3.38 |
| | 20-40 | 7.4 | 6.8 | 17.9 | 88.3 | 27.7 | 3.73 |
| | 40-60 | 7.8 | 7.0 | 28.8 | 83.2 | 25.3 | 4.02 |

Identical to 'Tegera', a decrease in the acid reaction of the medium decreased and its neutrality increased for 'Elena' cultivar in the third experimental year (**Table 8**) in all soil layers of the four variants.

Nitrogen content also reported higher values than the analyzed results from the previous two years. A significant increase was observed at all three depths of the conventional fertilization variant. Nitrogen was in the range of 17.9 mg/kg at soil layer 0-20 cm to 27.1 mg/kg at 40-60 cm in this variant.

The highest phosphorus content was found in organic fertilization (variant I) at depths of 20-40 and 40-60 cm, respectively (101.1 and 103.3 mg/100g) in 2018. Again as in 2017, soil layer of 40-60 cm depth in all variants had significant amounts of phosphorus.

In the last year of the experiment, the four soil profiles of the variants again had significant potassium content. Higher indicator values, as in 2017 were analyzed from the surface, cultivable soil layer at 0-20 cm.

Humus stockpile in the intra row spacing for the three-year experimental period varied from poor to well-preserved. The highest humus content was found at depths of 20-40 and 40-60 cm in the bio fertilization variant (5.86-6.94%) and the control (3.73-4.02%).

### 3. Phenological phases

Seasonal and climatic changes affect the phenological phases in the vegetation season and have a direct impact on the quantity and quality of the production (Cautín et al., 2005; Popski et al., 2013; Gitea et al., 2019).

The phenological phases and the time range of their course from the beginning to the end of the vegetation for plum cultivars of 'Tegera', 'Elena' and 'Stanley' for 2016-2018 are presented in **Table 9**.

**Table 9. Phenological calendar of 'Tegera', 'Elena' and 'Stanley' in 2016-2018**

| Indicators<br>Cultivar | Beginning of vegatation | White button | Beginning of flowering | Full flowering | End of flowering | Fruit harvesting | End of vegetation |
|---|---|---|---|---|---|---|---|
| Tegera | | | | 2016г. | | | |
| | 19.03 | 30.03 | 31.03 | 01.04 | 07.04 | 18.07 | 14.10 |
| | | | | 2017г. | | | |
| | 19.03 | 30.03 | 30.03 | 01.04 | 11.04 | 31.07 | 26.10 |
| | | | | 2018г. | | | |
| | 02.04 | 05.04 | 07.04 | 10.04 | 15.04 | 10.07 | 28.09 |
| Elena | | | | 2016г. | | | |
| | 12.03 | 24.03 | 28.03 | 31.03 | 08.04 | 26.08 | 28.11 |
| | | | | 2017г. | | | |
| | 20.03 | 31.03 | 31.03 | 02.04 | 11.04 | 04.09 | 03.11 |
| | | | | 2018г. | | | |
| | 02.04 | 05.04 | 08.04 | 11.04 | 18.04 | 21.08 | 05.10 |
| Stanley | | | | 2016г. | | | |
| | 29.03 | 31.03 | 01.04 | 04.04 | 11.04 | - | 24.10. |
| | | | | 2017г. | | | |
| | 22.03 | 31.03 | 02.04 | 04.04 | 14.04 | 04.09 | 05.11 |
| | | | | 2018г. | | | |
| | 05.04 | 08.04 | 10.04 | 12.04 | 17.04 | 10.08 | 02.10 |

In 2016-2018, the time interval of the phenological phases, from the beginning of vegetation to the end of flowering, in the three plum cultivars largely overlap.

The earliest beginning of vegetation is observed in the plum trees of 'Elena' cultivar. In 2016 it began on March 12, followed by 'Tegera' - March 19 and 'Stanley' - 29.03. White button and flowering phenophases began in the time range of 24.03 ('Elena' cultivar, 2016) to 08.04 ('Stanley' cultivar, 2018). The reason for the early development of fruit trees in 2016 was the higher average temperature in March. Flowering for all three varieties in the last experimental year, occurred at a later stage because February and March were up to 6°C colder, while April and May were warmer, compared to 2016 and 2017. The shorter vegetation period in 2018 for 'Tegera', 'Elena' and 'Stanley', probably is due to higher temperatures in April and May.

During the three experimental years, the fruit harvesting of 'Tegera' cultivar was carried out in July and 'Elena' from 20 July to 4 September. Due to the small amount of 'Stanley' fruit in 2016, the fruit ripening was not registered, but in 2017 harvesting took place on 04.09. and in 2018 on 10.08.

The end of vegetation of plum cultivars occurs from the end of September for 'Tegera' until the end of November for 'Elena'.

## 4. Vegetative indicators

Vegetative characteristics of fruit trees depend on the genetic characteristics of the species and cultivar, on the age and physiological state of the trees, the applied agrotechnics and climatic conditions.

### 4.1. Vegetative Indicators of ’Tegera’

The vegetative indices of ’Tegera’ plum variety by years and average over the period are shown in **Table 10**.

During the three years of vegetation and the average for the period, after the fertilization was carried out in different variants, the trunks increased, as the conventional fertilization was most pronounced - 49.18 cm (2016); 50.25 cm (2017) and 52.85 cm (2018); 50.76 cm (2016-2018)

In the first experimental year (2016), the highest average height of crowns of plum trees was found in bio fertilization variant with mathematically proven differences - 5.42m.

The crown volume varied significantly over the trial period. In the first and third experimental years, the largest tree crown volume was found in the bio fertilizer variant - 26.59 $m^3$ (2016) and 17.43 $m^3$ (2018), while in 2017 it was the chicken manure variant with mathematically proven differences - 23.81 $m^3$. The control variant had the lowest results, for all the three years and average for the period, respectively 14.25 $m^3$; 8.99 $m^3$; 9.46 $m^3$ and 10.90 $m^3$.

**Table 10. Vegetative indices of ’Tegera’ cultivar by years and average for the period (2016-2018)**

| Indicators Variant | Trunk circumference cm | Crown height m | Crown width in the row m | Crown width in towards row-spacing m | Crown volume $m^3$ | Length of annuam growth cm | Total annuam growth cm |
|---|---|---|---|---|---|---|---|
| | | | 2016 | | | | |
| I Bio fertilization | 45.95 | 5.42 | 3.78 | 4.88 | 26.59 | 9.24 | 36.97 |
| II Conventional fertilizer | 49.18 | 5.05 | 3.73 | 3.95 | 19.49 | 7.50 | 30.01 |
| III Chicken manure | 44.55 | 4.57 | 3.75 | 3.86 | 17.31 | 10.03 | 40.12 |
| IV Control | 42.60 | 4.11 | 3.87 | 3.41 | 14.25 | 7.90 | 31.61 |
| St error | 1.38 | 0.28 | 0.03 | 0.31 | 2.62 | 0.59 | 2.35 |
| St Dev | 2.77 | 0.57 | 0.06 | 0.62 | 5.25 | 1.17 | 4.69 |
| CV % | 6.08 | 11.91 | 1.63 | 15.33 | 27.03 | 13.55 | 13.53 |
| $LSD_{0.05}$ | ns | 0.74 | ns | 0.62 | 7.78 | 1.84 | - |
| | | | 2017 | | | | |
| I Bio fertilization | 49.45 | 5.27 | 3.32 | 4.01 | 18.52 | 10.28 | 41.12 |
| II Conventional fertilizer | 50.25 | 5.16 | 3.56 | 3.96 | 19.09 | 9.21 | 36.86 |
| III Chicken manure | 45.95 | 5.40 | 3.89 | 4.32 | 23.81 | 8.55 | 34.19 |
| IV Control | 42.48 | 3.83 | 2.86 | 3.13 | 8.99 | 10.48 | 41.93 |
| St error | 1.60 | 0.36 | 0.22 | 0.25 | 3.10 | 0.45 | 1.82 |
| St Dev | 3.20 | 0.73 | 0.43 | 0.51 | 6.21 | 0.91 | 3.64 |
| CV % | 6.88 | 14.85 | 12.72 | 13.20 | 35.29 | 9.46 | 9.46 |
| $LSD_{0.05}$ | ns | ns | 0.94 | ns | 9.59 | ns | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2018 | | | | |
| I Bio fertilization | 49.45 | 5.12 | 3.11 | 4.13 | 17.43 | 7.81 | 31.25 |
| II Conventional fertilizer | 52.85 | 4.37 | 3.17 | 3.40 | 13.94 | 9.62 | 38.47 |
| III Chicken manure | 47.78 | 4.19 | 3.20 | 3.45 | 13.20 | 8.81 | 35.24 |
| IV Control | 42.95 | 3.80 | 2.81 | 3.06 | 9.46 | 8.31 | 33.24 |
| St error | 2.05 | 0.27 | 0.08 | 0.22 | 1.63 | 0.38 | 1.53 |
| St Dev | 4.11 | 0.55 | 0.17 | 0.44 | 3.27 | 0.77 | 3.07 |
| CV % | 8.51 | 12.58 | 5.53 | 12.53 | 24.20 | 8.92 | 8.88 |
| $LSD_{0.05}$ | ns | 0.61 | ns | ns | ns | ns | - |
| | | | **2016-2018** | | | | |
| I Bio fertilization | 48.28 | 5.27 | 3.40 | 4.34 | 20.85 | 9.11 | 36.45 |
| II Conventional fertilizer | 50.76 | 4.86 | 3.49 | 3.77 | 17.51 | 8.78 | 35.11 |
| III Chicken manure | 46.09 | 4.72 | 3.61 | 3.88 | 18.11 | 9.13 | 36.52 |
| IV Control | 42.68 | 3.91 | 3.18 | 3.20 | 10.90 | 8.90 | 35.59 |
| CV % | 7.28 | 11.94 | 5.26 | 12.13 | 25.05 | 1.78 | 1.89 |

There is no definite correlation between the results of the variants regarding the one-year and total growth for the surveyed period of 2016-2018. The highest average values was found in the chicken manure variant, while the lowest in the conventional fertilization variant over the period.

### 4.2. Vegetative indices for ’Elena’ cultivar

During the three-year experimental period 2016-2018 for ’Elena’ cultivar, the growth dynamics of the trunk circumference was most pronounced in the conventional fertilization variant - 43.80 cm (2016); 45.53 cm (2017) and 46.88 cm (2018), (**Table 11**).

The fruit tree height before application of fertilizers was in the range from 3.95 m to 4.63 m. Over the next three-year period, the highest average height was found in the control variant, respectively 5.39 m (2016), 6.37 m (2017) and 4.69 m (2018). The average crown width, along the rows and towards the row spacing, had close values among the three fertilization variants and the controls. This dependence persists throughout the three years of observation, including in 2015 when the reported results are significantly lower.

During the trial period, the highest volume of tree crowns was in the control variant, with no statistical difference between the variants.

**Table 11. Vegetative indices for ’Elena’ cultivars over the years and average for the period (2016-2018)**

| Indicators<br>Variant | Trunk circumference cm | Crown height m | Crown width in the row m | Crown width in towards row-spacing m | Crown volume $m^3$ | Length of annuam growth cm | Total annuam growth cm |
|---|---|---|---|---|---|---|---|
| | | | 2016 | | | | |
| I Bio fertilization | 42.63 | 4.72 | 4.26 | 4.08 | 21.48 | 9.88 | 39.52 |
| II Conventional fertilizer | 43.80 | 4.87 | 3.67 | 4.11 | 19.28 | 11.12 | 44.50 |
| III Chicken manure | 43.28 | 4.24 | 4.20 | 4.27 | 19.90 | 8.74 | 34.96 |
| IV Control | 45.50 | 5.39 | 3.89 | 4.12 | 22.62 | 9.90 | 39.62 |
| St error | 0.61 | 0.24 | 0.14 | 0.04 | 0.76 | 0.48 | 1.95 |
| St Dev | 1.23 | 0.47 | 0.27 | 0.08 | 1.51 | 0.97 | 3.89 |
| CV % | 2.80 | 9.86 | 6.89 | 2.05 | 7.28 | 9.81 | 9.83 |
| $LSD_{0.05}$ | ns | ns | ns | ns | ns | ns | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2017 | | | | |
| I Bio fertilization | 43.63 | 4.72 | 3.86 | 4.31 | 20.61 | 9.07 | 36.28 |
| II Conventional fertilizer | 45.53 | 5.79 | 4.02 | 4.44 | 27.11 | 10.53 | 42.12 |
| III Chicken manure | 43.95 | 5.24 | 4.11 | 4.30 | 24.24 | 9.54 | 38.16 |
| IV Control | 46.58 | 6.37 | 3.95 | 4.32 | 28.50 | 7.58 | 30.30 |
| St error | 0.69 | 0.35 | 0.05 | 0.03 | 1.74 | 0.61 | 2.46 |
| St Dev | 1.38 | 0.71 | 0.10 | 0.06 | 3.49 | 1.23 | 4.92 |
| CV % | 3.08 | 12.84 | 2.66 | 1.51 | 13.89 | 13.38 | 13.40 |
| $LSD_{0.05}$ | ns | ns | ns | ns | ns | ns | - |
| | | | 2018 | | | | |
| I Bio fertilization | 44.23 | 4.33 | 2.99 | 4.20 | 14.88 | 8.68 | 34.74 |
| II Conventional fertilizer | 46.88 | 4.25 | 3.28 | 3.56 | 14.61 | 9.96 | 39.83 |
| III Chicken manure | 44.83 | 4.50 | 3.10 | 3.46 | 14.42 | 12.28 | 49.10 |
| IV Control | 47.18 | 4.69 | 3.26 | 3.43 | 16.89 | 13.08 | 52.32 |
| St error | 0.73 | 0.09 | 0.06 | 0.18 | 0.57 | 1.01 | 4.06 |
| St Dev | 1.47 | 0.19 | 0.13 | 0.36 | 1.14 | 2.03 | 8.13 |
| CV % | 3.21 | 4.27 | 4.12 | 9.83 | 7.5 | 18.45 | 18.48 |
| $LSD_{0.05}$ | ns | ns | ns | ns | ns | ns | - |
| | | | **2016-2018** | | | | |
| I Bio fertilization | 43.50 | 4.59 | 3.70 | 4.20 | 18.99 | 9.21 | 36.85 |
| II Conventional fertilizer | 45.40 | 4.97 | 3.66 | 4.04 | 20.33 | 10.54 | 42.15 |
| III Chicken manure | 44.02 | 4.66 | 3.80 | 4.01 | 19.52 | 10.19 | 40.74 |
| IV Control | 46.42 | 5.48 | 3.70 | 3.96 | 22.67 | 10.19 | 40.75 |
| CV % | 2.94. | 8.13 | 1.34 | 2.54 | 7.95 | 5.68 | 5.65 |

In 2016 and 2017, the highest annual and total growth was reported for the conventional fertilization variant, respectively: (11.12 cm; 44.50 cm and 10.53 cm; 42.12 cm), and in 2018 higher values of the indicators were reported in the control (13.08 cm and 52.32 cm).

## 5. Reproductive manifestations and fruit quality (2016-2018)

The productivity of fruit trees is a key indicator that reflects the effectiveness of a technology. It is a unifying indicator of all possible impacts and most accurately assesses the impact of the factors tested (Minev, 2013).

### 5.1. Reproductive characteristics and quality of 'Tegera' fruit

The reproductive indices of 'Tegera' plum cultivar are shown in **Table 12**.

In the first experimental year (2016), the highest percentage of useful fruit-set was reported in conventional fertilization variant and the control, with approximate results of 34-35%. A much lower percentage was found in bio-fertilization variant - 20.80%. During the second vegetation period (2017), the percentage fruit-set has been proven to increase in all variants, but again the conventional fertilization had the highest value - 67.71% and the organic fertilizer with the lowest - 46.12%.

**Table 12. Reproductive characteristics and quality of ’Tegera’ over years (2016-2017)**

| Indicators Variant | Good fruit-set % | Average fruit weight (g) | Stone weight (g) | Average tree yield (кg) | Fruit density (kg/cm$^2$) | Fruit flesh density (kg/cm$^2$) |
|---|---|---|---|---|---|---|
| | | | 2016 | | | |
| I Bio fertilization | 20.80 | 30.00 | - | 1.05 | - | - |
| II Conventional fertilizer | 34.60 | 32.40 | - | 2.01 | - | - |
| III Chicken manure | 32.20 | 31.20 | - | 2.81 | - | - |
| IV Control | 34.46 | 29.20 | - | 1.47 | - | - |
| St error | 3.28 | 0.70 | | 0.38 | | |
| St Dev | 6.57 | 1.40 | | 0.76 | | |
| CV % | 21.53 | 4.56 | - | 41.39 | - | - |
| $LSD_{0.05}$ | ns | ns | | ns | | |
| | | | 2017 | | | |
| I Bio fertilization | 46.13 | 31.16 | 1.76 | 14.30 | 4.94 | 1.68 |
| II Conventional fertilizer | 67.71 | 28.12 | 1.80 | 33.92 | 5.18 | 1.51 |
| III Chicken manure | 55.57 | 29.96 | 1.60 | 21.55 | 4.58 | 1.64 |
| IV Control | 52.73 | 24.48 | 1.68 | 17.42 | 5.16 | 1.31 |
| St error | 4.51 | 1.46 | 0.04 | 4.30 | 0.14 | 0.08 |
| St Dev | 9.03 | 2.91 | 0.09 | 8.61 | 0.28 | 0.17 |
| CV% | 16.26 | 10.25 | 5.19 | 39.50 | 5.61 | 10.86 |
| $LSD_{0.05}$ | 12.28 | 1.82 | - | 13.67 | ns | 0.29 |

**Table 13. Reproductive characteristics of ’Tegera’ average over the period (2016-2017)**

| Indicators Variant | Good fruit-set % | Average fruit weight (g) | Average tree yield (кg) |
|---|---|---|---|
| I Bio fertilization | 33.47 | 30.58 | 7.68 |
| II Conventional fertilizer | 51.16 | 30.26 | 17.97 |
| III Chicken manure | 43.89 | 30.58 | 12.18 |
| IV Control | 43.60 | 26.84 | 9.45 |
| CV % | 16.87 | 6.15 | 37.98 |

In 2018, the lowest percentage of useful fruit-set was reported for ’Tegera’ (**Figure 1**), which varied between 0.96% and 6.02%. These low values are the result of low temperatures during the flowering period decreasing to 0.4°C.

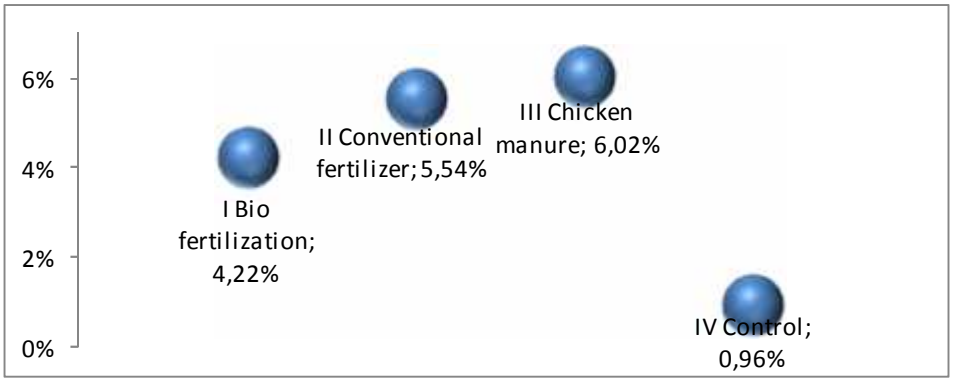


**Figure 1. Percentage of useful fruit-set for ’Tegera’ cultivar in 2018**

According to the average fruit weight in 2016, the largest fruit was gathered in the conventional fertilizer variant - 32.40 g, followed by chicken manure, bio-fertilization and control. In the second experimental year with statistical variability, the highest average values for fruit weight were reported for the bio fertilizer variant - 31.16 g, compared to the control - 24.48 g.

The average stone weight varied between different fertilization variants in close values, from 1.60 to 1.76g.

In the second experimental year, fruit density and fruit flesh density were identified. The highest average density of 5.18 kg/cm$^2$ was found in the conventional fertilizer variant and the lowest in the chicken manure variant - 4.58 kg/cm$^2$. The highest average density of fruit flesh was reported for bio-fertilization - 1.68 kg/cm$^2$. The high density of fruit in the first variant (bio-fertilization) is probably due to the positive effect of the fertilizers applied with 28% calcium oxide (CaO) content.

The highest average fruit yield in 2016 was found in the third variant (chicken manure) - 2.81 kg/tree and the lowest in the first one (bio-fertilizer) - 1.05 kg/tree. In general, the small amount of fruit in all variants during the year is the result of low temperatures during flowering, resulting in frost and drying of plums and stigma. The yield in 2017 was significantly higher. The highest yield of plum fruits are obtained from conventional fertilization - 33.92 kg/tree, and the lowest in organic fertilization - 14.30 kg/tree, with mathematically significant differences.

The highest average yield per unit of crown volume (kg/m$^3$) (**Figure 2**) was found in the bio-fertilization variant (2.71 kg/m$^3$) and the lowest in the conventional fertilization (0.97 kg/m$^3$).

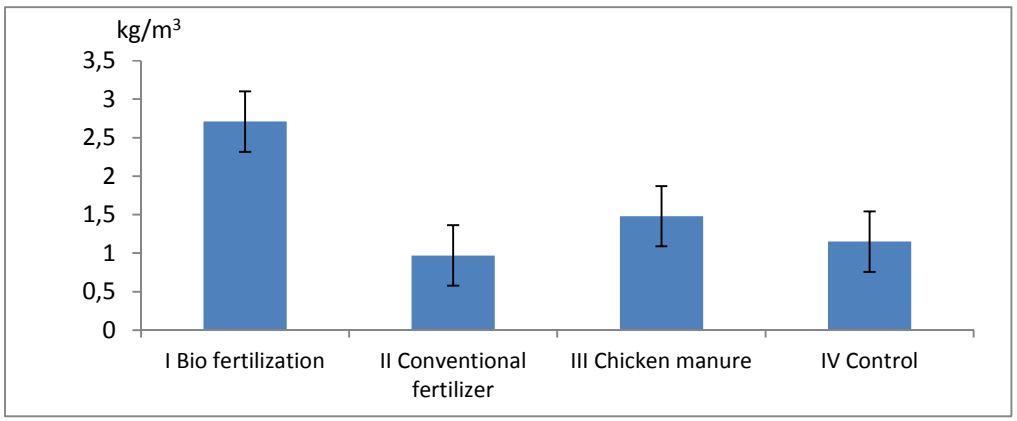


**Figure 2. Yield per unit of crown volume of 'Tegera', kg/m$^3$ (± SE)**

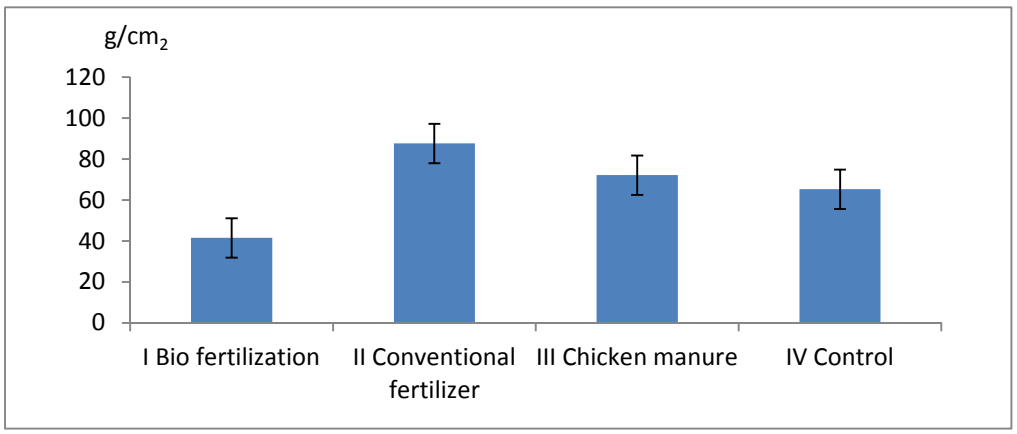


**Figure 3. Yield (g/cm$^2$) of trunk cross section for 'Tegera' cultivar (± SE)**

The yield, expressed as a productivity coeficient (g/cm$^2$) of the cross-section of the tree trunk, is in inverse dependence. The highest yield was found in the second variant (conventional fertilization) with 87.65 g/cm$^2$, while the bio fertilization gavevariant 41.46 g/cm$^2$ (**Figure 3**).

### 5.2. Reproductive characteristics and quality of 'Elena' fruits

The highest percantage of useful fruit-set in 2016 was found in the chicken manure variant - 31.55% (**Table 14**). Like 'Tegera', the control variant also had a high score of 26.41%. In the next 2017, the values of the indicator increased in all variants. The highest results were reported for bio and conventional fertilization.

During the three-year experimental period, the average fruit weight of the variants ranged from 19.92 g to 32.88 g, which determined them from medium to large.

In 2016, the highest average fruit weight was found in the control - 29.92 g, and in the next two years in the chicken manure variant - 32.88 and 27.79 g.

During the first two experimental years, the average fruit stone weight was in the range from 1.44 to 1.60 g. In 2018, the values of the indicator are below 1 g in the variants.

**Table 14. Reproductive characteristics and fruit quality of 'Elena' cultivar over the years and average for the period 2016-2018**

| Indicators<br>Variant | Good fruit-set<br>% | Average fruit weight<br>(g) | Stone weight<br>(g) | Average tree yield<br>(кg) | Fruit density<br>(kg/cm2) | Fruit flesh density<br>(kg/cm2) |
|---|---|---|---|---|---|---|
| | | | 2016 | | | |
| I Bio fertilization | 24.59 | 28.64 | 1.44 | 17.85 | 2.75 | 1.69 |
| II Conventional fertilizer | 22.48 | 28.96 | 1.52 | 22.85 | 4.39 | 2.40 |
| III Chicken manure | 31.55 | 27.28 | 1.60 | 18.10 | 3.33 | 1.01 |
| IV Control | 26.41 | 29.92 | 1.52 | 18.20 | 3.98 | 0.83 |
| St error | 1.94 | 0.54 | 0.03 | 1.20 | 0.36 | 0.36 |
| St Dev | 3.88 | 1.09 | 0.06 | 2.40 | 0.72 | 0.71 |
| CV% | 14.77 | 3.80 | 4.30 | 12.49 | 19.98 | 48.23 |
| $LSD_{0.05}$ | ns | ns | - | ns | 0.96 | 0.95 |
| | | | 2017 | | | |
| I Bio fertilization | 70.51 | 32.24 | 1.48 | 9.55 | 8.57 | 1.54 |
| II Conventional fertilizer | 75.58 | 32.80 | 1.60 | 13.98 | 9.35 | 1.88 |
| III Chicken manure | 60.39 | 32.88 | 1.56 | 5.00 | 7.49 | 1.53 |
| IV Control | 65.65 | 25.60 | 1.52 | 3.73 | 6.03 | 1.22 |
| St error | 3.25 | 1.76 | 0.02 | 2.33 | 0.72 | 0.13 |
| St Dev | 6.51 | 3.53 | 0.05 | 4.67 | 1.44 | 0.27 |
| CV% | 9.57 | 11.44 | 3.35 | 57.88 | 18.30 | 17.48 |
| $LSD_{0.05}$ | ns | 2.35 | - | 5.42 | 3.16 | 0.33 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | 2018 | | | |
| I Bio fertilization | 21.60 | 22.69 | 0.98 | 6.90 | 12.02 | 4.67 |
| II Conventional fertilizer | 19.25 | 19.92 | 0.98 | 8.45 | 12.43 | 4.95 |
| III Chicken manure | 14.03 | 27.79 | 0.97 | 5.43 | 10.68 | 4.25 |
| IV Control | 41.74 | 20.47 | 0.87 | 6.23 | 11.23 | 3.64 |
| St error | 6.07 | 1.79 | 0.02 | 0.64 | 0.39 | 0.28 |
| St Dev | 12.14 | 3.58 | 0.05 | 1.28 | 0.78 | 0.56 |
| CV% | 50.26 | 15.76 | 5.26 | 18.96 | 6.72 | 12.81 |
| $LSD_{0.05}$ | ns | ns | - | ns | 3.44 | 1.87 |
| | | | **2016-2018** | | | |
| I Bio fertilization | 38.90 | 27.86 | 1.30 | 11.43 | 7.78 | 2.63 |
| II Conventional fertilizer | 39.10 | 27.23 | 1.37 | 15.09 | 8.72 | 3.08 |
| III Chicken manure | 35.32 | 29.32 | 1.38 | 9.51 | 7.17 | 2.26 |
| IV Control | 44.60 | 25.33 | 1.30 | 9.39 | 7.08 | 1.90 |
| CV% | 9.67 | 6.01 | 3.00 | 23.31 | 9.76 | 20.32 |

The highest average tree yield for the first experimental year was gathered in the conventional fertilization variant - 22.85 kg/tree, and the lowest for the first variant (bio-fertilization) - 17.85 kg/tree. The results in the next year 2017 were significantly lower in all variants. The largest amount of fruit is obtained from conventional fertilization - 13.98 kg /tree, which is more than twice as much as other experimental variants, with mathematically proven differences.

The climatic conditions in 2018 - higher rainfall in February (96.9 mm), March (83.2 mm), June (174.3 mm) and July (241.1 mm) and subsequent drought in August adversely affect the low yield of fruits. Low temperatures during flowering, which dropped to 0.6 - 2C °, also had a negative impact on the yield.

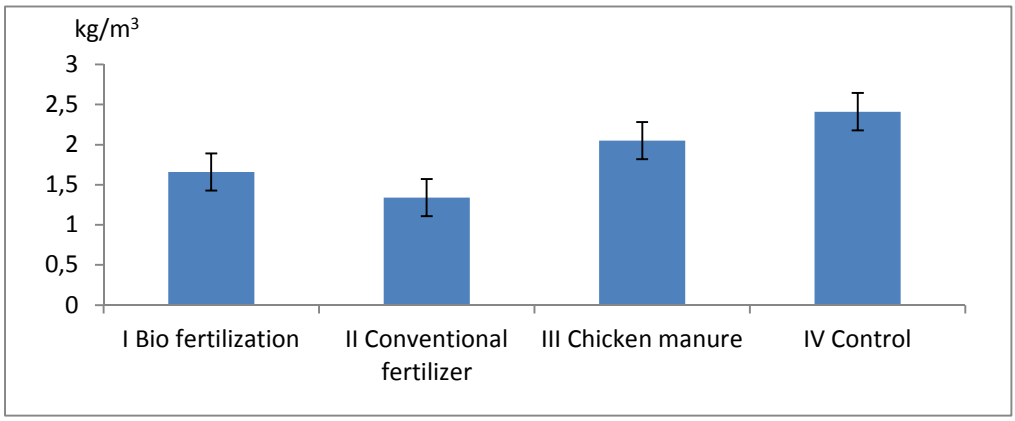


**Figure 4. Yield per unit of crown volume in 'Elena', kg/m$^3$ (± SE)**

The variants with fertilizers had a higher yield than the control on average during the experimental period. The largest amount of fruit produced was found in the conventional

fertilization variant - 15.09 kg/tree. The control variant had the highest yield per unit of crown volume - 2.41 kg/m$^3$ (**Figure 4**).

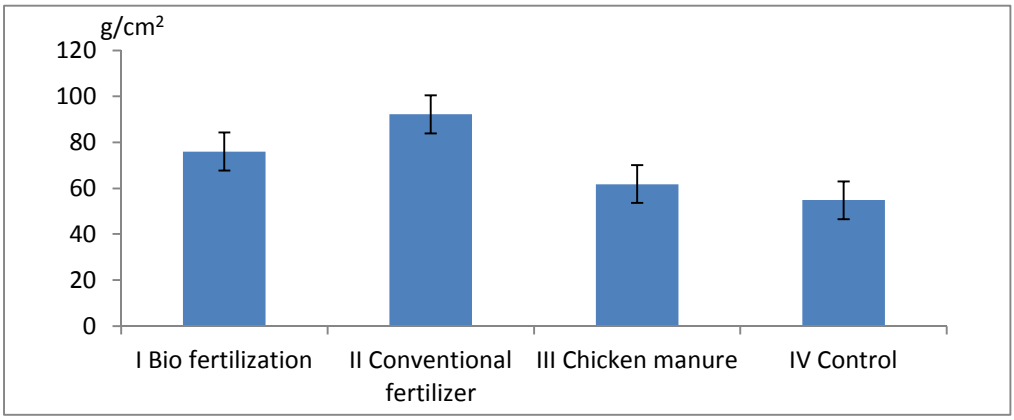


**Figure 5. Yield (g/cm$^2$) of trunk cross-section for 'Elena' (± SE)**

The yield (g/cm$^2$) of the tree trunk cross section in 'Elena' cultivar is from 54.75 g/cm2 in the control to 92.19 g/cm$^2$ in the conventional fertilization variant (**Figure 5**).

The highest results in relation to fruit density and fruit flesh density were found in the second variant (conventional fertilizer) during the three-year period with mathematically proven differences. In 2018, the highest values were reported for all variants.

Based on the analysis of reproductive indices in 2016-2018 for 'Tegera' and 'Elena' were found that both cultivars had a close average fruit weight and slight variation in the average stone weight.

Fruit yield for 'Tegera' cultivar was less in 2016 (because of frost) compared to the next experimental year, while the yield from 'Elena' cultivar in 2016 was significantly higher than the next two years. Higher fruit yields per kg/tree was found for 'Tegera' cultivar in 2016 and 2017 in the variants with conventional fertilizer and chicken manure, while for 'Elena' cultivar in the variants with conventional fertilizer and the control (2016); and conventional and bio-fertilization (2017 and 2018).

## 6. Biochemical composition and colour parameters of fresh and dried fruits (2016-2018)

Researches show that consumers today are looking for quality food, which require minimal processing (Zhelyazkov, 2015).

In order to qualify the products, they are subjected to various qualitative and quantitative analyzes, proving their healthy effect on the human body.

In the first experimental year 2016, a comparative analysis of the biochemical parameters between fresh and dried fruits of 'Tegera' and 'Elena' cultivars was conducted. The drying process was carried out by means of a heat pump in the technological laboratory at Food Research and Development Institute-Plovdiv.

The colour parameters of CIE Lab system were also reported according to the three colour coordinates L - colour brightness, + a - red and + b-yellow. The colour tone or dominant wavelength represented by a/b ratio was also calculated.

### 6.1. Biochemical composition of fresh and dried ’Tegera’ fruits

The analysis shows that fresh fruits of ’Tegera’ had a dry weight of 18 to 20% over the years of the study period (**Table 15**). As a result of the narrow boundaries between them, the reported variation coefficient is low.

In 2016, the amount of soluble solids analyzed in the four variants varied from 17% to 18%. In the next experimental year, the values decreased to 14-15% with low coefficient of variation. On average, during the experimental period, soluble solids were approximately 16%.

Slight variation in 2016 was also taken into account in the total sugars content. The average values of the indicator for the experimental period were the highest for the fertilization and the lowest for the control variant. Almost identical results reported in the range of 10.31% to 11.78% were obtained from the analysis of seven plum hybrids and three control cultivars by Milosevic and Milosevic, (2012).

**Table 15. Biochemical composition of fresh plum fruits of ’Tegera’ over the years and average for the period 2016-2017**

| Indicators<br>Variantи | Dry weight, % | Dry weight in Re, % | Total sugars, % | Inverted sugar, % | Sucrose, % | Malic acid, % | Ascorbic acid, mg % | Tannins, % | Anthocyanins, mg % | Pectin, % | Acidimetric coeficient |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2016 | | | | | | |
| I Bio fertilization | 19.10 | 17.30 | 10.05 | 4.85 | 4.94 | 0.64 | 4.40 | 0.270 | 19.19 | 0.87 | 15.70 |
| II Conventional fertilizer | 19.53 | 17.50 | 9.55 | 6.50 | 2.90 | 0.64 | 5.28 | 0.270 | 16.61 | 0.71 | 14.92 |
| III Chicken manure | 18.53 | 17.50 | 10.25 | 5.02 | 4.80 | 0.64 | 6.16 | 0.208 | 10.00 | 0.45 | 16.01 |
| IV Control | 18.70 | 17.50 | 10.05 | 4.05 | 5.70 | 0.64 | 5.28 | 0.249 | 48.39 | 0.51 | 15.70 |
| CV % | 2.35 | 0.57 | 2.99 | 19.82 | 25.97 | - | 13.61 | 11.73 | 72.23 | 30.25 | 2.98 |
| | | | | | 2017 | | | | | | |
| I Bio fertilization | 19.96 | 15.50 | 10.25 | 5.00 | 4.99 | 0.48 | 10.56 | 0.094 | 13.78 | 0.06 | 21.35 |
| II Conventional fertilizer | 19.39 | 14.50 | 9.90 | 4.85 | 4.80 | 0.55 | 19.36 | 0.094 | 5.97 | 0.05 | 18.00 |
| III Chicken manure | 19.66 | 14.00 | 9.20 | 4.70 | 4.28 | 0.55 | 8.80 | 0.131 | 6.13 | 0.64 | 16.73 |
| IV Control | 19.67 | 14.00 | 8.20 | 4.70 | 3.33 | 0.62 | 12.32 | 0.131 | 12.10 | 1.80 | 13.22 |
| CV % | 0.81 | 4.88 | 9.63 | 2.98 | 17.09 | 10.39 | 36.27 | 18.99 | 42.52 | 129.04 | 19.39 |
| | | | | | **2016-2017** | | | | | | |
| I Bio fertilization | 19.53 | 16.40 | 10.15 | 4.93 | 4.97 | 0.56 | 7.48 | 0.180 | 16.49 | 0.47 | 18.53 |
| II Conventional fertilizer | 19.46 | 16.00 | 9.73 | 5.68 | 3.85 | 0.60 | 12.32 | 0.180 | 11.29 | 0.38 | 16.46 |
| III Chicken manure | 19.10 | 15.75 | 9.73 | 4.86 | 4.54 | 0.60 | 7.48 | 0.170 | 8.07 | 0.55 | 16.37 |
| IV Control | 19.19 | 15.75 | 9.13 | 4.38 | 4.52 | 0.63 | 8.80 | 0.190 | 30.25 | 1.16 | 14.46 |
| CV % | 1.03 | 1.91 | 4.32 | 10.68 | 10.29 | 4.74 | 25.27 | 4.44 | 59.20 | 54.68 | 10.09 |

The highest average content of inverted sugar in fresh plum fruits of 'Tegera' was found in the first experimental year in the conventional fertilization variant and lowest in the control.

The results obtained indicate that for the period 2016-2017 the bio fertilizer variant is distinguished by a high percentage of sucrose with an average of 4.97%.

The analyzed and quantified organic acids have similar values among the four test variants. The average of the indicator during the years of study and the average for the experimental period is about 0.60%.

In 2017 compared to 2016, the most pronounced increased in the ascorbic acid content was found in the conventional fertilizer variant with 19.36 mg /%. The increase was also observed in the other experimental variants.

The amount of tannins from the variants in the second experimental year was lower than the previous year. It was 0.131% in the chicken manure variant and control, while it was 0.094% in the conventional fertilizer variant and the conventional fertilization.

The anthocyanin content in the second experimental year had significantly lower values and differences, which determined the high variation coefficient. For the period 2016-2017, high content was found in the control with an average value of 30.25 mg%, while the lowest anthocyanin content was found in the chicken manure with 8.07 mg%.

During the two-year biochemical analysis, the pectin amount varied significantly. In the first experimental year, the highest content was reported for bio-fertilization variant with 0.87%, and in the second one for the control - 1.80%.

The effect of fertilization on the results of the acidimetric coefficient (the ratio of sugars to acids), which largely determines the taste of the fruit, is clearly evident. According to Minev, (2002), plum fruit cultivars containing sugars from 11% to 17% have the best flavours and a percentage of acidity from 0.16% to 0.74%. In the second experimental year, fertilizer variants increased their values for the indicator. The highest acidimetric coefficient was found in the first and the second variant with bio and conventional fertilization, respectively 18.53 and 16.46.

**Table 16. Biochemical composition of dried plum fruits of 'Tegera' in 2016**

| Indicators<br>Variants | Dry weight, % | Total sugars, % | Inverted sugar, % | Sucrose, % | Malic acid, % | Ascorbic acid, mg % | Tannins, % | Anthocyanins, mg % | Pectin, % | Acidimetric coeficient |
|---|---|---|---|---|---|---|---|---|---|---|
| I Bio fertilization | 83.23 | 36.50 | 32.70 | 3.61 | 2.32 | 7.04 | 0.54 | 17.26 | 0.68 | 15.73 |
| II Conventional fertilizer | 82.85 | 42.70 | 34.40 | 7.88 | 2.19 | 8.80 | 0.457 | 20.32 | 0.41 | 19.50 |
| III Chicken manure | 79.09 | 38.90 | 35.40 | 3.32 | 1.93 | 7.04 | 0.457 | 10.81 | 0.11 | 20.15 |
| IV Control | 84.95 | 38.20 | 34.4 | 3.61 | 2.19 | 7.04 | 0.706 | 12.74 | 1.31 | 17.44 |
| CV % | 1.17 | 6.70 | 3.27 | 47.5 | 7.58 | 11.76 | 21.73 | 28.21 | 81.45 | 11.06 |

The biochemical analysis conducted in 2016 showed that dry weight in dried fruit of 'Tegera' had significantly higher results than the fresh ones. The differences in reported values between the variants are within narrow limits, which results in a very low coefficient of variation. The highest value was registered in the control - 84.95%. The lowest result was obtained for the third variant (chicken manure) - 79.09% (**Table 16**).

The highest total sugar content was registered in the conventional fertilization variant - 42.70% and the lowest in the bio-fertilization variant - 36.50%.

Almost similar results were obtained for invert sugar values, with a low CV% of the different fertilizer variants. A significant sucrose amount was registered in the conventional fertilization variant - 7.88%. In the other variants, the values are about 2 times lower than those of conventional fertilizers. A high coefficient of variation (47.50%) was reported.

Organic acid content ranged from 1.93% in chicken manure to 2.32% in the bio-fertilization variant with a low variation coefficient.

The ascorbic acid amount was 8.80 mg /% in conventional fertilization and 7.04 mg /% in the other three variants.

The tannins were in the range of 0.46% to 0.71% with a high coefficient of variation.

The highest anthocyanin content was found in the second variant - 20.32 mg /%, while in the first one they decreased to 17.26 mg /%. The lowest content was registered in the third variant - 10.81 mg /% and the control 12.74 mg /%. Again, the coefficient of variation is high in this indicator.

Pectin results are different. The lowest values were recorded in the fruits fertilized with chicken manure and the highest in the control - 1.31%. The coefficient of variation is high (81.45%)

According to Forni et al., (1992), quality plum fruit should have an acidimetric coefficient between 12 and 24. Our results are in the indicated range. The highest acidimetric coefficient for both fresh and dried fruits was registered for in the variant of chicken manure, for fresh fruit it was 16.01 and for dried - 20.15.

In the first experimental year, significant differences were observed in the content of total polyphenols and antioxidant activity in fresh and dried fruits in the variant.

The highest values of polyphenols in fresh fruit were reported for conventional fertilization - 210.00 mgGAE/100, followed by the control - 190.00 mgGAE/100, bio fertilization - 127.00 mgGAE/100 and chicken manure - 124.00 mgGAE/100 (Fig. 6). A similar amount of total polyphenols was analyzed by Kaulmann et al., (2014), ranging from 5 to 209 mgGAE/100g FW. Kim et al., (2003) also report similar results where total fresh fruit polyphenols range from 181.3 mgGAE/100g in the Stanley variety to 372.6 mgGAE/100g for 'Beltsville Elite' cultivar. As noted by Chun et al. (2003), the amount also ranges from 138.1 mgGAE/100g for NY 9 (NY 9) to 684.5 mgGAE/100g for Beltsville Elite. The highest in fruit was registered in the chicken manure variant - 926.67 µmolTE/100g and conventional fertilization - 597.78 µmolTE/100g, The lowest antioxidant activity was reported in the control - 114.44 µmolTE/100g The results had a high coefficient of variation (82.5%). Higher levels of antioxidant activity in the fertilization variant indicate its potential impact on the indicator.

The highest total polyphenols were reported in dried fruits in the conventional fertilization variant - 390.00 mgGAE/100, followed by bio- fertilization - 266.00 mgGAE/100, the control - 264.00 mgGAE/100 and chicken manure ¬ 260.00 mgGAE/100. In the study of Cinquanta et al. (2002) the total polyphenols content of dried plums varies from 340 to 610 mg GAE/100g dry weight.

The highest antioxidant activity was registered in the bio-fertilization variant - 220.00 µmolTE/100g and the control - 200.00 µmolTE/100g. The lowest is for chicken manure - 160.00 µmolTE/100 g.

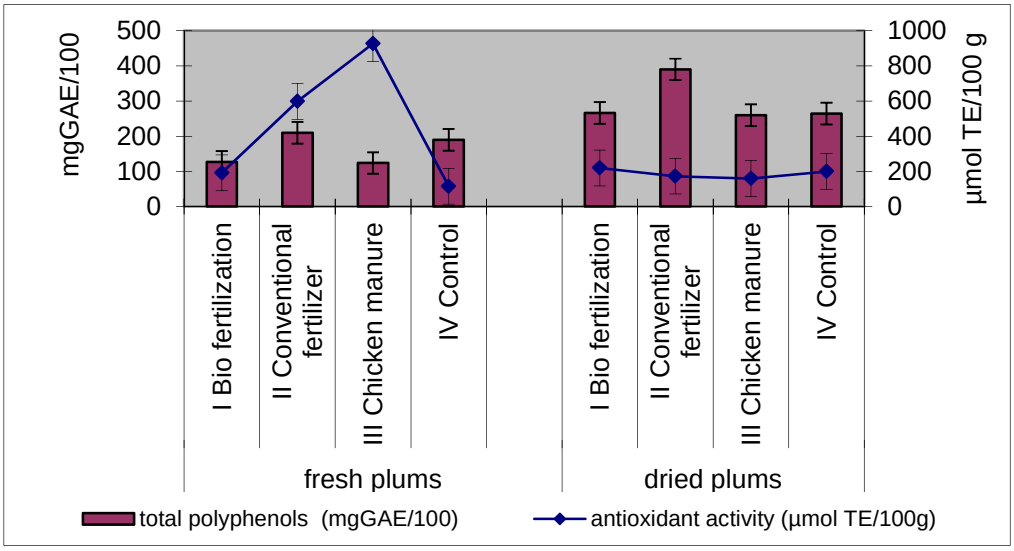


**Figure 6. Effect of different fertilization variants on the content of total polyphenols (mgGAE/100) and antioxidant activity (µmolTE/100g) in fresh and dried plum fruits of 'Tegera' cultivar in 2016. (± SE)**

### 6.2. Colour parameters of fresh and dried plum fruits of 'Tegera' cultivar in 2016

Determining the degree of impact of fertilizers applied on the fruit colour characteristics is an important element characterizing their quality.

In the case of fresh fruits, the highest colour brightness was registered in the bio-fertilization variant - 25.10 (**Table 17**), followed by the control and the other two fertilizer variants. The variation in the values for that indicator is low.

**Table 17. Colour characteristics of fresh and dried plum fruits of 'Tegera' cultivar in 2016**

| Indicators<br>Variant | Colour brightness, L | Red colour tone, a | Yellow colour tone, b | Colour tone, a/b |
|---|---|---|---|---|
| | | fresh fruit | | |
| I Bio fertilization | 25.10 | 29.21 | 15.81 | 1.85 |
| II Conventional fertilizer | 21.34 | 21.57 | 9.20 | 2.34 |
| III Chicken manure | 22.45 | 27.85 | 13.01 | 2.14 |
| IV Control | 24.04 | 31.08 | 13.70 | 2.27 |
| CV % | 7.17 | 15.03 | 21.32 | 10.07 |
| | | dried fruit | | |
| I Bio fertilization | 18.65 | 5.07 | 0.73 | 6.94 |
| II Conventional fertilizer | 17.32 | 6.69 | 4.71 | 1.42 |
| III Chicken manure | 19.50 | 4.96 | 2.38 | 2.08 |
| IV Control | 17.16 | 4.67 | 1.18 | 3.96 |
| CV % | 6.15 | 17.03 | 79.19 | 68.69 |

Regarding the red colour, fertilization had no effect. The highest values were registered in fruits from the control - 31.08 and from the variant with bio-fertilization - 29.21. The highest impact of fertilizing for the yellow colour was registered in the bio-fertilization variant - 15.81 and the lowest in the conventional fertilization - 9.20. The highest value of the qualitative indicator of color tone was registered in the conventional fertilization variant, followed by the control, chicken manure and bio-fertilization. Bio-fertilizers had an impact on the yellow colour in fresh fruit.

The value of colour brightness in dried fruit was lower than fresh fruit. The results obtained ranged from 17.16 (conventional fertilization) to 19.50 in the case of chicken manure. The red colour component does not show significant variation in values between variants. The highest amount was recorded in the fruits of conventional fertilization - 6.69, and the lowest in the nontreated control - 4.67. After the drying process, the colour components with few exceptions had higher values than the fertilized variants. A high variation coefficient was found for the yellow colour, as a result of its considerable variation between the formulations of the experiment. The highest amount was found in the conventional fertilization variant - 4.71, followed by chicken manure - 2.38, the control - 1.18 and bio fertilization - 0.73. 6:)The values significantly decreased in the bio-fertilization variant in dried fruits, compared to the same variant of the fresh fruit. In the same context, the slightest reduction in yellow tones in fruits with conventional fertilization is recorded - 4.71.
The same tendency for significant differences between the variants is observed in the color characteristic color tone. In the case of dried plum fruits, the first variant of organic fertilization is distinguished by its high value - 6.94, which is a sign of deterioration between the colour parameters of the fruits, compared to the fresh ones. The reported quantity in the control was almost twice lower - 3.96, followed by the variant with chicken manure - 2.08 and conventional fertilization - 1.42. The different values found between the variants determined a high coefficient of variation - 68.69%.
From the analysis of the data regarding the quality characteristics of fruits, the slightest change was registered by the variants of fresh and dried fruits with the application of chicken manure.

### 6.3. Biochemical composition of fresh and dried ’Elena’ fruit

The biochemical analysis of fresh plum fruits of ’Elena’ carried out during the three-year experimental period is presented in Table 18. Based on the obtained results, the values of dry weight of fruit is in the range from 16.23% (chicken manure 2018) to 21.02%. (control 2016). The control variant also has the highest average value for the study period 18.92%.

There are no significant differences in the content of dry refractometric substances between the experimental variants during the studied years, which determines their low coefficient of variation.

The values of total sugars have varied results over the study period. The difference in 2016 is noticeable between the first variant (14.30%) and the other variants, where its content is very close to 10%. From the analysis of the same indicator, Kaulmann et. al., 2014 find that the total content of sugars in plums varies between 8.5 and 19.6 g/100g of fresh weight. The range specified by the author also includes the results analyzed by us, recorded throughout the test period.

From the three-year biochemical analysis it was found that with each subsequent experimental year, the content of the invert sugar analyzed increased in all variants. The highest values were reported in the first variant (bio-fertilization) - in 2016. - 6.00%; 2017 - 7.00% and 2018 - 8.70%. On average for 2016-2018, the highest sucrose content was found in the conventional fertilization variant - 5.18%.

The amounts of organic acids are in close range, both during the respective experimental years and throughout the period. On average, they range from 0.37% (conventional fertilization) to 0.48% (control). The values obtained for ’Elena’ cultivar are lower than those obtained for ’Tegera’.

**Table 18. Biochemical composition of fresh plum fruits of 'Elena' cultivars over the years and average for the period 2016-2018**

| Indicators Variants | Dry weight, % | Dry weight in Re, % | Total sugars, % | Inverted sugar, % | Sucrose, % | Malic acid, % | Ascorbic acid, mg % | Tannins % | Anthocyanins, mg % | Pectin, % | Acidimetric coeficient |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2016 | | | | | | |
| I Bio fertilization | 20.46 | 21.00 | 14.30 | 6.00 | 7.89 | 0.45 | 5.28 | 0.145 | 13.39 | 0.91 | 31.77 |
| II Conventional fertilizer | 18.70 | 18.00 | 10.05 | 5.35 | 4.47 | 0.32 | 5.28 | 0.145 | 18.23 | 0.86 | 32.81 |
| III Chicken manure | 19.89 | 20.25 | 10.40 | 5.70 | 4.47 | 0.45 | 5.28 | 0.233 | 34.52 | 0.42 | 23.11 |
| IV Control | 21.02 | 19.00 | 10.90 | 5.35 | 5.27 | 0.45 | 5.28 | 0.187 | 18.23 | 0.94 | 24.22 |
| CV % | 4.95 | 6.80 | 17.17 | 5.53 | 29.35 | 15.57 | - | 22.22 | 43.81 | 30.77 | 17.94 |
| | | | | | 2017 | | | | | | |
| I Bio fertilization | 17.08 | 22.00 | 9.90 | 7.00 | 2.76 | 0.48 | 8.80 | 0.169 | 29.03 | 1.49 | 20.62 |
| II Conventional fertilizer | 16.68 | 21.00 | 12.95 | 6.35 | 6.27 | 0.41 | 5.28 | 0.056 | 6.45 | 1.19 | 31.58 |
| III Chicken manure | 18.22 | 20.00 | 13.15 | 7.00 | 5.84 | 0.41 | 7.04 | 0.094 | 13.23 | 1.34 | 32.07 |
| IV Control | 18.55 | 19.50 | 11.10 | 7.00 | 3.90 | 0.48 | 7.04 | 0.131 | 22.26 | 0.92 | 23.12 |
| CV % | 5.07 | 5.37 | 13.19 | 4.75 | 35.16 | 9.08 | 20.41 | 43.15 | 55.96 | 19.68 | 21.76 |
| | | | | | 2018 | | | | | | |
| I Bio fertilization | 17.25 | 18.50 | 12.95 | 8.70 | 4.04 | 0.45 | 8.80 | 0.181 | 9.84 | 0.06 | 28.77 |
| II Conventional fertilizer | 19.05 | 19.00 | 13.25 | 8.20 | 4.80 | 0.38 | 10.56 | 0.145 | 8.06 | 0.06 | 34.86 |
| III Chicken manure | 16.23 | 17.00 | 13.15 | 8.05 | 4.85 | 0.38 | 12.32 | 0.072 | 6.13 | 0.02 | 34.60 |
| IV Control | 17.18 | 18.00 | 13.65 | 8.55 | 4.85 | 0.51 | 8.80 | 0.163 | 13.06 | 0.13 | 26.76 |
| CV % | 8.18 | 4.69 | 2.18 | 3.58 | 8.42 | 13.95 | 16.60 | 28.57 | 31.71 | 66.66 | 13.12 |
| | | | | | **2016-2018** | | | | | | |
| I Bio fertilization | 18.26 | 20.50 | 12.38 | 7.23 | 4.90 | 0.46 | 7.63 | 0.165 | 17.42 | 0.82 | 27.05 |
| II Conventional fertilizer | 18.14 | 19.33 | 12.08 | 6.63 | 5.18 | 0.37 | 7.04 | 0.115 | 10.91 | 0.70 | 33.08 |
| III Chicken manure | 18.11 | 19.08 | 12.23 | 6.92 | 5.05 | 0.41 | 8.21 | 0.133 | 17.96 | 0.59 | 29.93 |
| IV Control | 18.92 | 18.83 | 11.88 | 6.97 | 4.67 | 0.48 | 7.04 | 0.160 | 17.85 | 0.66 | 24.70 |
| CV % | 2.07 | 3.75 | 1.72 | 3.46 | 4.24 | 9.3 | 7.48 | 14.28 | 21.33 | 13.04 | 12.61 |

Multiple results were also reported for the ascorbic acid indicator. In both cultivars, the average content of the element had close values between the experimental variants.

The quantitatively determined tannins and anthocyanins varying significantly over the three-year trial period, with a high variation factor. On average during the test period, the amount of tannins was highest for the bio fertilizer variant (0.165%) and lowest for conventional fertilizer (0.115%). The conventional fertilizer variant had the lowest average content for the period 2016-2018 - 10.91mg%.

The pectin amount in the second experimental year, significantly increased compared to the previous one, and in the next 2018 it decreased sharply.

The highest average acidimetric coefficient of fresh fruit in the two consecutive years 2017 and 2018 in the variants of conventional fertilization and chicken manure.

The total polyphenols and antioxidant activity in fresh plum fruits showed that total polyphenols ranged from 104.00 mgGAE/100 in the chicken manure variant (III variant) to 119.00 mgGAE/100 in the control ( Option IV). A high variation coefficient and a clear difference between the first and the other variants were obtained in terms of antioxidant activity. It is highest for biofertilization of 200.00 μmolTE/100g and in the other variants their values ranged from 110.00 μmolTE/100g to 123.00 μmolTE/100g (**Figure 7**).

In the case of dried fruits, the values of the dry weight between the variants are in the narrow range - 83.49-85.59%, which indicates that the drying process has proceeded to standard norms. A very low variation coefficient was established (**Table 19**).

The lowest total sugar content was registered in the variant with bio-fertilization - 6.70% compared to the other ones. The highest values were in the fruits of conventional fertilization - 17.80%. The results obtained from the variants for invert sugar and sucrose are almost analogous. For invert sugar, the values for conventional fertilization and chicken manure are respectively: 9.40% and 9.00%, and the lowest for bio-fertilization - 5.70%. The highest amounts of sucrose were found in fruits with conventional fertilization - 7.98% and controls - 7.32%. A much lower sucrose is reported than the first variant - 0.95%.

Organic acids are close to variants in the range 0.52 - 0.64%.

**Table 19. Biochemical composition of dried plum fruits of 'Elena' in 2016**

| Indicators<br>Variants | Dry weight, % | Total sugars, % | Inverted sugar, % | Sucrose, % | Киселини като ябълчна, % | Ascorbic acid, mg % | Tannins, % | Anthocyanins, mg % | Pectin, % | Acidimetric coeficient |
|---|---|---|---|---|---|---|---|---|---|---|
| I Bio fertilization | 83.49 | 6.70 | 5.70 | 0.95 | 0.64 | 7.04 | 0.249 | 37.10 | 0.07 | 10.47 |
| II Conventional fertilizer | 85.59 | 17.80 | 9.40 | 7.98 | 0.52 | 5.28 | 0.125 | 21.13 | 0.27 | 34.32 |
| III Chicken manure | 85.43 | 12.70 | 9.00 | 3.52 | 0.52 | 8.80 | 0.125 | 17.90 | 0.93 | 24.42 |
| IV Control | 85.40 | 15.40 | 7.70 | 7.32 | 0.64 | 7.04 | 0.083 | 20.65 | 0.30 | 24.06 |
| CV % | 1.16 | 36.34 | 21.01 | 67.00 | 12.07 | 20.41 | 50.00 | 36.05 | 94.87 | 41.91 |

The highest ascorbic acid amount was found in fertilizing with granulated chicken manure - 8.80 mg /% and the lowest in conventional fertilization - 5.28 mg/%. Bio fertilization and control results are the same - 7.04 mg /%.

There was a significant variation in the values of the tannin content for different types of fertilization. They reached 0.249% in the first variant. They were approximately twice lower in the second and third one - 0.125% and least in the control - 0.083%.

A high variation coefficient was observed in the anthocyanin values. They were in the range of 17.90 mg/% (variant III) to 37.10 mg/% (variant I). Their decrease in comparison to the bio-fertilization was 1.5 times converted to dry units. The tannin amount in the control was 20.65 mg/%.

The results were also different in the pectin content. The lowest values were registered in fruit with bio-fertilization - 0.07% and the highest in the chicken manure - 0.93%. An extremely high coefficient of variation was reported.

A significant difference is observed in the acididimetric coefficient of dried fruit in the bio-fertilization variant, which is 3 times smaller than the fresh ones. Other variants of fertilization do not show significant differences between fresh and dried fruits.

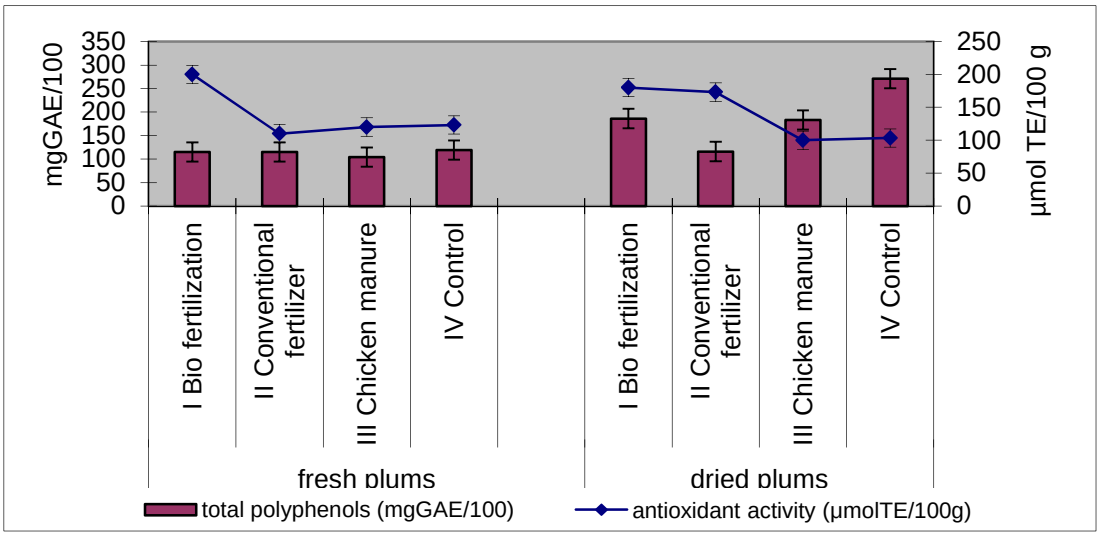


**Figure 7. Effect of different fertilizing variants on the content of total polyphenols (mgGAE/100) and antioxidant activity (µmolTE/100g) in fresh and dried plums of 'Elena' cultivar 2016 (± SE)**

The highest content of total polyphenols was found in dried fruits in the control - 271.00 mgGAE/100 and the variants with bio-fertilization - 186.00 mgGAE/100 and chicken manure - 183.00 mgGAE/100 (**Fig. 7**).

The highest antioxidant activity was registered in the bio-fertilization variants - 180.00 µmolTE/100g and the conventional fertilizer - 173.33 µmolTE/100g. Lower antioxidant activity was reported in the other two variants.

### 6.4. Colour parameters of fresh and dried plums of 'Elena' cultivar for 2016

Fruit colour parameters can be used to describe colour change and provide useful data on quality control in fruits and vegetables (Maskan et al., 2002).

In 2016, fresh fruits in the third variant (chicken manure) were distinguished with the highest brightness and those of conventional fertilization with the lowest (**Table 20**).

The colour characteristic of red colour tone is a low variation indicator in the experimental variants. Like 'Tegera'cultivar, the highest values were registered in the bio-fertilization - 28.89 and the control - 28.75.

**Table 20. Colour characteristics of fresh and dried plum fruits of 'Elena'cultivar in 2016**

| Indicators<br>Variant | Colour brightness,<br>L | Red colour tone,<br>a | Yellow colour tone,<br>b | Colour tone,<br>a/b |
|---|---|---|---|---|
| | | fresh fruit | | |
| I Bio fertilization | 25.81 | 28.89 | 13.61 | 2.12 |
| II Conventional fertilizer | 24.61 | 28.31 | 14.42 | 1.96 |
| III Chicken manure | 27.24 | 24.85 | 14.88 | 1.67 |
| IV Control | 26.82 | 28.75 | 14.57 | 1.97 |
| CV % | 4.49 | 6.92 | 3.77 | 9.75 |

| | | dried fruit | | |
|---|---|---|---|---|
| I Bio fertilization | 25.55 | 28.31 | 14.27 | 1.98 |
| II Conventional fertilizer | 27.13 | 27.21 | 14.75 | 1.84 |
| III Chicken manure | 26.60 | 26.82 | 15.04 | 1.78 |
| IV Control | 26.02 | 28.37 | 13.66 | 2.08 |
| CV % | 2.61 | 2.82 | 4.18 | 7.06 |

The yellow colour parameter has similar results among different fertilization variants and controls.

The colour tone indicator is in the range of 1.67, the value was reported in the chicken manure variant to 2.12 in the bio-fertilization variant.

Unlike fresh fruits, the highest colour brightness was distinguished in conventional fertilization - 27.13. The reported indicator had a low variation in the different fertilization variants.

The red tone colour parameter had similar values for control and bio fertilization, respectively 28.37 and 28.31. The lowest result was observed for chicken manure - 26.82.

The yellow colour was in the range from 13.66 registered in the control to 15.04 in the chicken manure variant.

The colour tone parameter for dried fruits identical to the red colour was most pronounced in the control - 2.08 and bio-fertilization - 1.98, and the least in the third variant (chicken manure).

### 6.5. Biochemical composition of dried plum fruits of ’Elena’ in an alternative energy source dryer

An alternative energy source dryer has been tested for comparison and analysis in plum drying technologies.

Dehydration using solar energy is an economical way of storing agricultural products, especially suitable for small to medium-sized fruits (Mekhilefa et al., 2011; Xingxing et al., 2012).

During the third experimental year, fresh plum fruits of ’Elena’ cultivar in the four experimental variants were subjected to drying in RIMSA - Troyan using an alternative energy source dryer.

After the dehydration of plum fruits (**photo 1**), their biochemical composition was analyzed.

**Photo 1. Drying of plum fruits of ’Elena’ in a dryer with an alternative source of energy**

The dry weight in the dried fruits was in the range of 86-87% (**Table 21**). The values obtained are approximately similar to those reported for fruits dried by heat pump.

**Table 21. Biochemical composition of dried plum fruits of 'Elena' cultivar in 2018**

| Indicators Variants | Dry weight, % | Total sugars, % | Inverted sugar, % | Sucrose, % | Malic acid, % | Ascorbic acid, mg % | Tannins, % | Anthocyanins, mg % | Pectin, % | Acidimetric coeficient |
|---|---|---|---|---|---|---|---|---|---|---|
| I Bio fertilization | 87.19 | 28.30 | 15.40 | 12.26 | 1.28 | 21.12 | 0.199 | 58.03 | 0.91 | 22.10 |
| II Conventional fertilizer | 86.79 | 29.00 | 15.40 | 12.92 | 1.40 | 17.60 | 0.181 | 29.35 | 1.31 | 20.71 |
| III Chicken manure | 86.53 | 28.30 | 18.80 | 9.03 | 1.54 | 17.60 | 0.325 | 27.27 | 1.05 | 18.37 |
| IV Control | 87.02 | 25.60 | 17.10 | 8.08 | 1.28 | 14.08 | 0.343 | 49.84 | 1.61 | 20.00 |
| CV % | 0.32 | 5.39 | 9.71 | 22.42 | 8.75 | 16.30 | 30.53 | 36.94 | 24.59 | 7.63 |

Unlike fresh fruits, in the case of dried fruits, the total sugars and sucrose amount was higher in the fertilization variant than the control.

The reported percentage of inverted sugar was in the range of 17.10% (control) - 18.80% (chicken manure) and approximately 15% in conventional and bio-fertilization. Organic acids ranged from 1.28% for bio-fertilization and the control to 1.54% for chicken manure. The content of ascorbic acid varied with an average coefficient (CV% 16.30) from 14.08 mg/% (control) to 21.12 mg/% (bio fertilizer). Unlike fresh fruits in dried fruits, the amount of anthocyanins was significantly higher, which ranged from 27.27 mg% (chicken manure) to 58.03 mg% (bio fertilizer), which was why the coefficient of variation was also high (CV% 36.94). An identical tendency to increase in values after some indicators after fruit drying is also observed in pectin results.

### 7. Agrochemical analysis of soil in plum plantation 'Stanley' cultivar

Soil fertility is essential in assessing the quality and productivity of fruit trees. It is expressed by providing the necessary nutrients for the trees. Therefore, genetic soil properties and fertilization are an important element of soil fertility management.

The analysis of the basic nutrients in the first experimental year 2016 revealed that within the intra-row the average values of the soil reaction at all three soil depths were similar. It was from medium to slightly acidic reaction of the medium - pH in $H_2O$ = 6.17-6.27; in KCl = 5.50-5.77 (**Table 22**).

**Table 22. Composition of agrochemical indices of soil layers in 'Stanley' plum cultivar in intra-row spacings (2016)**

| Soil layers cm | | pH | | $\sum$ N-$NH_4$+$NO_3$ | $P_2O_5$ | $K_2O$ | Humus |
|---|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | mg/kg | mg/100 g | | % |
| 0-20 cm | Minimum | 5.1 | 4.8 | 16.7 | 5.0 | 23.4 | 1.59 |
| | Maximum | 7.2 | 6.9 | 21.3 | 11.0 | 39.1 | 2.16 |
| | Mean | 6.17 | 5.77 | 19.00 | 7.93 | 29.60 | 1.92 |
| | St error | 0.61 | 0.61 | 1.33 | 1.73 | 4.82 | 0.17 |
| | St Dev | 1.05 | 1.06 | 2.30 | 3.00 | 8.35 | 0.29 |
| | CV % | 17.02 | 18.37 | 12.10 | 37.83 | 28.21 | 15.10 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 20-40 cm | Minimum | 5.2 | 4.2 | 16.7 | 1.6 | 13.7 | 0.55 |
| | Maximum | 7.5 | 7.3 | 20.7 | 2.7 | 25.0 | 1.07 |
| | Mean | 6.10 | 5.50 | 18.23 | 2.00 | 21.13 | 0.80 |
| | St error | 0.71 | 0.93 | 1.24 | 0.35 | 3.72 | 0.15 |
| | St Dev | 1.23 | 1.61 | 2.16 | 0.61 | 6.44 | 0.26 |
| | CV % | 20.16 | 29.27 | 11.85 | 30.5 | 30.47 | 32.50 |
| 40-60 cm | Minimum | 5.0 | 4.4 | 5.2 | 0.3 | 16.1 | 0.26 |
| | Maximum | 7.8 | 7.0 | 20.1 | 3.4 | 29.5 | 2.25 |
| | Mean | 6.27 | 5.52 | 11.90 | 2.00 | 22.00 | 1.09 |
| | St error | 0.41 | 0.39 | 2.01 | 0.54 | 2.32 | 0.29 |
| | St Dev | 0.99 | 0.97 | 4.92 | 1.32 | 5.69 | 0.71 |
| | CV % | 15.79 | 17.57 | 41.34 | 66.00 | 25.86 | 65.14 |

The amount of absorbed nitrogen, reported along the row, decreased with depth increasing, nevertheless the element was insufficient in all three soil layers. Variability in the first two layers of 0-20 cm and 20-40 cm was from medium to low, due to the reported almost identical minimum and maximum values. At a depth of 40-60 cm, the element ranged from 5.2 mg/kg to 20.1 mg/kg, which determined a high variation coefficient (CV 41.34%).

Phosphorus at a soil layer of 0-20 cm had an average result of 7.93 mg/100 g, which decreased sharply as the depth increased. Identical to nitrogen, at 40-60 cm, the variation in phosphorus values was large from 0.3 to 3.4 mg/100g, affecting respectively the significantly high coefficient of variation.

Inside the intra-row space, the potassium was highly variable at all soil depths. At 0-20 cm, the macronutrient averaged 29.60 mg/100g. at 20-40 cm - 21.13 mg/100g and at 40-60 cm - 22.00 mg/100g. As a result of the analysis it was found that the studied soil layers had good potassium content.

The highest humus content was registered in the surface layer 0-20 cm (average - 1.92%), which defined it as poorly preserved. The remaining two layers, 20-40 cm with 0.8% and 40-60 cm with 1.09%, were also very poorly stocked. The variation in organic matter values of 0-20 cm was medium and high for the other two depths.

**Table 23. Composition of agrochemical indicators of soil layers in the row spacing of 'Stanley' cultivar (2016)**

| Soil layers cm | | pH | | ∑ N-$NH_4$+$NO_3$ | $P_2O_5$ | $K_2O$ | Humus |
|---|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | mg/kg | mg / 100 g | | % |
| 0-20 cm | Minimum | 5.3 | 4.9 | 10.9 | 3.0 | 24.7 | 1.24 |
| | Maximum | 7.0 | 6.7 | 21.3 | 12.5 | 39.7 | 2.41 |
| | Mean | 6.20 | 5.78 | 16.31 | 6.71 | 32.30 | 1.88 |
| | St error | 0.17 | 0.17 | 1.09 | 0.93 | 1.74 | 0.10 |
| | St Dev | 0.53 | 0.52 | 3.29 | 2.78 | 5.21 | 0.31 |
| | CV % | 8.55 | 8.99 | 20.17 | 41.43 | 16.13 | 16.48 |
| 20-40 cm | Minimum | 4.5 | 4.1 | 12.7 | 0.4 | 15.6 | 0.43 |
| | Maximum | 7.1 | 6.9 | 20.2 | 3.9 | 25.3 | 1.23 |
| | Mean | 5.80 | 5.20 | 16.50 | 1.80 | 21.40 | 0.80 |
| | St error | 0.26 | 0.27 | 1.02 | 0.41 | 1.17 | 0.09 |
| | St Dev | 0.77 | 0.81 | 3.06 | 1.24 | 3.5 | 0.27 |
| | CV % | 13.27 | 15.57 | 18.54 | 68.88 | 16.35 | 33.75 |
| 40-60 cm | Minimum | 4.9 | 4.3 | 9.8 | 1.1 | 19.8 | 0.50 |
| | Maximum | 6.1 | 5.6 | 13.2 | 2.2 | 28.8 | 0.98 |
| | Mean | 5.27 | 4.72 | 11.80 | 1.60 | 23.05 | 0.82 |
| | St error | 0.28 | 0.30 | 0.71 | 0.27 | 2.00 | 0.11 |
| | St Dev | 0.57 | 0.60 | 1.43 | 0.53 | 4.00 | 0.22 |
| | CV % | 10.81 | 12.71 | 12.12 | 33.15 | 17.35 | 26.83 |

The data from the assessment of the agrochemical status of the soil in the row spacings of 'Stanley' (**Table 23**) showed that the soil reaction in KCl solution increased with increasing depth of the soil layers.

The 0-20 cm surface layer had a medium to slightly acidic reaction. In the next 20-40 cm layer with pH 5.2, the degree of acidity increased. The tendency to increase it continued at 40-60 cm depth with a strongly acid reaction of the soil - 4.7. The coefficient of variation at the three depths ranged from low to high.

The average nitrogen content in the row spacing, expressed in ammonia and nitrate at three depths ranged from 11.8 mg/kg in the 40-60 cm layer to 16.5 mg/kg at 20-40 cm. As a result of the quantification of nitrogen, soil layers was found to be low in nutrients.

The phosphorus amount in the interrows, identical to the intra row spacing, decreased as the depth increased. The highest average phosphorus content was reported at a depth of 0-20 cm - 6.71 mg/100g, as the highest value of 12.5 mg/100g was reported at that level. The results at 20-40 cm and 40-60 cm were respectively 1.8 mg/100 g and 1.6 mg/100 g respectively. Based on the data obtained, it can be determined that the soil layers, except for the first one, were poorly stocked with phosphorus, which determines the high variation coefficient.

The row spacing also had high potassium values. The variation in its content at different depths was average. Its highest amount was registered at the surface layer 0-20 cm - 32.30 mg/100g.

**Table 24. Composition of agrochemical parameters of soil layers in 'Stanley' plum cultivar in intra row spacings (2017)**

| Variant | Soil layer cm | pH | | ∑ N- NH4+NO3 | $P_2O_5$ | $K_2O$ | Humus |
|---|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | mg/kg | mg/100 g | | % |
| I Bio fertilization | 0-20 | 6.1 | 5.4 | 13.2 | 4.8 | 23.2 | 2.41 |
| | 20-40 | 5.6 | 4.8 | 14.4 | 2.2 | 18.3 | 2.48 |
| | 40-60 | 5.3 | 4.7 | 11.5 | 3.1 | 15.7 | 0.83 |
| II Conventional fertilizer | 0-20 | 6.1 | 5.2 | 11.5 | 6.7 | 30.2 | 2.10 |
| | 20-40 | 6.1 | 5.2 | 12.1 | 4.4 | 24.0 | 1.92 |
| | 40-60 | 6.1 | 5.1 | 16.7 | 1.4 | 18.3 | 0.94 |
| III Chicken manure | 0-20 | 6.3 | 5.5 | 57.6 | 14.0 | 31.5 | 2.08 |
| | 20-40 | 6.9 | 6.2 | 12.1 | 6.3 | 19.3 | 1.92 |
| | 40-60 | 6.9 | 6.2 | 13.2 | 1.5 | 17.2 | 1.06 |
| IV Control | 0-20 | 5.5 | 4.9 | 16.1 | 2.2 | 20.7 | 1.72 |
| | 20-40 | 6.1 | 5.2 | 15.6 | 1.0 | 19.4 | 0.90 |
| | 40-60 | 6.1 | 5.2 | 15.6 | 1.3 | 16.2 | 0.55 |

Similar to the results obtained in the intra row spacing, the highest humus content in the inter-row spacing was found in the surface soil layer 0-20 cm (on average - 1.88%), which defined it as low stocks. At the other two depths, humus content values were very low and almost equal, respectively: 0.80% and 0.82%.

In 2017, the soil layers in the fertilization variants retained medium to slightly acidic soil reaction of the medium - pH in $H_2O$ = 5.3-6.3; in KCl = 4.7-6.2. (**Table 24**). An exception was the soil depths of 20-40 cm and 40-60 cm from the chicken manure variant, where pH of the medium in water went to neutral.

As a result of the analysis in the second year, a decrease in the amount of nitrogen, randing from 11.5 mg/100kg to 16.7 mg/100kg was reported. Only at 0-20 cm surface layer in the chicken manure variant, a higher quantitative content was found - 57.6 mg/100kg.

In 2017, the available phosphorus content was different in stock compared to the different fertilization variants and soil layers. A significant increase in the indicator compared

to the previous year was recorded at a depth of 20-40 cm in conventional fertilization and chicken manure. An exception was observed in the controls in which no increase in phosphorus content was observed in any of the tested layers.

No significant quantitative change was analyzed for potassium, for all three soil depths from all the experimental variants. However, it is noted that with increasing soil depth, its content decreased.

The humus content in the intra-row spacing in 2017 was higher in the surface layer, except for bio-fertilization, where its values with the next soil layer were almost even compared to the other two in all fertilization variants, including the control. Its percentage content in 0-20 cm layer varied from 1.72% (Control) to 2.41% (bio-fertilization).

The agrochemical analysis conducted in 2018 found that after the applied two-year fertilization there was no difference in soil reaction of the medium both in water and in KCl solution (Table 24). At different depths of the four variants, a slight increase in the content of nitrogen was observed. An exception is the soil profile with bio-fertilizing. It increased the amount of the element in all three layers, as the highest result was found at a depth of 40-60cm (25.9 mg/kg).

**Table 25. Composition of Agrochemical Indicators of Soil Layers in Plum Stanley in Indoor Spaces (2018)**

| Variant | Soil layer cm | pH | | ∑ N- NH4+NO3 | $P_2O_5$ | $K_2O$ | Humus |
|---|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | mg / kg | mg / 100 g | | % |
| I Bio fertilization | 0-20 | 6.3 | 5.5 | 19.6 | 4.9 | 38.1 | 1.68 |
| | 20-40 | 6.3 | 5.6 | 17.0 | 3.7 | 36.0 | 1.69 |
| | 40-60 | 5.5 | 4.7 | 25.9 | 1.7 | 26.9 | 0.87 |
| II Conventional fertilizer | 0-20 | 6.2 | 5.3 | 23.0 | 5.3 | 27.4 | 1.98 |
| | 20-40 | 6.1 | 5.2 | 19.6 | 3.3 | 22.8 | 1.30 |
| | 40-60 | 6.1 | 5.1 | 16.7 | 1.6 | 21.9 | 1.22 |
| III Chicken manure | 0-20 | 7.1 | 6.3 | 17.3 | 9.0 | 30.9 | 2.49 |
| | 20-40 | 7.1 | 6.3 | 17.3 | 6.4 | 37.3 | 2.01 |
| | 40-60 | 7.3 | 6.7 | 23.0 | 2.4 | 22.4 | 1.49 |
| IV Control | 0-20 | 6.1 | 5.2 | 16.1 | 1.8 | 24.1 | 1.92 |
| | 20-40 | 6.6 | 5.7 | 22.5 | 2.9 | 23.4 | 0.72 |
| | 40-60 | 5.5 | 4.8 | 16.7 | 1.3 | 22.7 | 0.66 |

A three-year agrochemical analysis confirmed the poor soil availability of phosphorous. The values were close to those of the previous two years, ranging from 1.3 to 6.4 mg/100g.

In 2018, potassium retained its good stock. Its amount increased at all three soil depths in the bio-fertilization and control variants. Identical to 2017 with increasing soil depth, its content decreased.

There was no significant change in the humus content in 2017 compared to 2018. Higher values were reported in all four variants at the surface soil layer (0-20 cm). As the depth of the soil profile increased, the amount of humus decreased.

### 8. Vegetative indices of ’Stanley’

As a result of the fertilization in 2016, the trees in the conventional fertilization (II variant) had the highest average thickness of the trunks - 50.35 cm, and the smallest ones in the organic fertilization (I variant) - 47.90 cm. The trunks thickening in all variants of the experiment continued in the next two experimental years, except for the second variant, in which the values of the indicator for 2017 increased to 53.70 cm and remained unchanged

next year. Nevertheless, conventional fertilization over the entire study period and average for it (**Table 26**) had the highest value of 52.58 cm, compared to the other variants.

The average height of trees in 2015 before the start of the experiment, in the marked variants, ranged from 4.06 cm to 4.41 cm. In the next two years and the average for the period, the highest values of the indicator were reported for the conventional fertilization variant (2016 - 5.19 cm; 2017 - 6.03 cm; average for the period 2016-2018 - 6.03 cm). In terms of crown width along the row and towards row spacing, the results are in a close range between 2016 and 2017 variants. They are strikingly different from their values in 2018, where lower results were reported due to applied agricultural technology.

The results obtained from the volume of crowns indicate that this indicator is variable between the variants of the different years. Throughout the experimental period 2016-2018, the largest crown volume was registered in the conventional fertilization, respectively: 27.81 $m^3$; 32.45 $m^3$ and 34.22 $m^3$.

The calculation of the length of the annual and total growth at the end of the first vegetation show that conventional fertilization also had the highest values, respectively annual growth of 37.44 cm and total - 149.78 cm. Data reported at the end of the second year of vegetation had the best results for the annual, respectively, and total growth for the variant with bio fertilizer (35.13 cm; 140.51 cm) and at the end of the third year for chicken fertilizer (22.16 cm; 88.65 cm) . On average over the study period, fertilizer variants with bio and conventional fertilizers had the highest annual and total growth rates.

**Table 26. Vegetative indicators of 'Stanley' over the years and average for the period (2015-2018)**

| Indicators Variant | Trunk circumference cm | Crown height m | Crown width in the row m | Crown width in towards row-spacing m | Crown volume $m^3$ | Length of annuam growth cm | Total annuam growth cm |
|---|---|---|---|---|---|---|---|
| 2016 | | | | | | | |
| I Bio fertilization | 47.90 | 5.06 | 4.48 | 4.54 | 26.93 | 33.01 | 132.03 |
| II Conventional fertilizer | 50.35 | 5.19 | 4.53 | 4.52 | 27.81 | 37.44 | 149.78 |
| III Chicken manure | 49.65 | 5.13 | 4.69 | 4.29 | 27.06 | 30.04 | 120.16 |
| IV Control | 49.33 | 4.82 | 4.63 | 4.58 | 26.75 | 32.86 | 131.46 |
| St error | 0.51 | 0.08 | 0.04 | 0.06 | 0.23 | 1.52 | 6.12 |
| St Dev | 1.03 | 0.16 | 0.09 | 0.13 | 0.47 | 3.06 | 12.23 |
| CV % | 2.09 | 3.21 | 3.07 | 2.91 | 1.72 | 9.17 | 9.18 |
| $LSD_{0.05}$ | ns | ns | ns | ns | ns | ns | - |
| 2017 | | | | | | | |
| I Bio fertilization | 49.38 | 5.70 | 4.47 | 4.27 | 28.48 | 35.13 | 140.51 |
| II Conventional fertilizer | 53.70 | 6.03 | 4.24 | 4.83 | 32.45 | 27.01 | 108.06 |
| III Chicken manure | 51.03 | 5.96 | 4.72 | 4.09 | 30.26 | 29.20 | 116.81 |
| IV Control | 49.50 | 5.72 | 4.57 | 4.64 | 31.74 | 22.50 | 88.20 |
| St error | 1.00 | 0.08 | 0.10 | 0.17 | 0.88 | 2.62 | 10.84 |
| St Dev | 2.01 | 0.17 | 0.20 | 0.34 | 1.76 | 5.24 | 21.68 |
| CV % | 3.95 | 2.86 | 4.48 | 7.58 | 5.72 | 18.44 | 19.11 |
| $LSD_{0.05}$ | ns | ns | ns | ns | ns | ns | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2018 | | | | | | | |
| I Bio fertilization | 49.85 | 7.15 | 3.85 | 3.92 | 29.15 | 19.96 | 79.84 |
| II Conventional fertilizer | 53.70 | 6.78 | 3.53 | 4.37 | 34.22 | 21.33 | 85.32 |
| III Chicken manure | 51.83 | 5.96 | 4.17 | 4.01 | 26.10 | 22.16 | 88.65 |
| IV Control | 50.50 | 5.72 | 3.77 | 4.06 | 25.28 | 18.30 | 73.19 |
| St error | 0.84 | 0.33 | 0.13 | 0.09 | 2.02 | 0.84 | 3.38 |
| St Dev | 1.69 | 0.67 | 0.26 | 0.19 | 4.04 | 1.68 | 6.76 |
| CV % | 3.28 | 10.46 | 6.78 | 4.64 | 14.08 | 8.22 | 8.26 |
| $LSD_{0.05}$ | ns | ns | ns | ns | ns | ns | - |
| **2016-2018** | | | | | | | |
| I Bio fertilization | 49.04 | 5.97 | 4.27 | 4.24 | 28.19 | 29.37 | 117.46 |
| II Conventional fertilizer | 52.58 | 6.00 | 4.10 | 4.57 | 31.49 | 28.59 | 114.39 |
| III Chicken manure | 50.84 | 5.68 | 4.53 | 4.13 | 27.81 | 27.13 | 108.54 |
| IV Control | 49.78 | 5.42 | 4.32 | 4.43 | 27.92 | 24.55 | 97.62 |
| CV % | 3.02 | 4.68 | 3.95 | 4.37 | 6.10 | 7.73 | 7.98 |

## 9. Reproductive characteristics and quality of 'Stanley' frui

The average fruit weight with statistically significant differences was reported in 2017 ranged from 41.57 g (bio fertilizer) to 50.00 g (conventional fertilization (**Table 27**). For comparison, it was 43.33 g in the control.

The average stone weight values are in a very close range between the variants. Still, larger fruits had the fruits of conventional (1.96 g) and bio-fertilization (1.92 g).

The average yield of kg/tree in 2017 significantly varied in the variants from 5.00 kg (chicken manure) to 13.02 kg (conventional fertilization), therefore the variation coefficient was high 48.83%. The second fertilization variant was twice as high as the other three variants.

**Table 27. Reproductive characteristics and quality of 'Stanley' (2017)**

| Indicators Variant | Average fruit weight (g) | Stone weight (g) | Average tree yield (kg) | Fruit density ($kg/cm^2$) | Fruit flesh density ($kg/cm^2$) |
|---|---|---|---|---|---|
| 2017 | | | | | |
| I Bio fertilization | 41.57 | 1.84 | 6.22 | 4.99 | 1.50 |
| II Conventional fertilizer | 50.00 | 1.96 | 13.02 | 5.16 | 1.55 |
| III Chicken manure | 45.91 | 1.92 | 5.00 | 4.64 | 1.60 |
| IV Control | 43.33 | 1.80 | 5.95 | 4.35 | 1.41 |
| St error | 1.83 | 0.04 | 1.84 | 0.18 | 0.04 |
| St Dev | 3.66 | 0.07 | 3.68 | 0.36 | 0.08 |
| CV% | 8.10 | 3.88 | 48.83 | 7.56 | 5.34 |
| $LSD_{0.05}$ | 5.31 | - | ns | ns | Ns |

The average highest amount of fruit obtained per unit of tree crown volume (**Figure 8**) was registered in the chicken manure variant (5.56 $kg/m^3$), and the lowest one in the conventional fertilization (2.41 $kg/m^3$).

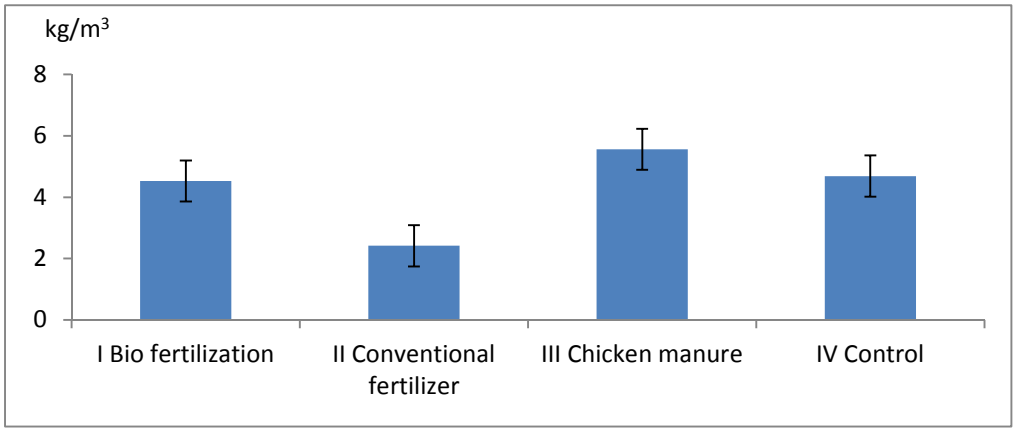


**Figure 8.Yield per unit of crown volume in 'Stanley' cultivar, kg/m$^3$ (± SE)**

The yield (**Figure 9**) is in inverse proportion expressed in g per cm$^2$ of the section of the tree trunk. The second variant (conventional fertilization) was 59.18 g/cm$^2$ and the chicken fertilizer was 24.33 g/cm$^2$.

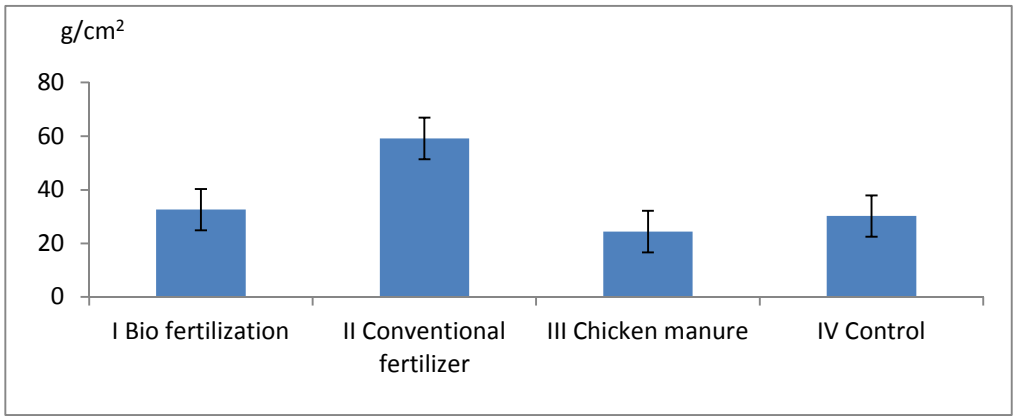


**Figure 9. Yield (g/cm$^2$) of the trunk cross section of 'Stanley' (± SE)**

The analysis of the average fruit density and its flesh shows that the highest fruit firmness was registered in the conventional fertilization, with a result of 5.16 kg/cm$^2$. The most dense fruit flesh was analyzed in the third variant (chicken manure) - 1.60 kg/cm$^2$. The fruits of the control are characterized by the lowest fruit firmness and the lowest fruit flesh density, respectively: 4.35 kg/cm$^2$ and 1.41 kg/cm$^2$ (**Table 27**)

### 10. Biochemical composition of fresh and dried plum fruits of 'Stanley'

The biochemical analysis of fresh fruit plums in 2017 (**Table 28**) showed that the results of the first variant with bio-fertilization were higher in dry refractometrically, ascorbic acid and pectin indicators than the other fertilizatin variants and the control.

**Table 28. Biochemical composition of fresh fruit of 'Stanley' (2017)**

| Indicators Variants | Dry weight, % | Dry weight in Re, % | Total sugars, % | Inverted sugar, % | Sucrose, % | Malic acid, % | Ascorbic acid, mg % | Tannins % | Anthocyanins, mg % | Pectin, % | Acidimetric coeficient |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I Bio fertilization | 19.10 | 19.50 | 11.30 | 7.00 | 4.09 | 0.48 | 8.80 | 0.150 | 10.48 | 1.49 | 23.54 |
| II Conventional fertilizer | 19.20 | 18.50 | 11.75 | 4.20 | 7.17 | 0.41 | 5.28 | 0.112 | 21.94 | 0.58 | 28.66 |
| III Chicken manure | 20.22 | 18.00 | 10.40 | 7.50 | 2.76 | 0.48 | 7.04 | 0.206 | 10.81 | 0.49 | 21.67 |
| IV Control | 18.71 | 18.50 | 12.80 | 7.70 | 4.85 | 0.50 | 5.28 | 0.206 | 22.90 | 1.00 | 25.60 |
| CV % | 3.34 | 3.38 | 8.63 | 24.65 | 39.20 | 8.44 | 25.53 | 27.30 | 41.20 | 51.42 | 12.04 |

The highest amount of total sugars, inverted sugar and acids was registered in the nontreated control. Significant differences were reported in sucrose values. The highest content was found in conventional fertilization - 7.17%, which was almost three times higher than chicken manure - 2.76%, therefore the indicator had a high coefficient of variation (CV 39.20%). The ascorbic acid amount was in the range of 5.28 mg% registered in the conventional fertilization and the control to 8.80 mg% analyzed for bio fertilization.

From the obtained data it is clear that the control variant had the highest content of tannins (0.206%) and anthocyanins (22.90 mg%), and for both indicators the coefficient of variation between the fertilizer variants was high. The pectin index analyzed was high in bio-fertilization - 1.49%, low in the control - 1.00% and the lowest in the other two variants (CV 51.42%).

The acidimetric coefficient for fresh fruit was in the range of 21.67 (chicken manure) to 28.66 (conventional fertilization), determining the average variation coefficient (CV 12.04%).

**Table 29. Biochemical composition of dried plum fruits of 'Stanley' in 2017**

| Indicators Variants | Dry weight, % | Total sugars, % | Inverted sugar, % | Sucrose, % | Malic acid, % | Ascorbic acid, mg % | Tannins, % | Anthocyanins, mg % | Pectin, % | Acidimetric coeficient |
|---|---|---|---|---|---|---|---|---|---|---|
| I Bio fertilization | 83.39 | 11.40 | 8.70 | 2.57 | 1.09 | 7.04 | 0.094 | 11.13 | 0.69 | 10.46 |
| II Conventional fertilizer | 84.90 | 11.70 | 9.70 | 1.90 | 0.82 | 8.80 | 0.112 | 5.48 | 1.12 | 14.27 |
| III Chicken manure | 84.79 | 11.40 | 8.40 | 2.85 | 0.82 | 7.04 | 0.094 | 10.48 | 0.82 | 13.90 |
| IVControl | 85.72 | 16.40 | 14.40 | 1.90 | 0.96 | 5.28 | 0.131 | 17.26 | 1.16 | 17.08 |
| CV % | 1.14 | 19.28 | 27.08 | 20.89 | 14.06 | 20.41 | 16.40 | 43.54 | 24.18 | 19.46 |

The dry weight of dried fruits naturally had significantly higher values than the fresh ones (**Table 29**). Values that ranged from 83.39 to 85.72%.

Like fresh fruits, the highest amount of total and inverted sugar was found in the nontreated controls. Both indicators have a high coefficient of variation, respectively: CV 27.08% and 20.89%

The highest sucrose content was found in chicken manure - 2.85% and bio-fertilization - 2.75%. The other two variants overlap with a score of 1.90%. The ascorbic acid amount varied from 5.28 mg /% to 8.80 mg /%. The values reported for organic fertilization and chicken manure are identical to the control value - 7.04 mg /%. Control fruits had the highest content of tannins - 0.131 mg/%. Significantly varying results are observed in the quantification of anthocyanins. Here again, similar to the results in fresh fruits, the control had the highest value - 17.26 mg%.

Pectin is an indicator with different content between different fertilization options. The lowest amount was registered in bio-fertilization - 0.69%. higher in chicken manure - 0.82%, conventional fertilizer - 1.12% and the highest in the control - 1.16% (CV 24.18%).

Regarding the acidimetric coefficient for dried fruits, it had twice lower values than the fresh ones, but retaining its average variation coefficient between the variants - 19.46%.

Significant differences in fresh fruits were observed between the variants in the amount of total polyphenols (**Figure 10**). The highest amount was registered in conventional fertilizer - 200.00 mgGAE/100, and lowest in chicken fertilizer - 30.00 mgGAE/100. High antioxidant activity was registered in bio-fertilization - 1063.33 µmolTE/100 g. In the control, the value also decreased to 926.67 µmolTE/100 g. The lowest content was recorded for chicken manure - 890.00 µmolTE/100 g.

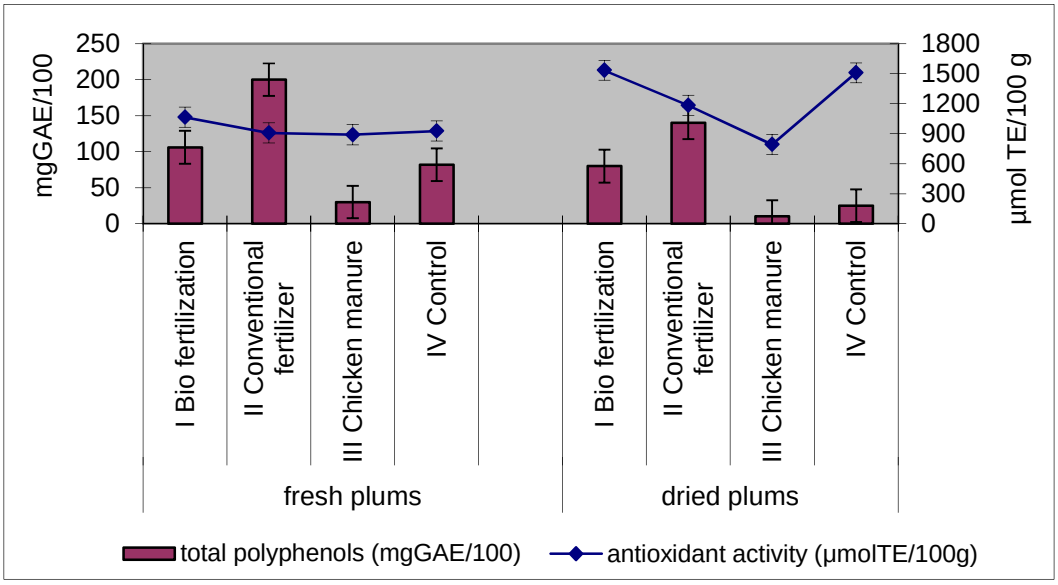


**Figure. 10. Effect of different fertilizing variants on total polyphenols content (mgGAE/100) and antioxidant activity (µmolTE/ 100 g) in fresh and dried 'Stanley' plum fruits (± SE)**

For dried fruits, there is a tendency for significant differences in the content of total polyphenols between the variants. Compared to the fresh ones, they had lower values. Here, too, the highest amount was registered in conventional fertilization - 140.00 mgGAE/100, and the lowest for chicken manure - 10.00 mgGAE/100.

The antioxidant activity analyzed has significantly higher values than fresh fruits, except in the third variant. The highest result was observed for bio fertilization - 1533.33 µmolTE/100 g, and the lowest for chicken manure - 791.67 µmolTE/100 g.

**11. Colour parameters of fresh and dried plum fruits of 'Elena' in 2016.**

Due to the determined colour characteristics of fresh plum fruits, the chicken manure was distinguished as the variant with the best results in all tested parameters (**Table 30**).

**Table 30. Colour parameters of fresh and dried plum fruits of 'Stanley' in 2017**

| Indicators<br>Variant | Colour brightness, L | Red colour tone, a | Yellow colour tone, b | Colour tone, a/b |
|---|---|---|---|---|
| fresh fruit | | | | |
| I Bio fertilization | 27.03 | 5.40 | 9.07 | 0.59 |
| II Conventional fertilizer | 27.86 | 5.27 | 8.44 | 0.62 |
| III Chicken manure | 30.88 | 7.68 | 19.33 | 0.40 |
| IV Control | 28.05 | 5.69 | 7.42 | 0.77 |
| CV % | 5.89 | 18.74 | 50.17 | 25.54 |
| dried fruit | | | | |
| I Bio fertilization | 28.30 | 7.90 | 12.55 | 0.64 |
| II Conventional fertilizer | 25.65 | 3.70 | 3.67 | 1.01 |
| III Chicken manure | 25.94 | 4.20 | 3.84 | 1.09 |
| IV Control | 19.99 | 4.10 | 1.98 | 2.07 |
| CV % | 14.12 | 39.44 | 86.53 | 50.78 |

About the colour brightness indicator, higher results were obtained with chicken manure and control over the other two variants. The same trend persists with the red colour tone.

The yellow colour parameter had highly variable values between variants. From 7.42 in the control to 19.33 in chicken manure.

The colour characteristic of colour tone had the highest value in the control - 0.77 and the lowest in chicken manure - 0.40.

For dried fruits, colour tones were characterized by significantly varying values between variants (**Table 30**).

The red tone ranges from 3.7 to 7.9 and the yellow from 3.67 to 12.55. Data on colour brightness, red and yellow colour tone are the highest for the bio fertilizer variant.

Identical to fresh fruits, the colour tone was the highest in the control variant - 2.07, which was also a high variation coefficient - 50.78%.

## VI. CONCLUSIONS

1. On the basis of the results obtained for the agrochemical status of the soil from the plum plantations, following organic fertilization, the following conclusions can be drawn:

- for 'Tegera' cultivar, the intra-row spacing has a very good reserve of phosphorus and potassium from soil layers 0-20 cm, 20-40 cm and 40-60 cm and with a good nitrogen reserve of 20-40 cm depth;
- row spacings are low in nitrogen, good in phosphorus and very good in potassium from 0-20 cm soil layer. The depth of 40-60 cm has an average content of phosphorus and potassium at 20-40 cm and 40-60 cm;

- 'Elena' cultivar has a very good stock of phosphorus and potassium of three depths from the intra-row space of trees and nitrogen from the soil layer 0-20 cm;

- row spacing are low in nitrogen, from weak (20-40 cm) to medium phosphorus stock (0-20 cm and 40-60 cm). The amount of potassium varies from very good storage at soil layer 0-20 cm to medium at 20-40 cm and 40-60 cm.

- for 'Stanley', the intra-row spacing has insufficient nitrogen, a good reserve of phosphorus from the cultivated soil layer (0-20 cm) and very good with potassium from the three studied soil layers. Approximately identical results were obtained from the row spacing of the cultivar.

- The acidity (pH-KCl) of the soil layers of the intra-row and row spacing is acidic to slightly acidic, with the exception of the 40-60 cm layer of the row spacing of 'Tegera' (6.57) and 'Elena' (6.75) varieties with a nearly neutral reaction. Humus content characterizes the soil profile of the intra-row and row spacing as poorly preserved.

2. The phenological calendars of 'Tegera', 'Elena' and 'Stanley' cultivars determine the degree of development of their main features and properties under the soil and climatic conditions of the Trojan region.

3. The impact degrees of the applied fertilization on the vegetative indices of the cultivars are determined:

- conventional fertilization had the greatest impact on the circumference of tree trunks of 'Tegera' and 'Stanley';

- the highest average tree height for 'Tegera' is reported for bio and conventional fertilization variants, and for 'Elena' the results are higher. 'Stanley' has the highest rates in the conventional and bio-fertilization.

-the volume of crowns in 'Tegera' trees is higher than the variants of bio- fertilization and chicken manure. For 'Elena' and 'Stanley' - in the conventional fertilization.

- the average annual and total growth in 'Tegera' is higher than the variant with chicken manure and bio-fertilization, and in Elena in the conventional fertilization variant. For Stanley, the highest values are found in bio-fertilization and conventional fertilization.

4. The best results with respect to the percentage of useful fruit-set are in the conventional fertilizer variant for Tehera and the conventional and bio-fertilization variant in 'Elena'.

5. The average fruit weight of 'Tegera' fertilizer variants is larger than that of the control. For 'Elena', the highest average fruit weight was measured in the chicken manure variant, while for 'Stanley' in the variants with conventional and chicken manure.

The average fruit weight is determined by 'Tegera' and 'Elena' with large and 'Stanley' with very large fruits.

6. The highest average yield (kg/tree) was registered in the conventional fertilizer and chicken manure variant (for 'Tegera') and conventional and bio-fertilization (for 'Elena' and 'Stanley'). There is a certain dependence in the sequence of results between average yields per kg/tree and yields to g/cm$^2$ from the cross-section of tree trunks. The highest results for the three cultivars are reported by conventional fertilizer variants.

7. Quality parameters - the highest values of average fruit density and fruit flesh was found in conventional fertilization (for the three varieties), fruit flesh in the bio-fertilization and chicken manure (for 'Tegera'), bio-fertilization and conventional fertilizers ('Elena') and from the chicken manure ('Stanley').

8. The highest content of total polyphenols of fresh (210.00 mgGAE/100) and dried fruits (390.00 mgGAE/100) was registered in 'Tegera' cultivar in the variants with conventional fertilization. For 'Elena' in the control variant (fresh-119.00 mgGAE/100, dried-271.00 mgGAE/100) and for 'Stanley' in the conventional fertilization (fresh-200.00 mgGAE/100, dried-140.00 mgGAE/100).

9. The highest antioxidant activity of fresh fruits was registered in the chicken manure variant (926.67 μmolTE/100 g) and conventional fertilizer (597.78 μmolTE/100 g) for 'Tegera', while for dried fruit in the bio-fertilization (220.00 μmolTE/100 g) and the control (200.00 μmolTE/100 g), whereas for 'Elena' cultivars (fresh-200.00 μmolTE/100 g, dried-180.00 μmolTE/100 g) and 'Stanley' (fresh-1063.33 μmolTE/100 g, dried-1533.33 μmolTE/100 g) in the bio-fertilization variant had the highest values for both types of fruit.

10. The highest values of the acidimetric coefficient of fresh and dried fruits was registered in the chicken manure variant (for 'Tegera') and for 'Elena' the variant with conventional fertilization was distinguished. 'For Stanley' - for fresh in the conventional fertilizers and for dried fruit in the control.

On average, the highest acididimetric coefficient for fresh fruits was reported for 'Tegera' in the bio-fertilization variant-18.53, compared to the control with the lowest at 14.46. For Elena, it was in the conventional fertilization variant -33.08 and the control-24.70.

11. The colour parameters of plum fruits (fresh and dried) show a positive dependence in 'Stanley' - higher values of fresh fruits than the variant with chicken manure were found, and for dried fruit in the bio-fertilization.

12. The values of the macronutrient and pigment composition in the leaf samples in the periods before and after the harvesting of the fruit are variable in the individual elements, which may show to some extent some signs of the physiology of the cultivar: an increase in the values of phosphorus and potassium after harvest in the third year of the experiment, in which case the yield was represented by a small amount of fruit on the trees.

'Elena' had higher amounts of potassium after the second year of the experiment.

The quantitative determination of the pigment composition revealed the following dependencies: a decrease in chlorophyll 'a", chlorophyll "b" and β-carotene after harvest was observed in the bio-fertilizer, conventional and chicken manure variants with 'Tegera'. An exception was observed in leaf diagnostics in control trees, where an increase in the values of the studied parameters was reported.

For 'Elena' variety, the results show a decrease in the values of the pigment composition in the leaves after the harvest, with some exceptions, with a slight increase in the amount of chlorophyll "b" in 2017 in the bio-fertilizer variant and significantly larger differences in the same pigment from the chicken manure variant in 2018 (before-0.51 and after the harvest-1.26).

Unlike 'Tegera' and 'Elena', 'Stanley' obtained higher chlorophyll "a" values after fruit harvesting in the conventional fertilization variant, chicken manure and control, as well as chlorophyll "b" in all variants in 2017, when more significant fruit bearing was reported. In the following year, when small yields were reported, higher β-carotene values were found in all variants

13. Storage of fruits under refrigeration conditions in a convincing manner

prove that fruit of 'Elena' cultivar have a longer period - up to 35 days. The highest amount of fresh fruits with good quality for consumption, during the study period, was gathered in the chicken manure and bio-fertilizer variants.

14. Correlation dependencies show that potassium content, chlorophyll "a" and β-carotene values in 'Tegera' influence the length of annual and, respectively, the total growth; nitrogen is positively correlated with potassium, chlorophyll "a", chlorophyll "b" and β-carotene; the average fruit weight correlates with the density of the fruit and fruit flesh;

In Elena, the average weight of the fruit is influenced by the indices of chlorophyll "a", chlorophyll "b" and β-carotene;

The useful fruit-set is directly dependent on the circumference of the trunk, the height and volume of the crowns of trees;

In 'Stanley', the average fruit weights and the average tree yield correlate with the circumference of the tree trunk. Nitrogen values influence the height of the trees, the length of the annual and total growth and the density of the fruit flesh.

The highest fruit yield was found for the three cultivars in the conventional fertilizers.

## VII. CONTRIBUTIONS

### Originality

- ✓ The originality of the development is that for the first time in Bulgaria has been assessed the soil reserve with nutrients nitrogen, phosphorus and potassium, as well as pH and humus of the soil layers (0-20 cm; 20-40 cm and 40-60 cm) in plum plantations after long-term stockpile fertilizing in trenches and local organic fertilization.
- ✓ The nutrient composition (N-P-K), pH, humus of row spacing at depths were determined: 0-20 cm; 20-40 cm and 40-60 cm covered with tall fescue with plum cultivars, such as 'Tegera' and 'Elena' and black fallow for 'Stanley'.
- ✓ The post-cumulative effect of organic stockpile fertilizing with manure after eighteen years has been established. Phosphorus and potassium are high in most of the soil layers studied, and nitrogen in some cultivars at soil depths (0-20 cm and 20-40 cm).
- ✓ The study of agrochemical soil analysis of the wide-spread 'Stanley' after sixteen years of local organic stockpile fertilizing of the basic nutrients, which shows that the cultivated soil layer (0-20 cm) is richer in phosphorus and potassium, and for the other two cultivars (20-40 cm and 40-60 cm) only potassium.
- ✓ The applied fertilization in the cultivation of plum trees after prolonged trench and local organic fertilization has a positive effect on their vegetative and reproductive characteristics.
- ✓ The established soil stock with the main nutrients N, P and K defines the trenching method of planting fruit trees as more effective.
- ✓ Correlation treatments between some indicators show some differences, regarding the relationship between them and to a great extent emphasize the individuality of the cultivars.

### Confirmative

The period limits for the phenological phases have been determined. 'Tegera' was defined as early ripening and 'Elena' for late ripening.

### Applied scientific character

A comparative analysis has been made between the different variants of fertilization on the vegetative parameters of the plum trees. A greater complex effect of fertilization on 'Tegera' and 'Stanley' varieties has been reported.

- ✓ Positive effect on the average fruit yield was found in the variants with the application of conventional and bio-fertilizers in 'Elena' and 'Stanley' and with the conventional and chicken fertilizer in 'Tegera'. A positive dependence between the yields kg/tree and g/cm$^2$ of the cross-section of tree trunks of all variants in the three cultivars was reported.
- ✓ The highest fruit density was found in the application of conventional fertilizers, and for the fruit flesh in the bio-fertilization, conventional and chicken manure.

- ✓ The content of total polyphenols and the antioxidant activity of fresh and dried fruits were analyzed and the effect of fertilizers on both indicators was evaluated. The results are different for cultivars and variants of fertilization.
- ✓ The established parameters of the nutrients and the pigment composition in the leaf samples significantly determine some of the characteristics of the physiology and genotypic specificity of the cultivars.
- ✓ The storage period of plum fruits of 'Tegera' and 'Elena' cultivars in different fertilization variants is investigated, as the first one has a period of 21 days, when the highest amount of quality plum fruits was found in the variant of bio-fertilization. 'Elena' was found to have a shelf life of 29 to 35 days. The best quality fruits were registered in the variants of chicken manure and bio-fertilization.
- ✓ An economic analysis of the cost of fertilizer inputs on cultivation technologies and the revenue generated from the varieties has been made.

## PUBLICATIONS RELATING TO DISSERTATION WORK

**Hristova, D.**, 2019. Quality of Fresh and Dry Plum Cultivars after Aplication of Conventional and Organic Fertilizers, *Journal of Balkan Ecology*, 22, (1), 19-25.

## Update of some technological elements in the production of plum fruit


Abstract

During the period 2016-2018, a scientific experiment was conducted in the demonstration and experimental orchards of the Research Institute of Mountain Stockbreeding and Agriculture, Troyan, on the opportunities for controlling nutritional deficiencies in fruit-bearing plum plantations, which had been established using stockpile fertilization in trenches and local organic fertilizing. They were grown according to biological and conventional technologies.

Three plum cultivars were studied, such as 'Tegera', 'Elena' and 'Stanley'. The impact of innovative conventional and biological fertilizers was studies on the agrochemical status of soils, the phenological, vegetative and reproductive characteristics of their trees and fruit quality.

After the eighteen-year period of planting of 'Tegera' and 'Elena' trees in trenches, the soil agrochemical analysis of 0-20 cm, 20-40 cm and 40-60 cm depths revealed that the intra-row space had well preserved nitrogen and very good phosphorus and potassium content in both cultivars. The row spacings had low nitrogen content and well-preserved phosphorus and potassium content.

The soil agrochemical analysis, after sixteen years of local organic fertilization of 'Stanley' cultivar, revealed that the intra row spacing and row spacing had insufficient nitrogen content, well-preserved phosphorus content in the cultivated soil layer (0-20 cm) and very good potassium level.

The course of the phenological phases of 'Tegera', 'Elena' and 'Stanley' cultivars depends on the agro-climatic conditions of the Troyan region.

The reported impact of applied fertilization on the vegetative indicators of those three cultivars determined that conventional fertilization had the greatest impact on the trunk circumference of 'Tegera' and 'Stanley' trees. The crown volume of 'Tegera' trees was higher in the variants with bio-fertilization and chicken manure, whereas for 'Elena' and 'Stanley' in the conventional variant. The conventional fertilizing of 'Tegera' and 'Elena' had a higher

percentage of useful fruit-set. Higher average yield (kg/tree) was reported for all three cultivars for the same variant. Plum fruits of 'Elena' had the highest average weight in the variant with chicken manure, whereas for 'Stanley' in the variants with the conventional fertilization and chicken manure.

Higher fruit density was found in the variants with conventional fertilization, whereas higher density of fruit flesh was found in the variants with conventional fertilizer and chicken manure.

The results of the analyzed content of total polyphenols and the antioxidant activity of fresh and dried fruits are varied for the different cultivars and fertilizing variants.

The correlation treatments between the observed indicators and the fertilization manifestations showed some differences regarding the interrelation between them and emphasized the individuality of the cultivars to a great extent.