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"Agrosym 2018"
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IMPACT OF VERMICOMPOST EXTRACTS ON STRAWBERRY PRODUCTION AND SUSTAINABILITY OF AGROECO SYSTEMS

Marijana PEŠAKOVIĆ[1*], Jelena TOMIĆ[1], Slobodan MILENKOVIĆ[2], Radosav CEROVIĆ[3], Žaklina KARAKLAJIĆ STAJIĆ[1], Ivana GLIŠIĆ[1], Svetlana M. PAUNOVIĆ[1], Milan LUKIĆ[1]

[1]Fruit Research Institute Čačak, Čačak, Republic of Serbia
[2]Faculty of Biofarming, Megatrend University, Bačka Topola, Republic of Serbia
[3]Innovation centre of Faculty of Technology and Metallurgy, University of Belgrade, Belgrade, Republic of Serbia
*Corresponding author: mpesakovic@institut-cacak.org

Abstract

Quality and balanced fertilization is one of the most important orchard management practices in fruit production. However, fertilization in conventional production systems is mainly focused on obtaining the highest yield. This usually requires increased utilization of synthetic nitrogen fertilizers, which significantly contributes to a series of undesirable effects and results in excessive environmental pollution. Since organic production system is considered as an important factor of the strategy for the development of agricultural sector, it is necessary to increase this kind of production. To find a way to overcome the mentioned problems, the use of vermicompost extracts is appeared as potential solution. Therefore, we conducted a study on the effects of vermicompost extract on yield-related characteristics (yield per plant, yield per unit area), physical (fruit weight, length, breadth, and firmness) and chemical fruits properties (total phenolics and antioxidant capacity) of 'Senga Sengana' strawberry cultivar, as well as microbiological properties of strawberry rhizosphere (total microbial count, numbers of soil fungi, actinomycetes, aminoheterotrophs, oligonitrophilic bacteria and *Azotobacter*). The obtained results indicate that application of vermicompost extracts in organic strawberry production had a positive effect on plant yield and fruit quality. Positive effects on soil biogenicity have also been observed. Therefore, vermicompost extract application can be considered as an appropriate practice in production of healthy and environmentally safe strawberries with satisfying basic postulates of sustainable agriculture.

Keywords: *Vermicompost extracts, Microorganisms, Organic strawberry production, Yield, Fruit Quality.*

Introduction

Ever-increasing studies have warned that the use of nitrogen chemical fertilizers, which is constantly increasing and whose use will be doubled and even tripled by 2050, causes various problems that adversely affect the environment and human health. Despite these, according to the Food and Agriculture Organization of the United Nations, the annual global consumption of chemical fertilizers in the period 1960-1990 increased from 46,000,000 to 130,000,000 tonnes, reaching 190,400,000 tons in 2015 (*http://www.fao.org/3/a-av252e.pdf*).

Introduction of living cells of microorganisms into the soil, the use of vermicompost or compost products - teas, extracts or leachates for improving plant nutrition are great natural resources that can contribute to overcome the mentioned problems.

In many countries such as Germany (Ernst et al., 2008), Spain (Monroy et al., 2009), USA (Arancon et al., 2006) and Vietnam (Yadav et al., 2010), vermicomposting is viewed as one of the key steps in sustainable waste management. Thanks to better physical characteristics, greater microbial and enzymatic activity, as well as larger content of easily accessible nutrients, vermicompost has a number of advantages over chemical fertilizers, and according to Venugopal et al. (2010) and Abul-Soud et al. (2009) vermicompost is significantly more

acceptable by manufacturers compared to compost. Quaik et al. (2012) associate increased interest in vermicomposting with its positive impact on the environment.
Beside the aforementioned methods of plant nutrition, with the aim of sustainable use of natural resources, a considerable attention is paid to the use of compost products - teas, extracts or lichates. Ingham (2002) states that compost teas (fluids extracted from compost) and the benefits of their application were known even by the ancient Romans. However, its role has been neglected due to the increasing use of chemical fertilizers. In recent years, interest in their use has increased along with requirements for health food production. Considering the fact that compost tea contains useful microorganisms and soluble nutrients, both organic and inorganic, its application enables the efficient use of nutrients in the sustainable and economically justified manner and improves waste management from agriculture. Diver (2002) points out that compost and herbal teas are tools that can increase the productivity of crops and inoculate philo- and rhizosphere with soluble nutrients, useful microorganisms and microbial metabolites.
The aim of this study was to determine the effects (advantages and disadvantages) of the application of some alternative fertilization methods (liquid biopreparation based on vermicompost) on yield-related characteristics and fruit quality attributes of strawberries grown in the organic production system.

Material and Methods

An open field trial was conducted on 'Senga Sengana' strawberry plants at the experimental plantation located near Čačak, Republic of Serbia (43^{o} 53' N latitude, 20^{o} 20' E longitude, 225 m altitude) during the two consecutive seasons (2016–2017 and 2017–2018) . The experiment was set up at a randomized block design, in three replications. The frigo strawberry plants were planted in a single row system. The rows were spaced about 80 cm apart, and the plants were set 15 cm apart in the rows. Treatments contained vermicompost-based product (vermicompost extracts) prepared at the Fruit Research Institute Čačak, whereas untreated soil and plants served as control.
Production of biopreparation is based on a specially obtained liquid extract of vermicompost enriched with various strains of useful microorganisms (bacteria strains of the genus *Azotobacter* sp., *Bacillus* sp. and *Pseudomonas* sp. as well as *Trichoderma* sp. fungus). Its application was carried out in three ways: rhizobial (R), foliar+rhizobial (F+R) and foliar (F). Treatments were carried out five times during vegetation period (in accordance with the corresponding phenological development stages of strawberry and 30 days after harvest) in the amount of 400 l ha^{-1} of the respective preparation. The generative potential of the strawberry plants, which included yield per plant (g) and yield per unit area (t/ha), was determined by collecting and measuring the weight of picked fruits in each harvest
To assess the physical fruit properties a sample of 60 fruits in each replication were randomly selected. Samples were colected at full maturity stage. An average fruit weight was measured using the Adventurer Pro AV812M balance (±0.01g accuracy) and the data were expressed in g. The fruit dimensions (mm) including length and breadth, were also determined in the selected samples using the 'Carl Roth GmbH' vernier scales (±0.05 mm accuracy). Firmness of fruit was measured using a hand-held shore-type penetrometer and data were expressed in N. Chemical properties of the fruit were studied as well, such as the content of total phenolics (TPH) and antioxidant capacity (AC). TPH was determined using a modified Folin-Ciocalteu colorimetric method (Singleton et al., 1999; Liu et al., 2002) with results expressed as mg gallic acid equivalents (GAE) 100 g^{-1} FW. AC was determined by the ABTS test according to Re et al. (1999) and the results were expressed as Trolox equivalents, mmol 100 g FW.
For the purpose of determining microbiological properties in strawberry rhizosphere, total numbers of microorganisms, fungi, actinomycetes, oligonitrophils, aminoheterotrophs, and

Azotobacter were determined as colony forming units (CFUs) on agar plates by Serial Dilution Plate method (Pochon & Tardieux, 1962).
The mean value from the 2-year investigation were presented in Figures.

Results and Discussion

Effect of the examined preparation (vermicompost extracts) on the generative potential of strawberry is shown in Figure 1.

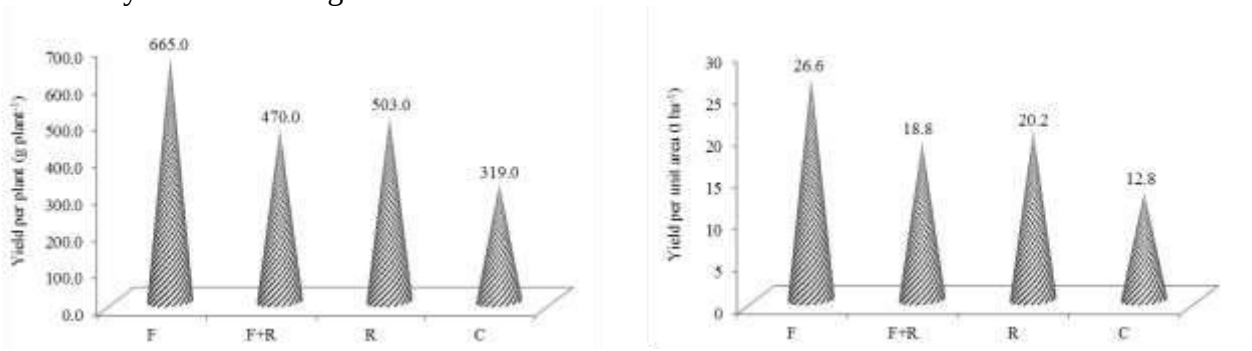

Figure 1. The influence of the vermicompost extracts application on strawberry yield

Higher yield per both plant and unit area was determined in all variants of the vermicompost extracts application. This occurrence can be explained by the fact that the microorganisms contained in biopreparation leave ready food for plants in the soil and / or affect the increase in the content of bioregulators such as indoleacetic acid or gyberilic acid (Arshad and Frankenberger, 1993; Glick, 1995). Diver (2002) points out that compost and herbal teas represent tools that can increase crop productivity and inoculate philo- and rhizosphere with soluble nutrients, useful microorganisms and microbiological metabolites. Singh et al. (2010) having examined the influence of vermicompost lichates found the increase of leaf area index, vegetative growth and yield of strawberry. A positive influence of compost tea on the yield of strawberries was found by Welke (2005) too.
The applied vermicompost extracts positively influenced the weight, firmness, length and width of the fruit (Figure 2). However no statistical significance was observed. Positive effects of biofertilization on the firmness of strawberry 'Senga Sengana' were claimed by Sas-Paszt et al. (2008).

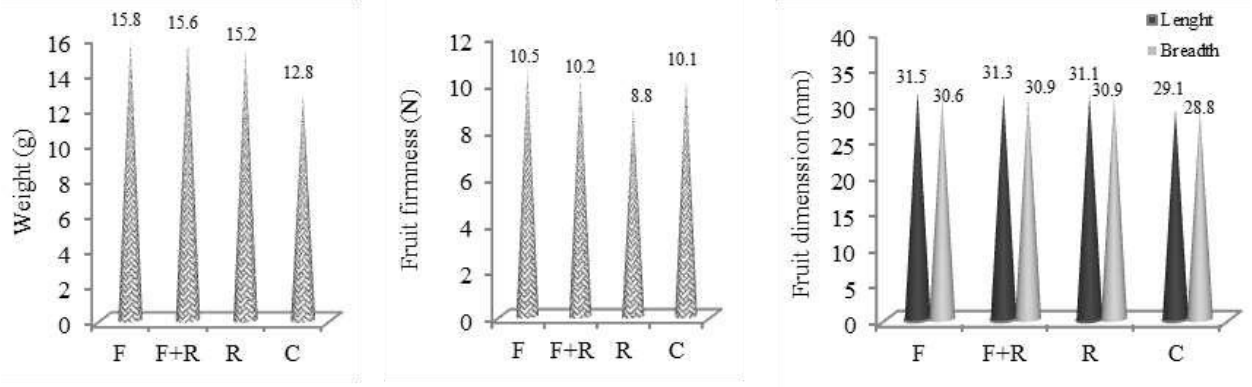

Figure 2. The influence of the vermicompost extracts application on physical attributes of strawberry fruits

The conducted research also points to the positive impact of vermicompost extracts on the content of total phenolic and antioxidant capacity (Figure 3) which is most likely the result of more intensive mineralization processes in soil under that conditions. In such conditions, the activity of the root itself increases, and its physiological functions become more intense. This

is in agreement with the results obtained by Kivijärvi (1999), pointing out that the synthesis of phenolic compounds in berries can be increased if the production technology is implemented without the use of pesticides and mineral nutrients.

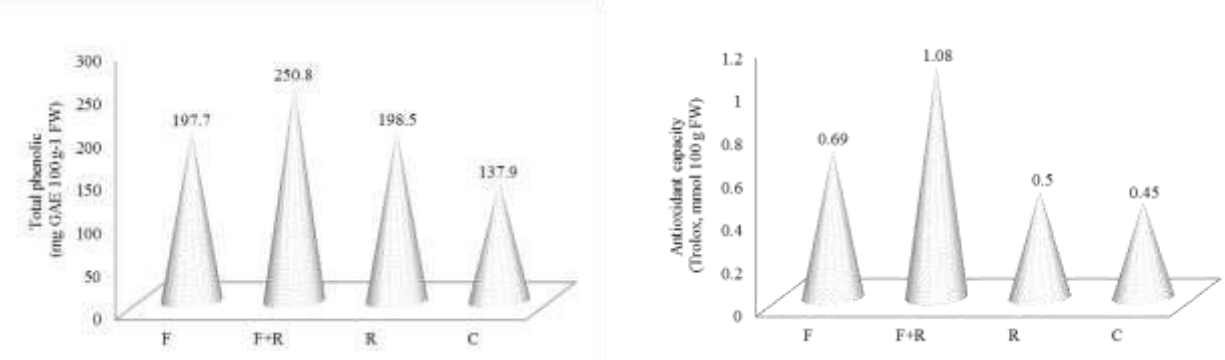

Figure 3. The influence of the vermicompost extracts application on TPH and AC in strawberry fruits

The conducted research has also shown the stimulating influence of vermicompost extracts on the presence of different groups of microorganisms in the strawberry rhizosphere (Figure 4). Our previous research (Pešaković et al., 2013; Pešaković and Milivojević, 2014) relating to the effect of microbial inoculation on soil biological activity also showed a positive influence of inoculation of strawberry rhizosphere, before all, by the diazotrophic *Klebsiella planticola* TSHA-91, but also by a mixture of bacteria of the genus *Azotobacter, Derxia, Pseudomonas* and *Bacillus*. This phenomenon is the result of nitrogenfixation ability of the strains contained in the biofertilizer but also the cumulative effect of a number of effects such as inhibition of phytopathogen development, phytotohormone synthesis (Sukhovitskaja et al., 2004) detoxification of heavy metals and synthesis of exocellular polysaccharides. Statistically significant differences were recorded only in the F+R variant.

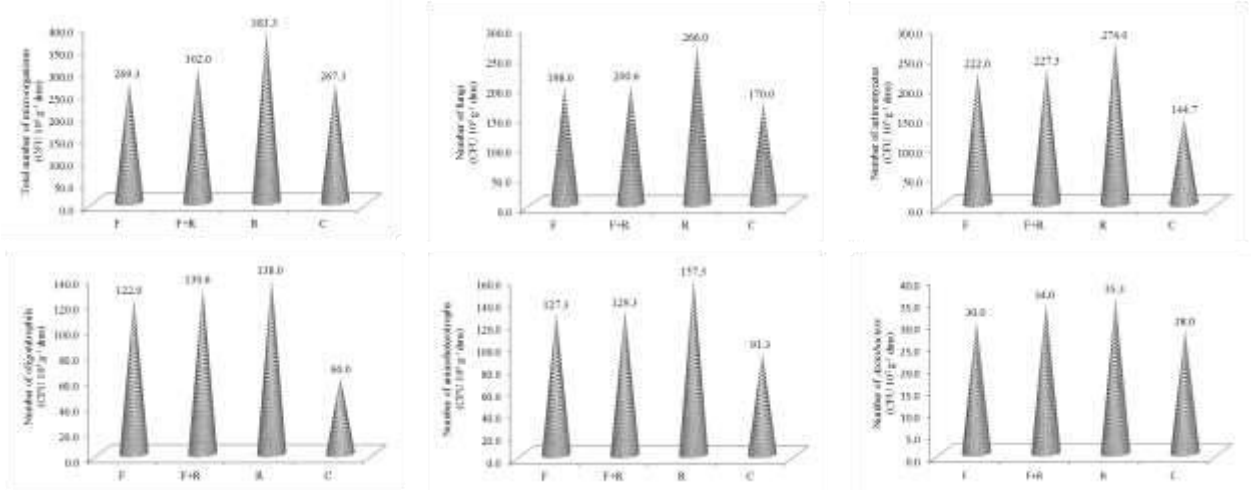

Figure 4. The influence of the vermicompost extracts application on the soil microorganisms

Conclusions

Application of biopreparation based on vermicompost (vermicompost extracts) enriched with various microorganisms strains has positively influenced the generative potential, fruit quality and the microbiological properties of soil in the open field organic strawberry production.

Bio-fertilizers applied in this study can contribute to the improvement of existing technology, allowing substitution of chemical fertilization by biofertilization that satisfies the basic postulates of sustainable agriculture.

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