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IMPACT OF BIOLOGICAL EFFECTIVE MICROORGANISMS (EM) PREPARATIONS ON SOME PHYSICO-CHEMICAL PROPERTIES OF SOIL AND THE VEGETATIVE GROWTH OF APPLE-TREE ROOTSTOCKS

Summary. Effect of preparations from Effective Microorganisms (EM) group on physico-chemical soil property changes as well as on the vegetative growth of apple-tree rootstock M.9 has been estimated. Among the tested preparations, a mixture of EM-A and EM-5 has shown to be the most effective one. Its application caused a distinct acceleration of organic matter mineralization in the soil, it increased the volume of the root system of rootstocks and increased the growth of the assimilative surface of leaves.

Key words: EM preparations, M.9 rootstock, physico-chemical properties of soil, vegetative growth

Introduction

Effective Microorganisms (EM) represent an example of biological preparations used in agriculture. They contain some microorganisms occurring in nature, mainly including bacteria and fungi (HIGA and PARR 1994). Preparations from EM group are used among others in ecological agriculture as the so called soil improvement means correcting the production properties. Opinions about their positive influence on increasing diversity of the useful soil microflora, improving the vegetative growth of plants and improvement of their general condition and thereby on their resistance to diseases and pests are also expressed (STEWART and DALY 1999).

Estimation of the effectiveness of EM preparations in agriculture refers mainly to field plants (CHAUDHRY et AL. 2005, PISKIER 2006, JAVAID 2006). Information regarding their effectiveness in horticulture and particularly in pomiculture is rather limited.

The objective of the present work was to estimate the effect of preparations from EM group on some physico-chemical properties of soil and on the growth parameters of the vegetative apple-tree rootstocks.

Material and methods

Experiments were established on the area of the Experimental Station in Przybroda, Pomicultural Department of Agricultural University of Poznań. Studies were carried out in two cycles in the vegetation season 2006/07. In spring, plastic containers of 5 l volume were filled with soil originating from herbicide strips from apple-tree orchard. Into each container, vegetative apple-tree rootstock M.9 was placed. In the experiment, two preparations which belong to the group of Effective Microorganisms (EM) and which are called EM-A and EM-5 were used. They are produced from commercially available EM concentrate according to the recommendations of the producer. For obtaining 1 l of preparation EM-A, 50 ml of molasses and 50 ml of EM concentrate desolved in 900 ml of water. In order to obtain 1 l of EM-5 preparation, 100 ml of molasses and 100 ml of EM concentrate desolved in 800 ml of water. After the lapse of seven days, 50 ml of vinegar and 100 ml of 40% alcohol were added.

The following four combinations were applied:

- combination 1: without any spray by EM preparations (control),
- combination 2: spray with EM-A preparation,
- combination 3: spray with EM-5 preparation,
- combination 4: joined application of EM-A and EM-5 preparation spray.

Each combination included six replications (containers).

The preparations EM-A and EM-5 were applied to leaves and to the soil surface. Treatments were carried out in two terms of the vegetation period: in the second half of June and in August, using the following doses of preparations:

- EM-A: 10 ml/m² in 50 ml of water (corresponding to 100 l/ha in 500 l of water),
- EM-5: 2 ml/m² in 30 ml of water (corresponding to 20 l/ha in 300 l of water).

Sprays were carried out on cloudy days with a high air humidity.

In the experiment the physico-chemical properties of soil, development of root system and growth intensity of the vegetative parts of rootstocks were estimated. In each year soil samples for analyses were taken in September. From each combination, six samples weighing 0.5 kg each were taken. After mixing one representative sample of soil combination weighing 1.5 kg was obtained. After sample drying, the following determinations were made in the sample: percentage content of organic matter, pH reaction, contents of soluble form of phosphorus, potassium, magnesium and mineral nitrogen.

Measurement of soil pH was potentiometrically performed in soil suspension with KCl and H₂O solution (in 1:2.5 proportion) and CaCl₂ (in 1:5 proportion). In order to obtain organic matter content, Tiurin's method was used. Contents of phosphorus and potassium were determined by Egner-Riehm method, magnesium – by Schachtschabel method and nitrogen by HOUB et AL. (1986) method. Soil analysis was carried out in three replications.

In 2006, at the end of vegetation period, the estimation of the vegetation growth of apple-tree rootstocks was carried out. It included measurement of the number, length and diameter of lateral shoots and the diameter of the main shoot measured at the height of 10 cm. In 2007, the measurements of growth intensity were repeated on the same plants, additionally extended by measurement of the mass of the lateral shoots and of the main shoot.

The estimation of the growth of the root system of rootstocks included the determination of the number and diameter of the main roots, as well as the mass of the root system. The measurements were made in September after removal of rootstocks from the containers.

Using the computer program "Skwer", the summary assimilation surface of leaves was calculated. Material for studies was taken at the beginning of September, before leaf fall.

Statistical calculations were made on the basis of the analysis of variance and the application of Duncan's test for significance level $\alpha = 0.05$.

Results and discussion

Soil surface spraying with EM-group preparations changed some physico-chemical soil properties. The percentage content of organic matter in soil treated with EM preparations was significantly lower in comparison with the control (Table 1). Soil pH has changed as well, especially after the joined application of EM-A and EM-5 preparations.

Table 1. Some physico-chemical properties of soil treated with EM preparations
Tabela 1. Niektóre fizyczno-chemiczne właściwości gleby traktowanej preparatami EM

Combination	Content of organic matter (%)	pH reaction		
		1 m KCl	1 m H ₂ O	0.01 m CaCl ₂
Control	1.89 b	5.2 b	6.3 a	5.7 b
EM-A	1.22 a	4.8 a	6.1 a	5.3 a
EM-5	1.39 a	5.1 b	6.1 a	5.4 a
EM-A + EM-5	1.20 a	5.8 c	6.5 b	5.9 c

Mean values marked with the same letter do not differ significantly at probability level $\alpha = 0.05$.

The estimation of soil chemical properties indicated a significantly less amount of nitrogen, phosphorus and potassium forms available to plants in the soil treated with EM preparations in comparison with the control. The differences were particularly visible in case of a joined use of EM-5 and EM-A (Table 2). An exception was magnesium. Its content in the soil treated with a mixture of preparations was significantly higher.

Table 2. Average in years 2006-2007 content of some mineral elements in 1 kg of d.m. of soil treated with EM preparations (mg)

Tabela 2. Średnia z lat 2006-2007 zawartość niektórych składników mineralnych w 1 kg s.m. gleby traktowanej preparatami EM (mg)

Combination	Phosphorus	Potassium	Magnesium	Mineral nitrogen
Control	61.2 b	168.0 b	213.7 b	33.5 c
EM-A	62.3 b	161.8 b	167.3 a	25.5 b
EM-5	59.3 ab	133.3 a	219.7 b	18.9 a
EM-A + EM-5	56.1 a	140.3 a	246.6 c	22.1 ab

Mean values marked with the same letter do not differ significantly at probability level $\alpha = 0.05$.

Smaller amounts of nitrogen, phosphorus and potassium forms available to plants in the soil treated with EM group preparations resulted most probably from the increased utilizations of these elements by the root system of apple-tree rootstocks transferred to the experimental containers. Analyses of growth parameters of the root system of rootstocks as well as their above-ground parts confirm this presumption. With the joined application of EM-A and AM-5 preparations, the growth of root system was more intensive in comparison with the control combination. This is testified by the significantly greater diameters of the main roots as well as by the mass of the root system (Table 3, Fig. 1). Root system of rootstocks sprayed with EM preparations was characterized by a great number of small root hairs.

Table 3. Effect of EM preparations on the development of root system of apple-tree rootstock
Tabela 3. Wpływ preparatów EM na rozwój systemu korzeniowego podkładki jabłoni

Combination	Number of main roots	Diameter of main roots (mm)	Mass of roots (g)
Control	6.0 a	2.42 a	6.3 a
EM-A	9.7 a	2.63 a	13.1 b
EM-5	7.3 a	3.93 b	14.2 ab
EM-A + EM-5	10.0 a	3.84 b	18.9 b

Mean values marked with the same letter do not differ significantly at probability level $\alpha = 0.05$.

Well-developed root system of apple-tree rootstocks sprayed with EM preparations had an influence also on the development of the above-ground plant parts. Rootstocks treated with EM-A preparation and the mixture of EM preparations had a significantly greater mass and length of lateral shoots in comparison with the control combination (Table 4). In the absence of significant differences, one must state that the number and the diameter of the lateral shoots of rootstocks sprayed with EM-A preparation and the mixture of EM preparations was higher. Furthermore, preparations from EM group

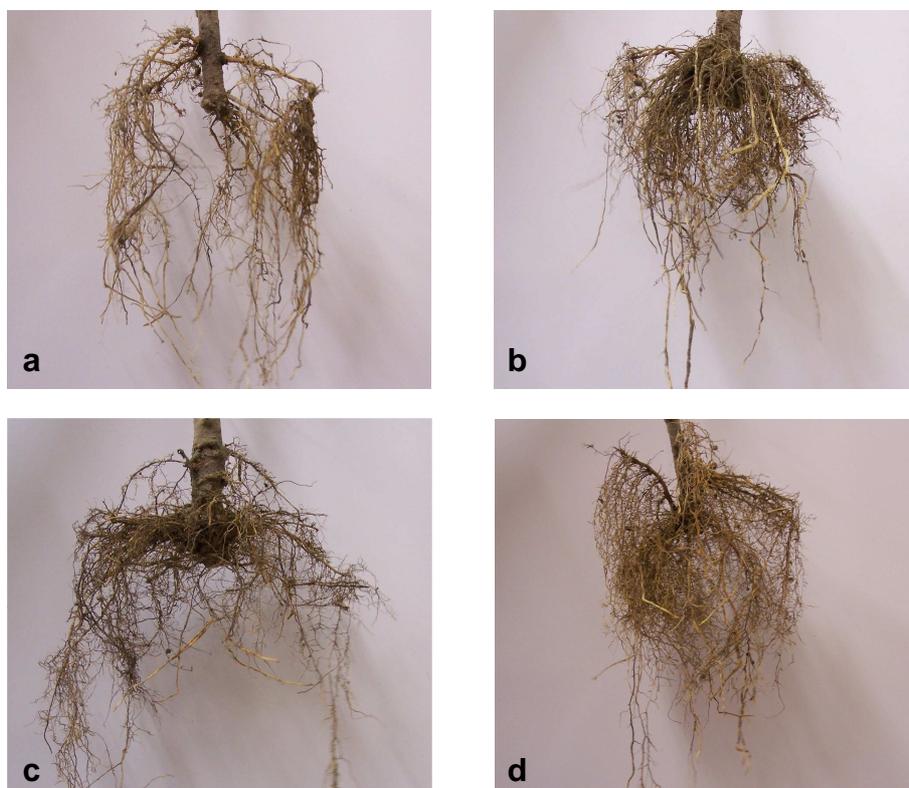


Fig. 1. Influence of EM preparations on root system growing of apple-tree rootstocks: a – control, b – EM-A application, c – EM-5 application, d – EM-A and EM-5 application
 Rys. 1. Wpływ preparatów EM na wzrost systemu korzeniowego podkładek jabłoni: a – kontrola, b – zastosowanie EM-A, c – zastosowanie EM-5, d – zastosowanie EM-A i EM-5

Table 4. Influence of EM preparations on vegetative growth of apple-tree rootstocks in years 2006-2007

Tabela 4. Wpływ preparatów EM na wzrost wegetatywny podkładek jabłoni w latach 2006-2007

Combination	Diameter of main shoot (mm)	Mass of main shoot (g)	Number of lateral shoots	Length of lateral shoots (cm)	Diameter of lateral shoots (mm)	Mass of lateral shoots (g)
Control	11.5 a	30.7 a	5.0 a	4.9 a	3.4 a	1.9 a
EM-A	12.9 a	40.8 a	6.3 a	11.4 b	3.3 a	5.4 ab
EM-5	14.0 a	49.4 a	7.0 a	10.0 ab	3.5 a	5.5 ab
EM-A + EM-5	10.9 a	32.1 a	8.0 a	6.9 ab	4.8 a	5.9 b

Mean values marked with the same letter do not differ significantly at probability level $\alpha = 0.05$.

contributed to the increase of mass and assimilative leaf surface area of apple-tree rootstocks (Figs. 2, 3). The application of the mixture of EM-A and EM-5 preparations increased total leaf surface area by 152 cm² in comparison with the combination of not sprayed rootstocks (Fig. 3).

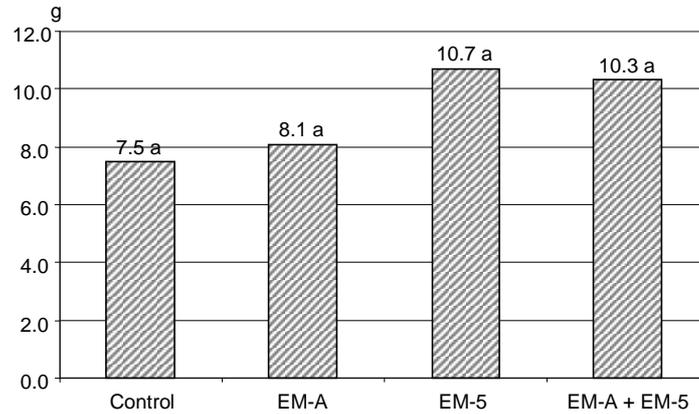


Fig. 2. Influence of EM preparations on leaves mass of apple-tree rootstocks in years 2006-2007. Mean values marked with the same letter do not differ significantly at probability level $\alpha = 0.05$

Rys. 2. Wpływ preparatów EM na masę liści podkładek jabłoni w latach 2006-2007. Średnie wartości oznaczone tą samą literą nie różnią się istotnie na poziomie prawdopodobieństwa $\alpha = 0,05$

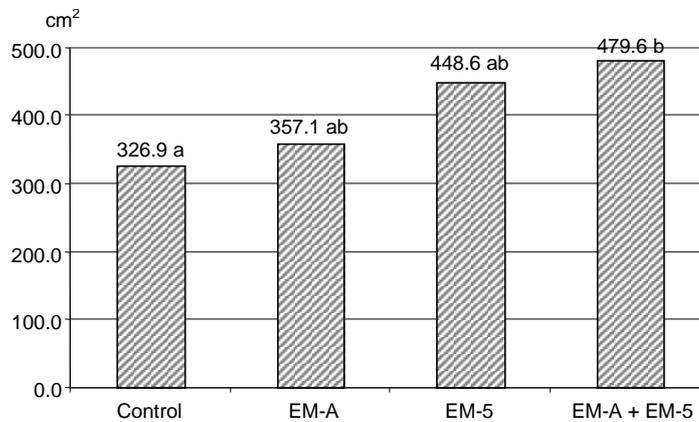


Fig. 3. Influence of EM preparations on total leaves area of apple-tree rootstocks in years 2006-2007. Mean values marked with the same letter do not differ significantly at probability level $\alpha = 0.05$

Rys. 3. Wpływ preparatów EM na powierzchnię asymilacyjną liści podkładek jabłoni w latach 2006-2007. Średnie wartości oznaczone tą samą literą nie różnią się istotnie na poziomie prawdopodobieństwa $\alpha = 0,05$

The obtained results confirm the present opinion about the positive impact of EM preparations on the improvement of the production properties of soil (HIGA and WIDIDANA 1991, VALARINI et AL. 2003). Their use similarly as in the experiment by STEWART and DALY (1999), accelerated the mineralization of organic matter in soil. A greater amount of nutritional forms available to plants and the decrease of soil acidity caused a distinct improvement of growth parameters both in the underground and above-ground parts of rootstocks.

Conclusions

1. The use of a mixture of EM-A and EM-5 preparations accelerated significantly the mineralization of organic matter in soil and decreased soil acidity.
2. Application of EM preparations had a positive effect on the growth of root system and the above-ground parts of M.9. rootstocks.

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WPLYW BIOLOGICZNYCH PREPARATÓW EM (EFEKTYWNE MIKROORGANIZMY) NA NIEKTÓRE FIZYCZNO-CHEMICZNE WŁAŚCIWOŚCI GLEBY ORAZ NA WZROST WEGETATYWNY PODKŁADEK JABŁONI

Streszczenie. Oceniano wpływ preparatów z grupy Efektywnych Mikroorganizmów (EM) na zmianę fizyczno-chemicznych właściwości gleby oraz na wzrost wegetatywny podkładki jabłoni M.9. Spośród testowanych preparatów najbardziej efektywna okazała się mieszanka preparatów EM-A i EM-5. Jej zastosowanie wyraźnie przyspieszało mineralizację materii organicznej w glebie, zwiększało objętość systemu korzeniowego podkładek oraz powodowało wzrost powierzchni asymilacyjnej liści.

Słowa kluczowe: preparaty EM, podkładka M.9, fizyczno-chemiczne właściwości gleby, wzrost wegetatywny

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