Influence of effective microorganisms (EM) on yield and quality in organic apple production

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Abstract

In a three-year field experiment from 2005 – 2007 the effects of the plant strengthening agent EMa® (effective mikroorganisms, EM) was tested. Yield, fruit quality and shelf life have been analyzed at the apple variety 'Arlet' on an organically managed farm. The tests have been located in the surroundings of Graz in Styria, Austria, a typical apple cultivation region. Due to the low disease and pest pressure in the year 2007, no significant differences between variants could be detected. After three years the EM-treated trees showed a significantly higher growth and bore bigger fruits, but no difference in the yield per tree could be detected. Because of the significantly thicker trunk diameters the specific yield of the EM variant was correspondingly lower than in the control. An effect on fruit quality and on storage behavior could not be observed. The amount of well shaped seeds in EM-treated apples was significantly higher than in the control group. On the basis of these results the application of effective microorganisms can be conceivable in situations where strong growth is desired, like in nurseries and when replanting orchards.

Keywords: effective microorganisms, apple, organic production, yield, quality

Introduction

In organic fruit growing only a few plant protection agents are allowed to use. Most of them are less efficient than those are allowed in conventional fruit growing. Therefore research for alternatives is necessary. Apart from registered plant agents there are substances allowed with effects on plants and not directly on pest. These are called plant helping agents and they are classified as fertilizers.

One of these agents are the effective microorganisms (EM). It's a mixture of naturally collected and bred organisms and consists of different types. The most important types are lactic acid bacteria, yeast and photosynthetic bacteria (Kyan et al., 1999). EM influences the microbial environment in a way that the regenerative microorganisms become dominant. According to manufacturer, this should influence plant growth, plant quality and soil fertility positive.

Material and Methods

The field trials took place in an apple orchard near Graz in Austria, a typical region for apple growing in Austria. In spring 2005, trees of the apple cultivar 'Arlet' on M9 were planted in 3 m x 0.9 m distance and cultivated organically. The effect of EM was evaluated by comparing two variants, 'EM' (= with additional EM treatments on leaves and on soil (Table 1)) and 'control' (= without additional EM treatments) in three replications with 12 trees per replication. Treatments were applied with a tractor mounted sprayer.

Apple scab *(Venturia inaequalis)* was investigated on about 100 twigs each replication. Twigs with spots on their leaves were counted. For all other assessments all 12 trees in each replication were used.

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36 apples per replication have been used for laboratory investigations. The first laboratory study was done on 12th September 2007 and for a second time at 18th February 2007 after cold storage (3 °C).

Three boxes (about 18 kg) out of each replication have been taken for storage investigations. The temperature was about +3°C until 14.5.2008, when the apples were taken out of the storage room.

Table 1: Additional EM treatments in the 'EM' variant

Date	treatment	dosage	water	target
03.07.05	EMa	25 l/ha	100 l/ha	soil
24.08.05	EMa	25 l/ha	100 l/ha	soil
01.05.06	EMa	25 l/ha	100 l/ha	soil
27.06.06	EMa	25 l/ha	100 l/ha	soil
30.06.06	EMa	5 l/ha	200 l/ha	tree
11.07.06	EMa	5 l/ha	200 l/ha	tree
08.08.06	EMa	5 l/ha	200 l/ha	tree
14.08.06	EMa	25 l/ha	100 l/ha	soil
23.08.06	EMa	5 l/ha	200 l/ha	soil
15.03.07	EMa / EM 5 / EM FPE	7 / 0.5 / 0.5 l/ha	200 l/ha	tree
17.04.07	EMa	15 l/ha	100 l/ha	soil
23.04.07	EMa / EM 5 / EM FPE	7 / 0.5 / 0.5 l/ha	200 l/ha	tree
29.05.07	EMa / EM 5 / EM FPE	7 / 0.5 / 0.5 l/ha	200 l/ha	tree
08.06.07	EMa / EM 5 / EM FPE	7 / 0.5 / 0.5 l/ha	200 l/ha	tree
08.06.07	EMa / EM 5 / EM FPE	7 / 0.5 / 0.5 l/ha	200 l/ha	tree
11.06.07	EMa	15 l/ha	100 l/ha	soil
17.06.07	EMa / EM 5 / EM FPE	7 / 0.5 / 0.5 l/ha	200 l/ha	tree
28.06.07	EMa / EM 5 / EM FPE	7 / 0.5 / 0.5 l/ha	200 l/ha	tree
08.07.07	EMa / EM 5 / EM FPE	7 / 0.5 / 0.5 l/ha	200 l/ha	tree
17.07.07	EMa / EM 5 / EM FPE	7 / 0.5 / 0.5 l/ha	200 l/ha	tree
26.07.07	EMa / EM 5 / EM FPE	7 / 0.5 / 0.5 l/ha	200 l/ha	tree
07.08.07	EMa / EM 5 / EM FPE	7 / 0.5 / 0.5 l/ha	200 l/ha	tree
17.08.07	EMa	15 l/ha	100 l/ha	soil
04.11.07	EMa	15 l/ha	100 l/ha	soil

Results

Damage by apple scab was only found in 2006. 34.41% diseased twigs have been discovered in EM treatment variant while in the variant without EM 50.7% twigs were infected. Leaf infections could be reduced significantly by the use of EM (figure 1).

After the first year the trunk circumference was on the same level in both variants. In the following years the EM treated trees grew more vigorously than those without EM (figure 2).

No differences could be observed in the color and size of leave between both variants. In 2007 higher fruit weights could be observed in the EM variant. The apples had an average single fruit weight of 160 g, apples without EM treatment had only 149 g (table 2). The average yield per tree was also higher in the EM variant (10.29 kg) in comparison to the control (9.72 kg), however this difference was not significant. The specific yield (kg per cm² trunk cross section diameter) was in the EM treated variant lower than in control, because of the more vigorous growth in the EM variant.

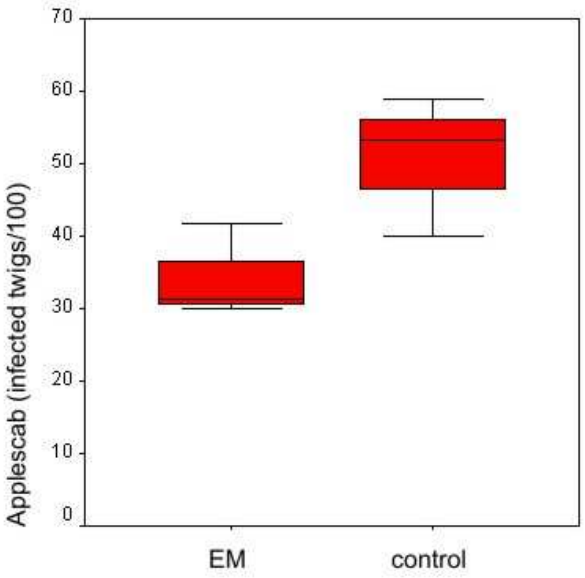


Figure 1: Apple scab *(Venturia inaequalis)* infections on leaves in 2006 (18th september)

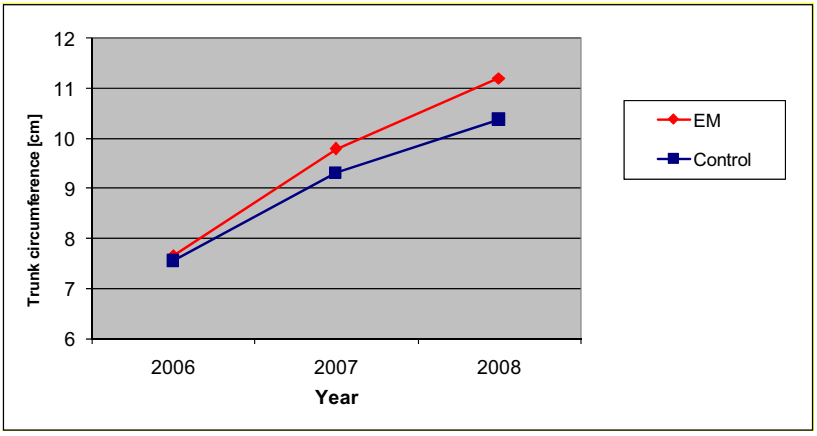


Figure 2: Trunk circumference

Table 2: Yield and fruit weight in 2007

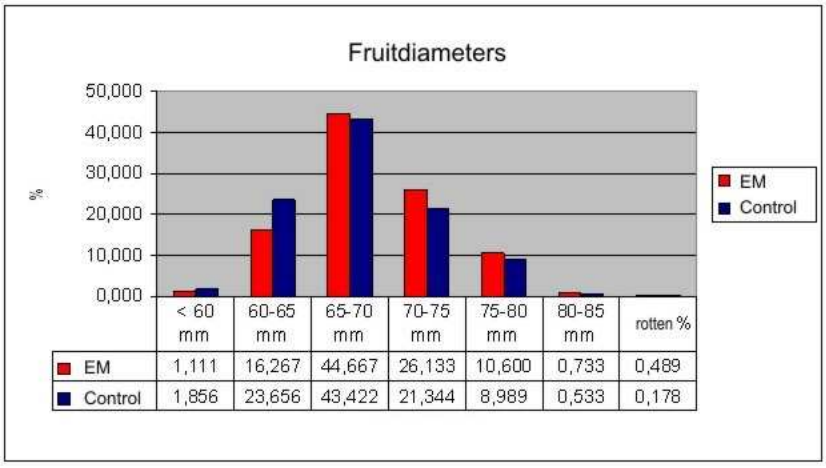
	Yield		Specific yield		Fruit weight	Seeds
	Pieces/tree	kg/tree	pieces/cm²	kg/cm²	g	well shaped
EM	65.72	10.29	6.64	1.04	159.82	5.81
Control	67.19 ns*	9.72 ns*	7.96 s*	1.15 s*	148.95 s*	4.61 s*
* Stat: SPSS 11.0.0; Univariate Analysis of Variance; ns = not significant, s = significant						

There was no difference between the variants in fruit colour, fruit form and fruit firmness. The mean amount of well shaped seed was significantly higher at EM treated apples (5.81) than in the control (4.61). The amount of decayed seed was equal.

Vitamin C content was at 103.69 mg/l in the control variant higher than in the EM variant (98.75 mg/l).

The electrochemical parameters (pH value, conductivity, redox potential and P Value) showed no differences.

After the storage (14th may 2008) the amount of rotten fruits was more or less the same. The investigation of the size classes showed that in the EM variant contained a greater amount of bigger fruits (figure 3).



	< 60 mm	60-65 mm	65-70 mm	70-75 mm	75-80 mm	80-85 mm	rotten %
EM	1,111	16,267	44,667	26,133	10,600	0,733	0,489
Control	1,856	23,656	43,422	21,344	8,989	0,533	0,178

Figure 3: Fruit diameters at yield in 2007

Discussion

In our trial the EM treatment had the effect of a stronger growth of the trees. A reason for this could be that the effective microorganisms promote better nutrition utilization because the nutrition content in EM is very low, about 0.1 % nitrogen and 1% available phosphorus (Kaliq et al., 2006). Although the growth in the EM treatment was stronger, a significantly higher yield could not be observed. However Ndona (2008) as well as Xu et al. (2000) could verify in their testing an increasing yield by EM treatment on tomatoes, respectively on peas and onion. Specific yield decreases because auf the thicker trunk diameters in the EM treatment. The increasing number of seed in the EM treated fruits and the bigger apples could be also an indication for a better nutrient supply. On the basis of these results the application of effective microorganisms can be conceivable in situations where strong growth is required, like in nurseries and when replanting orchards.

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