



(RESEARCH ARTICLE)



Effective microorganisms for the cultivation and qualitative improvement of onion (*Allium cepa* L.)

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Abstract

The aim of the study was to investigate how effective microorganisms (EM) affect the quality and growth of onions cvs "Dorata di Bologna", "Lunga di Firenze", "Bianca Musona", "Rossa di Tropea". An experiment was carried out with 2 treatments: 1) soil inoculated with EM microorganisms; 2) soil without EM microorganisms (control). The test showed a significant increase in the agronomic parameters analysed in the plants treated with Effective microorganisms. In fact, all the onions of the different varieties, treated with EM microorganisms, showed a significant increase in bulbs weight, bulbs diameter, bulbs length and root weight. There is also an increase in radical growth in the theses with Effective Microorganisms, an aspect confirmed in other experiments in vegetable and ornamental crops. Increased root growth results in improved resistance to water and transplant stress and a higher supply of nutrients to the plant, which consequently grows better. It is therefore clear from the evidence that the use of this selection of microorganisms, inoculated into the soil, can significantly improve the quality of onions bulbs.

Keywords: Effective microorganisms (EM); Plant quality; Rhizobacteria; Horticulture; Vegetable plants; Soil improvement

1. Introduction

Effective microorganisms are a commercial microbial selection containing a mixture of coexisting beneficial microorganisms collected from the natural environment.

This selection was developed at the University of Ryukyus, Japan, in early 1980 by Prof. Dr. Terou Higa. About 80 different microorganisms are able to positively influence the decomposing organic substance in such a way as to transform it into a process of "promoting life".

The main species involved in EM include [1-2]:

- Lactic acid bacteria – *Lactobacillus plantarum*, *L. casei*, *Streptococcus lactis*;
- Photosynthetic bacteria – *Rhodospseudomonas palustris*, *Rhodobacter spaeroides* [3];
- Yeast – *Saccharomyces cereviasiae*, *Candida utilis*;
- Actinomycetes – *Streptomyces albus*, *S. griseus*;
- Fermenting fungi – *Aspergillus oryzae*, *Mucor hiemalis*.

EM is a fermented mixed culture of naturally occurring species of microorganisms coexisting in an acid environment (pH less than 3.5). Microorganisms in EM improve crop health and yield by increasing photosynthesis, producing bioactive substances such as hormones and enzymes, accelerating the decomposition of organic materials and controlling soil diseases. Effective microorganisms can be used as herbal insecticides to control insects and pathogenic

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microorganisms and can also be used as plant growth inducers. Soil microorganisms have an important influence on soil fertility and plant health. EMs interact with the soil-plant ecosystem by controlling plant pathogens and disease agents, solubilising minerals, increasing plant energy availability, stimulating the photosynthetic system, maintaining the microbiological balance of the soil, fixing biological nitrogen [4]. A characteristic of this mixture is the coexistence of aerobic and anaerobic micro-organisms. After Higa's research in Japan [1], the characteristics of EM have been studied in many countries. Studies have shown positive effects of the application of EM on soils and plants on soil quality and nutrient supply [5], plant growth [6], crop yield [7], [5] and crop quality [8-11]. However, in some studies no positive effects were found [4], [12-13].

This study has tested the possible use of EM microorganisms in the cultivation and improvement of the quality of onion (*Allium cepa L.*), to increase knowledge and improve the protocols of use of this microbial selection applied in various fields of agriculture around the world.

2. Material and methods

2.1. Greenhouse experiment and growing conditions

The experiments began in early November 2018 (mean temperature 7.5°C), were carried out in experimental greenhouses of the CREA-OF of Pescia (Pt), Tuscany, Italy (43°54'N 10°41'E) on bulbs of onion (cvs "Dorata di Bologna", "Lunga di Firenze", "Bianca Musona", "Rossa di Tropea"). The bulbs were placed in pots ø 14 cm; 40 bulbs for thesis divided into replicas of 20 bulbs each, for all types of onion.

All bulbs were fed with the same amount of nutrients supplied through controlled release fertilizer (5 kg m⁻³ of Osmocote Pro® 3 - 4 months containing 190 g/kg N, 39 g/kg P, 83 g/kg K) blended with the growing medium before transplant.

The 2 experimental theses in cultivation were:

Thesis without EM (CTRL), with only water.

Thesis with (EM) with activated in dilution 1:100 (2L of 1:100 dilution inoculum was used with EM for every 10L of peat, same proportion for the control thesis where only water was used);

The lighting of the greenhouse at the plant level was about 12,000 lux with high pressure sodium lamps. The plants were lit for 16 hours a day. A minimum daytime temperature of 20 °C and a night-time temperature of 18 °C were maintained in the greenhouse. On the 6th of June, bulbs weight, diameter (for all cvs) and length (only for cv "Lunga di Firenze") were recorded.

2.2. Statistics

The experiment was carried out in a randomized complete block design. Collected data were analysed by one-way ANOVA, using GLM univariate procedure, to assess significant ($P \leq 0.05$, 0.01 and 0.001) differences among treatments. Mean values were then separated by LSD multiple-range test ($P = 0.05$). Statistics and graphics were supported by the programs Costat (version 6.451) and Excel (Office 2010).

3. Results

3.1. Plant growth

The test showed a significant increase in the agronomic parameters analysed in the plants treated with Effective Microorganisms. In fact, all the onions of the different varieties, treated with EM microorganisms, showed a significant increase in bulb weight, bulb diameter, bulb length (only for cv "Lunga di Firenze") and root weight.

In "Dorata di Bologna", the diameter of the bulb was 36.36 mm in the EM thesis, against 27.69 mm of the control (Fig.1A), 49.13 g in the EM thesis, against 22.87 g of the control with regard to the weight of the bulb (Fig.1B). There is also an increase in root weight, 17.11 g in EM compared to 12.33 g in control (Fig. 1C, 5A).

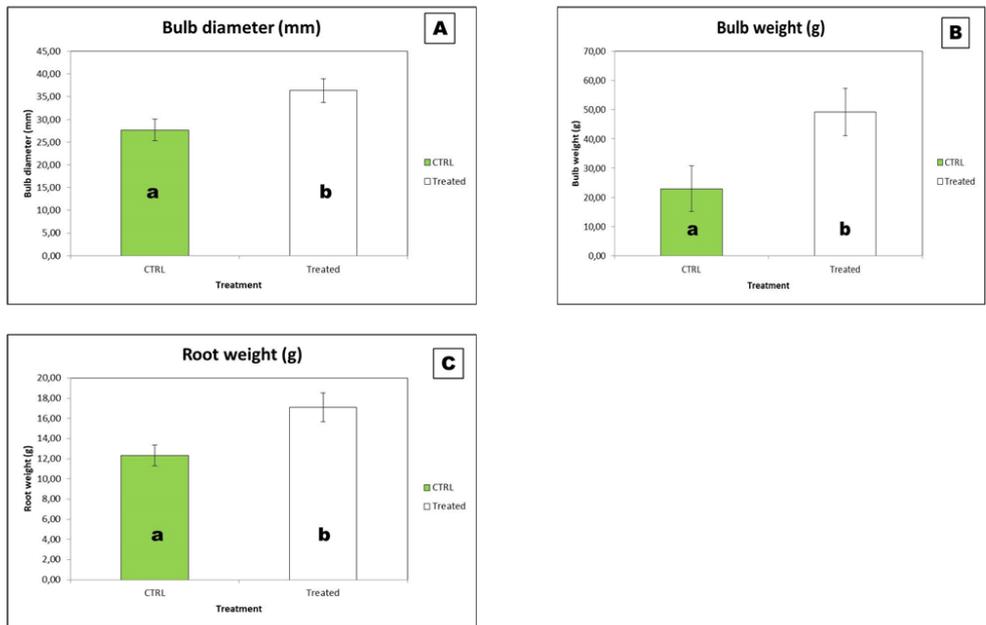


Figure 1 Effect of Effective Microorganisms (EM) on the growth of onion cv “Dorata di Bologna”. Each value reported in the graph is the mean of three replicates \pm standard deviation. Statistical analysis performed through one-way ANOVA. Different letters for the same parameter indicate significant differences according to LSD test ($P = 0.05$).

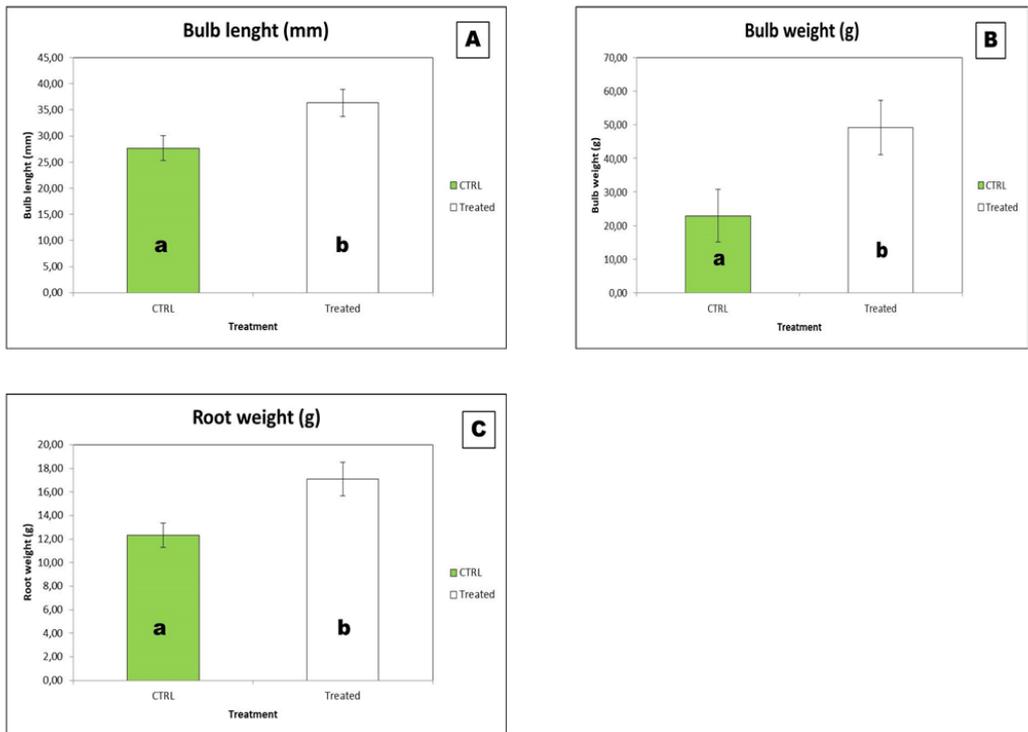


Figure 2 Effect of Effective Microorganisms (EM) on the growth of onion cv “Lunga di Firenze”. Each value reported in the graph is the mean of three replicates \pm standard deviation. Statistical analysis performed through one-way ANOVA. Different letters for the same parameter indicate significant differences according to LSD test ($P = 0.05$).

In “Lunga di Firenze”, the length of the bulbs increased, 96.60 mm in EM, compared to 80.81 mm for the control (Fig. 2A). There is an increase in the weight of the treated bulbs, 32.55 g against 16.92 g of the untreated control (Fig. 2B). In addition, there is an increase in radical weight, 58.66 g in the EM-treated thesis, compared to 37.11 g in the untreated control (Fig. 2C, 5B).

In “Bianca Musona”, the data show a significant increase in the diameter of the bulb, 36.81 mm in EM, compared to 20.25 mm in the control (Fig.3A). There is also a significant increase in the weight of the bulbs, 42.71 g in EM compared to 17.46 g in the untreated control (Fig.3B). The data also show a significant increase in radical weight, 37.56 g in EM compared to 28.66 g in untreated control (Fig.3C, 5C).

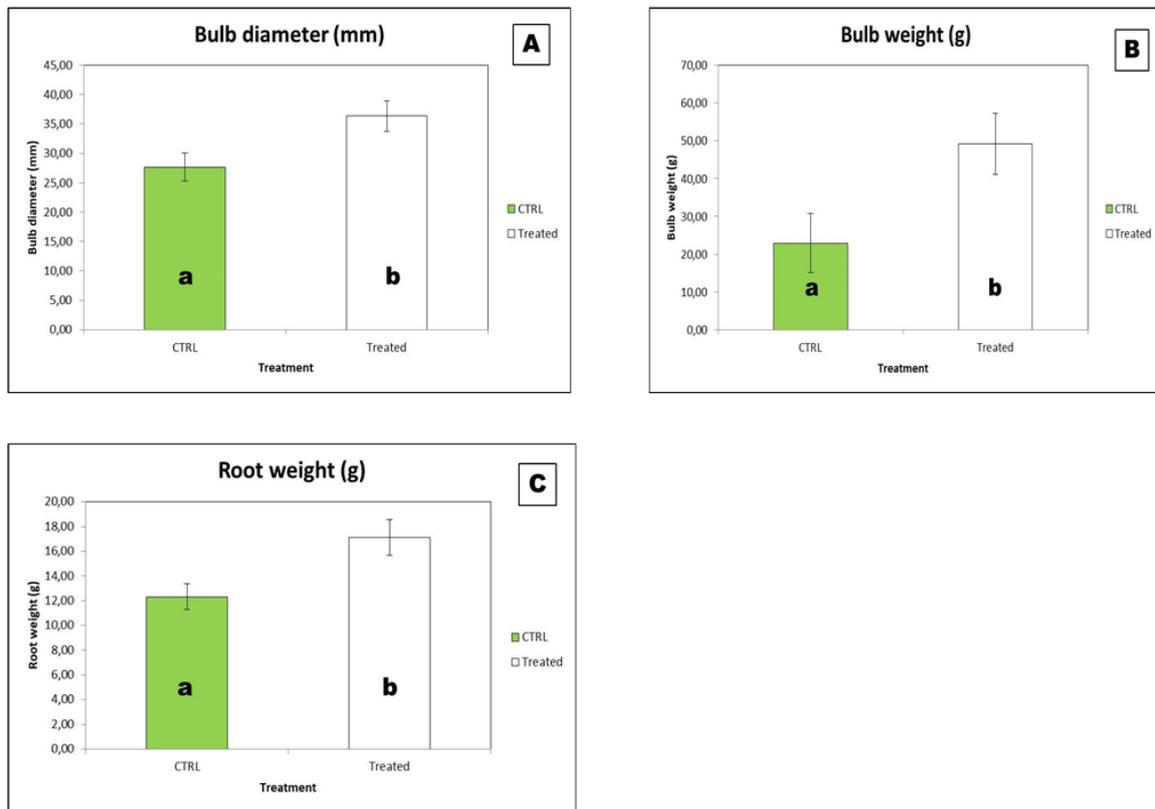


Figure 3 Effect of Effective Microorganisms (EM) on the growth of onion cv “Bianca Musona”. Each value reported in the graph is the mean of three replicates \pm standard deviation. Statistical analysis performed through one-way ANOVA. Different letters for the same parameter indicate significant differences according to LSD test ($P = 0.05$).

In “Rossa di Tropea” the data show a significant increase in the diameter of the bulb, 38.55 mm in Em compared to 24.22 mm of the control (Fig. 4A). In addition, there was a significant increase in the weight of the bulb, 50.11 g in EM compared with 21.39 g in the control (Fig.4B). The test also showed, as for the other onion varieties, a significant increase in root weight, 28.99 g in EM compared to 23.44 g in the untreated control (Fig. 4C, 5D).

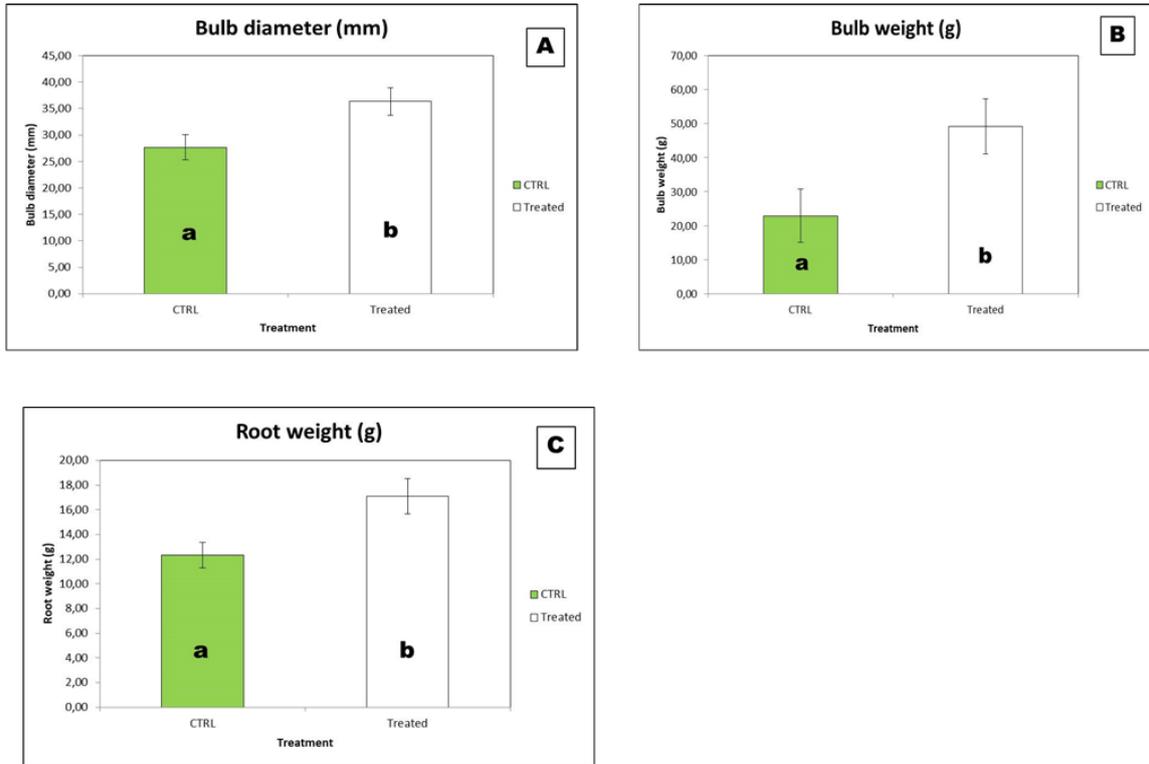


Figure 4 Effect of Effective Microorganisms (EM) on the growth of onion cv “Rossa di Tropea”. Each value reported in the graph is the mean of three replicates \pm standard deviation. Statistical analysis performed through one-way ANOVA. Different letters for the same parameter indicate significant differences according to LSD test ($P = 0.05$).

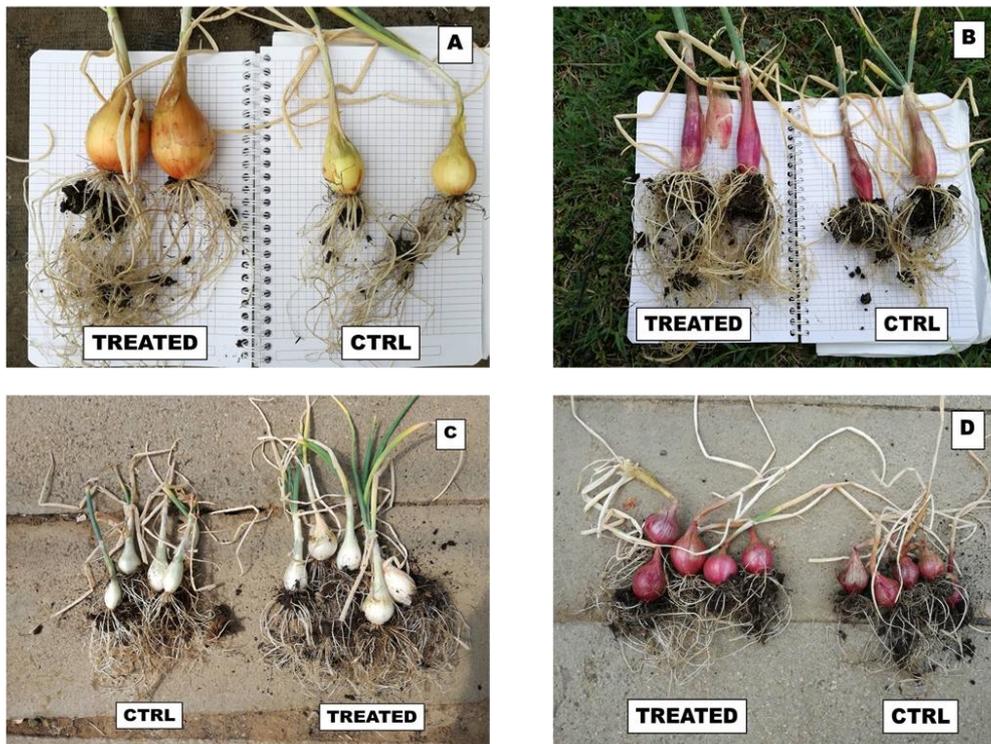


Figure 5 Comparison of onions treated with Effective microorganisms and control, cvs “Dorata di Bologna” (A), “Lunga di Firenze” (B), “Bianca Musona” (C), “Rossa di Tropea” (D).

4. Discussion

The literature does not reveal studies on the effects of Effective Microorganisms on the quality of onion plants, although several works show the effects of this microbial selection on horticultural, ornamental and fruit crops [14][15].

In this trial all varieties of onions treated with EM microorganisms showed a significant increase in diameter, weight and length of bulbs and root weight.

EM microorganisms stimulate onion bulbs already at the time of transplantation because they guarantee a better water supply and an increase in the solubilization of minerals present in the substrate and in the soil, in particular Ca, P and Mg. Ca influences many beneficial processes for the plant: a high content of Ca leads to fewer diseases, reduction of insect attack, better preservation of the product [4]. The results show a faster growth rate of EM-treated onion bulbs and a reduction in the possible development of diseases.

Scientists have shown that Effective Microorganisms can increase fruit weight, yield and photosynthesis [16]. EM applied with green manure significantly increased tomato yields, which in the third year of cultivation were comparable to those obtained with chemical fertilizers [17].

There is also an increase in radical growth in the theses with Effective Microorganisms, an aspect confirmed in other experiments in vegetable and ornamental crops [18][19]. Increased root development results in increased resistance to water and transplant stress [20] and a higher supply of nutrients to the plant, which consequently grows better.

5. Conclusion

The test showed how the use of Effective Microorganisms can improve the quality of the onion bulbs cvs "Dorata di Bologna", "Lunga di Firenze", "Bianca Musona", "Rossa di Tropea", in particular by significantly increasing the diameter, weight, length of the bulbs and root weight. EM microorganisms can have a positive effect on the absorption of other minerals, particularly calcium, by promoting plant growth, improving product quality, growth rate and resistance to biotic and abiotic stress.

Compliance with ethical standards

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Disclosure of conflict of interest

Disclosure of conflict of interest none to declare.

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