Effects of a plant enhancement liquid, FFC Vegemake©, for plant growth©

K. Ichikawa[a], J. Ueda and T. Fujimori

Institute of Biological Process Research, Akatsuka Garden Co., Ltd., 1868-3 Takanoo-cho, Tsu, Mie 514-2293, Japan.

INTRODUCTION

Since 1984, Akatsuka Garden Company has focused on the behavior of certain ions, especially iron ions in water and interactions of water molecules with them. We have continued research on various solutions to not only accelerate plant growth, but also activate physiological functions of plants. Based on this research, we have developed FFC materials such as "FFC-Ceramics" (for water improvement), "FFC-Ace" (for soil improvement) and others.

In addition, many agricultural producers in Japan have been utilizing FFC materials to rejuvenate plants and increase profits. Those producers have also explored many other possible methods of using FFC materials and consequently found good ways that benefit their actual production sites.

As a result, they have obtained many advantages over years of use, such as improved productivity, cost reduction, decreased dependence on agricultural chemicals among others. Additionally, it has been reported that "FFC-Ace" enhances the growth of plants under laboratory conditions while improving disease resistance, drought resistance, and salt stress tolerance (Ichikawa and Fujimori, 2012, 2013; Ichikawa et al., 2014, 2015; Fujita et al., 2010; Hasegawa et al., 2006; Konkol et al., 2012; Shiraishi et al., 2010; Toyoda et al., 2010).

A plant enhancement liquid is, in general, a liquid that contains no nitrogen, phosphate, or potassium, that is used for vitalizing plant growth. It contains micronutrients and various kinds of organic matter (vitamins, amino acids, etc.). It makes a higher impact via application by foliar spraying and pouring into the soil than by the usual method of conventional spraying.

FFC Vegemake© (hereinafter, referred to as "FFC-VM") is a high-safety plant enhancement liquid, which has been developed in 2016 using FFC materials. FFC-VM contains water treated with FFC ceramics, as well as a plant extract, a sugar, and an organic acid. Therefore, FFC-VM serves as a high-performance enhancer due to the effects of the ingredients, as well as the water treated with FFC ceramics.

In this study, we report an effect of foliar spraying of FFC-VM on some plants.

MATERIALS AND METHODS

Comparison of initial growth of a small turnip

Seeds of a small turnip (*Brassica rapa* subsp. *rapa* 'Kintoki-Kokabu') were sown in a raised seedling tray, which was filled with commercially available soil for vegetables. The small turnips were grown in a greenhouse under natural light for 21 days. Half of the small turnips were cultivated via foliar spraying of a diluted solution of FFC-VM (2000-fold dilution with tap water) every 3 days. The other half of the turnips were cultivated via foliar spraying of tap water only. After 21 days, the shoot fresh weight, and the dry weight of the small turnips were measured.

Comparison of growth of flower seedlings of *Calibrachoa* Million Bells®

Flower seedlings of *Calibrachoa* 'SUNbelki', Million Bells® Yellow (Suntory Flowers Co., Ltd.) were planted in a planter, which was filled with commercially available soil for raising seedlings. The planter was placed outdoors, and the flower seedlings were cultivated under natural light for 77 days. Foliar sprayings were done for all of the flower seedlings. Half were sprayed with a diluted solution of FFC-VM (2000-fold dilution with tap water) every 7 days,

[a]E-mail:kazu.ichikawa@akatsuka.gr.jp

and the other half were sprayed with tap water only. Both test sections were watered with an identical amount of tap water via watering can.

Comparison of growth, fruition, and analysis of amino acids of cherry tomatoes

Cherry tomatoes seedlings (*Solanum lycopersicum* 'Suzunari') of were planted in a pot, which was filled with commercially available soil for raising seedlings. The seedlings were watered with tap water every 2 days. Foliar sprayings were done for the flower seedlings. One-half was sprayed with a diluted solution of FFC-VM (2000-fold dilution with tap water) every 7 days, and the other half was sprayed with tap water. After 57 days, all the cherry tomatoes were harvested and then the amount of amino acids in the liquid extracts was analyzed and measured by HPLC measurement.

RESULTS AND DISCUSSIONS

The result of the experiment of the comparison of initial growth of a small turnip is shown in Figures 1 and 2. In comparison with the initial growth, fresh shoot weight of the small turnips treated with foliar spraying of FFC-VM was approximately 1.27 times higher than that of those treated with tap water alone (Figure 1). The roots of the treated plants were more elongated. Additionally, the root hair was more well-developed (Figure 2). These results suggest that FFC-VM applied through foliar spraying accelerates growth of both shoots and roots of small turnips.

In the second experiment, the comparison of growth of flower seedlings of *Calibrachoa* 'SUNbelki', Million Bells® Yellow (Figure 3) shows that the flower seedlings treated via foliar spraying of FFC-VM blossom much more than those treated with tap water alone (Figure 3).

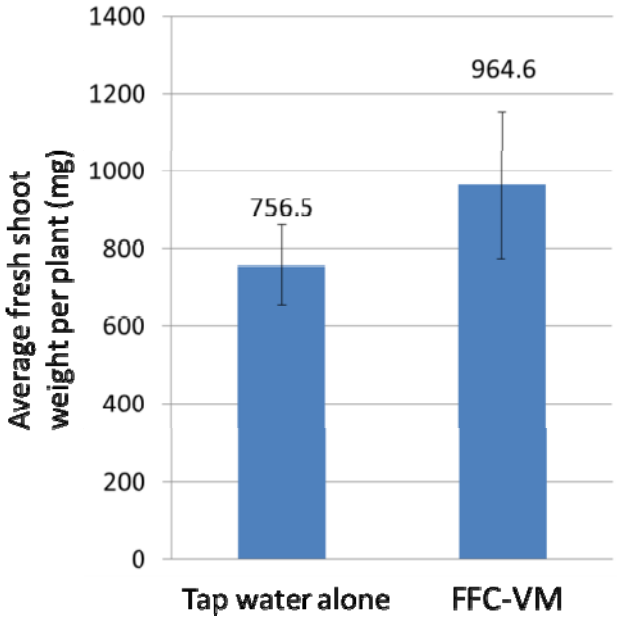

Figure 1. The experiment of the comparison of initial growth of a small turnip (*Brassica rapa* subsp. *rapa* 'Kintoki-Kokabu'): average fresh shoot weight per plant.

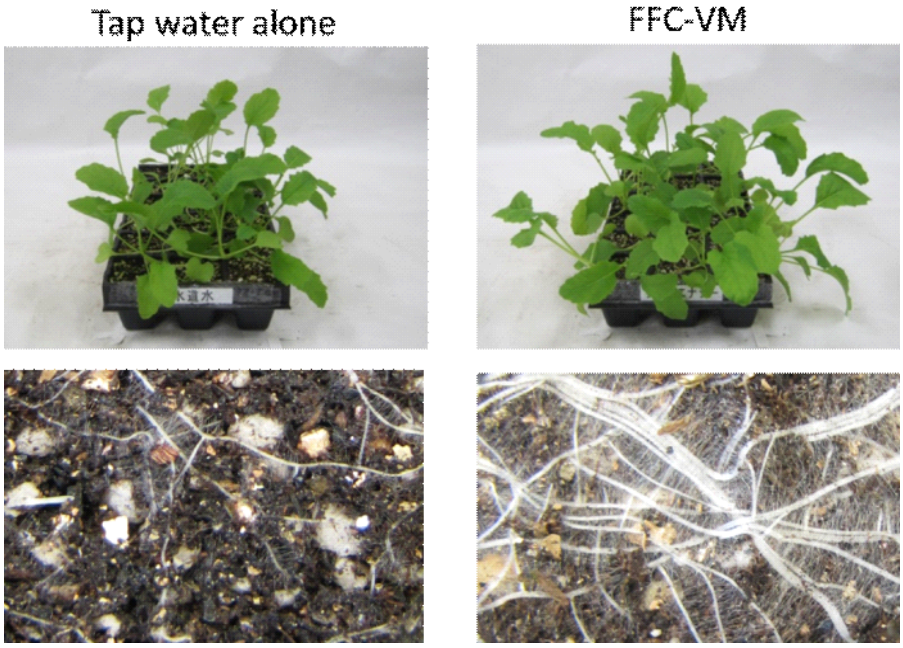

Figure 2. The experiment of the comparison of initial growth of a small turnip (*Brassica rapa* subsp. *rapa* 'Kintoki-Kokabu'): appearance of shoots and roots.

Figure 3. Comparison of growth of flower seedlings of *Calibrachoa* 'SUNbelki', Million Bells® Yellow.

The result of the experiment of the comparison of growth, fruition, and analysis of amino acids of cherry tomatoes demonstrated that the average weight of cherry tomato fruits cultivated with FFC-VM, as well as the number of fruition, was higher than those treated with tap water alone (Table 1). In addition, the concentration of glutamic acid in the cherry tomato fruits cultivated with FFC-VM was approximately 31% higher than that of those treated with tap water alone (Table 1).

Overall, these results support the effectiveness of foliar spraying of FFC-VM on overall plant growth, increases of the number of flowers, increases in yield, and improvement in overall quality of plants and crops.

Table 1. Results of cultivation experiments of cherry tomatoes (*Solanum lycopersicum* 'Suzunari').

	Tap water	FFC-VM
Average fresh weight per fruit (g) *n*=5	5.9	6.8
Number of fruit for 4 months	39	50
Glutamic acid content (μg mg^{-1} fresh weight)	1.710	2.247

Literature cited

Fujita, K., Suzuki, T., Hasegawa, S., Meguro, A., Sugiura, S.H., Toyoda, K., Shiraishi, T., Sakaguchi, E., Nishimura, T., and Kunoh, H. (2010). Enhancement of growth and yield of barley by the soil conditioner FFC-ace. Scientific Reports of the Faculty of Agriculture. Okayama University *99*, 13–20.

Hasegawa, S., Meguro, A., Shimizu, M., Nishimura, T., and Kunoh, H. (2006). The ceramic bead that is suitable for a carrier of plant-rooting accelerator, *Streptomyces* sp. MBR-52. Actinomycetologica *20* (*2*), 23–29 http://dx.doi.org/10.3209/saj.20.23.

Ichikawa, K., and Fujimori, T. (2012). Effects on growth of plants by the soil conditioner FFC-Ace. Comb. Proc. Intl. Plant Prop. Soc. *62*, 455–462.

Ichikawa, K., and Fujimori, T. (2013). Soil conditioner FFC-Ace© effects on growth and quality berries of wine grapes. Comb. Proc. Intl. Plant Prop. Soc. *63*, 357–360.

Ichikawa, K., Fujimori, T., and Nakanishi, Y. (2014). Effect of a soil conditioner FFC-Ace© on growth of sugarcane and quality of soil penetration water. Comb. Proc. Intl. Plant Prop. Soc. *64*, 367–371.

Ichikawa, K., Ueda, J., and Fujimori, T. (2015). Effects of soil conditioner FFC-Ace© on inhibited plant growth under acidic soil conditions. Comb. Proc. Intl. Plant Prop. Soc. *65*, 123–125.

Konkol, N.R., McNamara, C.J., Bearce-Lee, K.A., Kunoh, H., and Mitchell, R. (2012). Novel method of micronutrient application increases radish (*Raphnus stivus*) and shirona (*Brassica papa* var. *pekinensis*) biomass. J. Plant Nutr. *35* (*3*), 471–479 http://dx.doi.org/10.1080/01904167.2012.639925.

Shiraishi, T., Toyoda, K., Suzuki, T., Meguro, A., Hasegawa, S., Nishimura, T., and Kunoh, H. (2010). Effect of FFC ceramic water on the infection process of a fungal pathogen. Scientific Reports of the Faculty of Agric. Okayama Univ. *99*, 27–34.

Toyoda, K., Matsuoka, S., Meguro, A., Hasegawa, S., Nishimura, T., Kunoh, H., and Shiraishi, T. (2010). FFC ceramic water™ enhances plant apyrase activity. Scientific Reports of the Faculty of Agric. Okayama Univ. *99*, 21–26.