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Abstract

The objective of our research is to make extraordinary sweet tomatoes. Based on the hypothesis that the sugar content of tomatoes increases by giving environmental and physical stress we carried out the following experiments.

We grew them under a variety of stress and then measured the sugar content level. Giving three kinds of stress: “reduction in watering”, “picking off unwanted tomatoes” and “reduction in the fertilizer amount” respectively, we saw a rise in the sugar content level. In addition, we carried out another experiment where both of the two kinds of stress, reduction in watering” and “picking off the unwanted tomatoes”, are given at the same time. As a result, the sugar content increased compared to the experiments where we give one stress respectively. These results show an increase in the sugar content by giving certain environmental and physical stress. Therefore, we conclude that the specific environmental and physical stress gives a rise in the sugar content, and a combination of them produces extraordinary sweet tomatoes.

Keywords: tomatoes, sugar content, environmental and physical stress

In order to make extraordinary sweet tomatoes ~effects of stress and sugar content~

Introduction

Recently, highly sweet tomatoes as fruit tomatoes have been on the market at a high price compared to the regular tomatoes, and the demand for sweeter tomatoes has been on the increase. However, the high price is working as a deterrent for consumers. Therefore, we thought that we should figure out a less expensive way to turn regular tomatoes into highly sweet tomatoes., which is to use common methods which are used to make other fruits sweeter. Through researching a variety of plant methods, to give several stresses such as picking off the unwanted fruits and reduction in watering induces a rise in the sugar content level of the fruits. In order to evaluate the effects of the environmental and physical stress on the sugar content level of tomatoes, we grew the tomatoes under a variety of stress. And by measuring the sugar content level and investigating the relation between environmental and physical stress and sugar content, we tested how to harvest extraordinary sweet tomatoes.

Materials and Methods

1 Experiment materials

two tomato varieties: Cherry tomatoes and Saturn tomatoes
In both varieties different sizes were used. To minimize phenotypic and genotypic individually, by making a cutting, we cloned tomato trees. Also, as much as possible, the tomatoes of the same size were collected. However, diseased and dead ones were

picked off immediately and we measured the sugar concentration levels of them.

2 How to measure sugar content

We measure sugar content level by cutting the cropped tomatoes in half and drop juice in saccharimeter. Both halves were measured to to prevent partial existence of sugar from affecting the experiment results. In addition to this, we harvest tomatoes in full ripe stage. (Full ripe stage means the state where the fruit is covered with orange and red colors but the bottom is still green in color and the flesh is a little hard.) Approximately the same size tomatoes were cropped. Sick and dead individuals, however, were cropped as soon as the symptoms appears, when sugar content level was measured The reading of sugar concentration level were taken advantages per experiment and treated as the experimental results.

3 methods of experiment and research

3.1 Effect of physical stress on plants

We gave stress at two different ripening stages as below.

A. Right after the formation of tomatoes buds
B. Mature green stage right before turning into light red stage

Under the stress, "picking off unwanted tomatoes" at both A and B, the number of tomatoes were cut down to one fruits per tree. Under the stress, "tomato being damaged", they were damaged in two different stages. At the stage A, the tomatoes being so small, they were pricked with a needle. At the stage B, the tomatoes were slit with a razor.

Under the condition of removal of the unwanted leaves, at the mature green stage, all the leaves were trimmed off all the branches except one leaf left on a branch.

3.2 Effects of environmental stress on plants

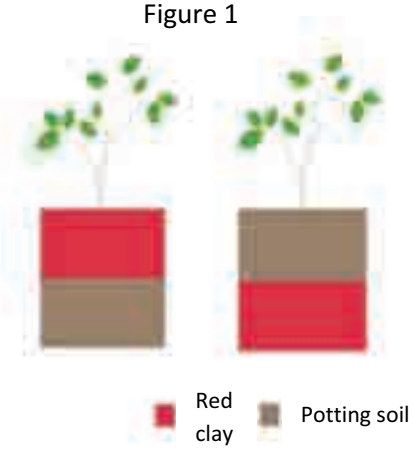
By environmental stress we mean two factors: the amount of water and the pH value of the soil.

By changing the amount of water, we gave stress to tomatoes. First we gave one third , the tomato trees received water either one third or triple amount of the regular amount at a time.

Next we planted tomatoes in the soil of two different pH values, either alkali soil or acidic soil. With respect to alkali soil, it was prepared by mixing the regular potting soil with slaked lime. The potting soil itself is already acidic; therefore, the potting soil was available as acidic soil.

In terms of changing in the fertilizer amount, as it is shown the above diagram, for planter C, the red clay soil and potting soil were placed in the upper and lower half of the planter respectively. For planter D, these two layers were placed in a reversed manner (Figure1). These planters were prepared to grow tomatoes.

Figure 1

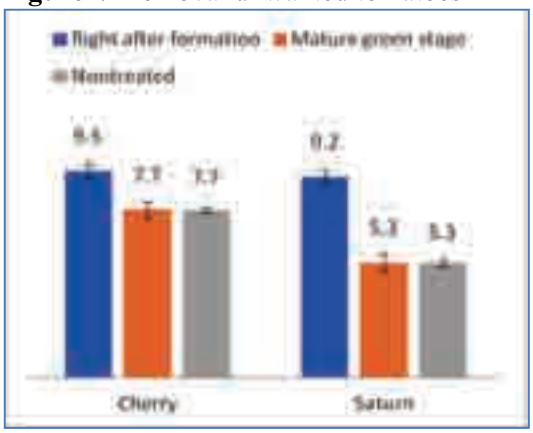


Results and Discussion

1Result

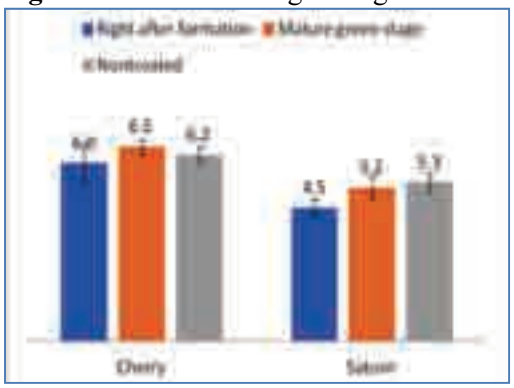
1.1 Effects of physical stress on plants

Figure2. Removal unwanted tomatoes



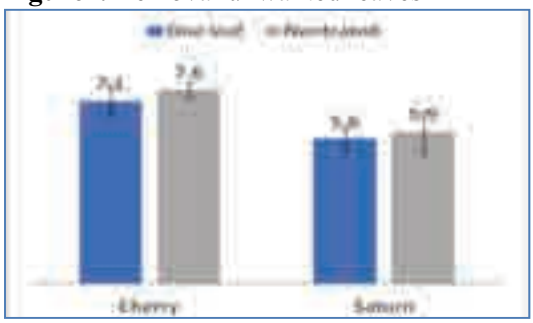
By removing the unwanted tomatoes the sugar concentration levels increased in both varieties Cherry and Saturn tomatoes(Figure2**)**. Also, removal of the unwanted tomatoes at the early stage induced an elevation of the sugar concentration levels in the tomatoes.

Figure3. Tomatoes being damaged



By damaging , the sugar concentration levels were lower when damaged at the mature green stage (Figure3). Also one of Saturn tomato trees contracted a disease, and the average of the sugar concentration readings slightly decreased.

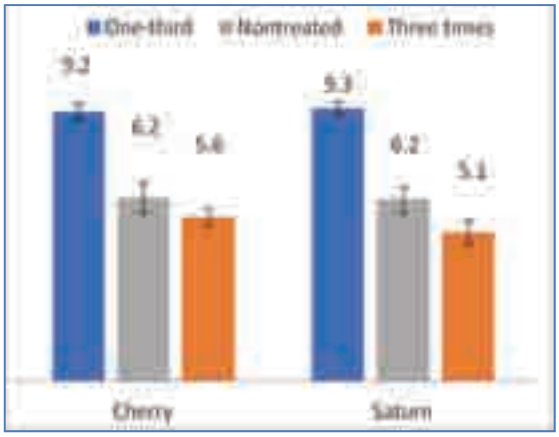
Figure4. Removal unwanted leaves



By removing the unwanted leaves, there was a tendency to increase the sugar concentration level without removal of them(Figure4).

1.2 Effects of environmental stress on plants
1.2.1 Relation between water amount and sugar concentration level**.**

Figure5. Change the water amount

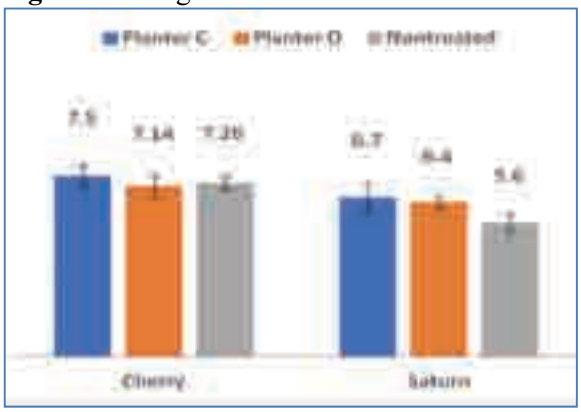


The sugar concentration levels decreased in both kinds of tomatoes when the water amount given went up (Figure5). On the other hand, when the amount quantity of water given went down, the sugar concentration levels were widely increased, but these tomatoes grew slower than non-treated ones, and they were small in size. Also, those plants that received a small amount of water rooted firmly into the ground.

1.2.2 Relation between soil pH level and sugar concentration level
The tomato trees grew in the acidic soil; however, there was no change seen through the study. On the other hand, under the condition of alkali soil, the tomato trees withered up, and the data was not able to be collected.

1.2.3 Relation between fertilizer amount and sugar concentration level

Figure6. Change the fertilizer amount



The tomatoes grown in planter C (red clay soil in the upper layer, potting soil in the lower layer) showed a higher sugar level than planter D (potting soil in the upper layer, red clay soil in the lower layer) (Figure6). When comparing the growth rates, at the beginning, the trees in the plantar D grew faster, but the trees in the planter

C caught up with the growth rate of the planter D and grew faster later on. Also, the tomato tree roots in the planter C were more firmly fixed in the soil than those of the planter D.

2. Discussion

4.1 Effects of physical stress on plants

Of the three removals, the removals of the unwanted leaves, the tomatoes in damage, the unwanted tomatoes, the only removal which showed a rise in the sugar concentration level is the removal of the unwanted tomatoes. Presumably this happens because removal of them makes more photosynthesized sugar available to a small number of tomatoes. Concerning the removal of the unwanted leaves, when it was time to trim them off, those tomatoes were large enough. For that reason, even though they were largely removed, it did impact the sugar concentration levels of those tomatoes.

4.2. Effects of environmental stress on plants

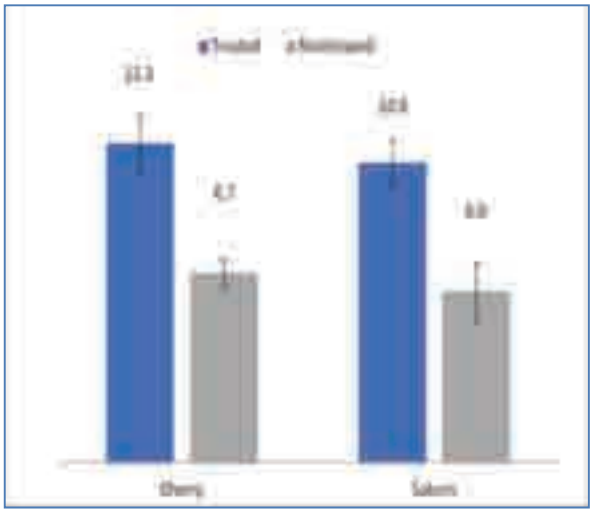
Two conditions such as reduction in watering and reduction in the fertilizer amount gave a rise in the sugar concentration levels. Because any tomato trees that received less water grew slowly and to a smaller amount, the consistency of the tomatoes probably became dense. Also tomatoes in a dry environmental condition absorb water efficiently. For that reason, it can be thought that the condensing of the tomato components facilitated the sugar levels increasing.

The tomato trees kept distant from the fertilizer are expected to spread their roots towards the direction of water and fertilizer. The action of trying to root towards the far distant fertilizer becomes stress against tomato trees and presumably affects the sugar concentration levels.

Conclusions

From the results mentioned above, these three conditions, “reduction in watering”, “removal of the unwanted tomatoes” and “reduction in the fertilizer amount”, respectively give tomatoes environmental and physical stresses that induce a rise in the sugar concentration levels. Thus, we made an assumption that if these conditions were combined together, the sugar concentration levels would expectedly jump up. For this reason, we simultaneously conducted two stress tests: “reduction in watering” and “removal of the unwanted tomatoes, and the following results were obtained.

Figure7. Reduce the water amount and pick off tomatoes



From those experiments, we were able to harvest extraordinarily sweet tomatoes (Figure7). The technique, thinning, was utilized, and in addition to it, when the plants received less than a certain amount of water, the sugar levels increased considerably. Therefore, giving tomatoes a combination of environmental and physical stressors is therefore likely to harvest extraordinarily sweet tomatoes.

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