

## MORPHOLOGICAL CHARACTERISTICS AND YIELD OF CUCUMBER DEPENDING ON GRAFTING

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### Summary

Talking about a cucumber (*Cucumis sativus* L.) widespread means that it should be immediately emphasized how widespread it is in our country (Bosnia and Herzegovina), both in food and production. Based on that, there is an urgent need for quality and disease-resistant varieties/hybrids produced by technology which reduces the possibility of disease emergence. Greenhouse production of grafted cucumber in Bosnia and Herzegovina in recent years is experiencing significant expansion.

Grafted plants of the cucumber hybrid 'Charta' were comparatively analyzed with the non-grafted, in order to record the main morphological and productive differences between them.

The examined parameters were the number of lateral roots, number of roots hairs, root mass, leaf length and yields.

The results of this study show that grafted cucumber in relation to non-grafted achieves a higher yield ( $161.64 \pm 20.82$  kg/50m<sup>2</sup>), while morphological characteristics were mostly similar. Significant differences were observed only in the number of lateral roots ( $18.00 \pm 2.65$ ).

Key words: *Cucumis sativus* L., *grafting method*, *root mass*, *marketable yield*

### INTRODUCTION

Cucumber cultivation is one of the most profitable gardening productions in Bosnia and Herzegovina. It is cultivated as a cucurbit in an open field or as an industrial cucumber – cornichon in greenhouses (Karić *et al.*, 2017). In the past couple of years, cucumber production in different greenhouse types has become of interest. Cucumbers in greenhouses are cultivated as the main culture. It is often the case that there's a complete disregard for all principles of gardening crop rotation. A series of difficulties burdens the intense vegetable production in greenhouses - i.e., the producers with only one production object can hardly appease the consumers while maintaining optimal crop rotation. The production of one culture in repeated production cycles leads to soil

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fatigue, the appearance of various diseases and vermin, and lastly to crop yield reduction (Behmen *et al.*, 2021). Greenhouses, in which a single culture was produced for several years (2-3), needs additional investments into soil disinfection - a rather expensive agro technical measure, whether it is done using overheated steam or chemicals. The production of grafted plants was established with the aim of sterilization-free production with a significantly lower risk of plant root diseases (*Fusarium certicilium*, *Rizoh-tonia*), as well as soil vermin (Nematods). By grafting desired varieties or hybrids on selective rootstocks, the production is continued with minimal risk of the abovementioned diseases and vermin to which cucumbers are rather susceptible. In line with everything stated so far, plant grafting is the most ecologically acceptable method used to decrease pesticide use. Alongside diseases, cucumber is extremely susceptible to abiotic stressors, especially unfavorable air and soil temperature (Balliu *et al.*, 2021; Gruda *et al.*, 2017). It has been established that, in comparison to the ungrafted ones, grafted cucumbers better absorb water and nutrients from the soil, while also having longer leaves which impacts the higher crop yield (Goreta Ban *et al.*, 2014). Cucumbers are usually grafted onto different pumpkins rootstocks (*Cucurbita maxima x C. Moschata*), (*Cucurbita ficifolia*), (*Lagenaria siceraria*), (*Cucurbita pepo*) (El-Eslamboly and Deabes, 2014). Cucumber grafting on pumpkins enhanced the cucumber's tolerance to salt (Liu *et al.*, 2012; Lei *et al.*, 2014; Niu *et al.*, 2018). The grafting technique is getting more prominent in the areas where there is a large number of people per square meter of farmland and the possibility of their activity is lower. It happens that a variety or a hybrid has good characteristics as a market value (mass, yield, color, taste), alongside some bad characteristics such as poor tolerance level to agents and causes of stress. As opposed to the former ones, certain genotypes of some vegetable varieties have resistance to or are highly tolerant of certain soil pathogens, drought, and high or low temperatures. Compared to cucumbers, pumpkins are more resistant to unfavorable abiotic causes, especially to lower temperatures. With a large volume of research, it has been concluded that by grafting of fruit vegetables onto rootstocks with strong root system resistant to soil pathogens with a pronounced nutrient and water absorption - represents one of the more ecologically acceptable methods for a crop yield increase (Fallik and Ilić, 2014; Petropoulos *et al.*, 2012). Cucumbers grafting had no statistically significant impact on the crop quality, but there was a statistically significant impact on the absorption of nitrogen, phosphorus, potassium, calcium and magnesium compared to ungrafted plants (Noor *et al.*, 2019). Plants grafting increases crop yield without a negative impact on the quality of vegetables. However, the positive effects of grafting can be changed by choosing the rootstock (Toth *et al.*, 2021). Grafted plants grow much quicker, they're more robust so they need a fewer number of plants per square meter, even 50% fewer compared to usual vegetable production without grafting. Despite the fewer number of plants per square meter, grafted plants yield larger and higher-quality fruits, so a bigger yield and a higher market value of the product is achieved by their production (Behmen *et al.*, 2021).

Vegetable grafting was adopted in the beginning of the 20th century. However, much earlier through practice, it was established that different genotypes and vegetable

varieties have a greater difference in resistance to stress causes (high and low temperature, soil saltiness, etc.), vermin and pathogens. In practice, the most frequent case is that vegetable variety or hybrid (line/genotype) has good market characteristics (thickness, mass, crop yield, color, taste), alongside some bad characteristics which exacerbate and increase the cost of its production (e.g. poor tolerance to diseases and vermin). On the other side, certain genotypes of some vegetable varieties with a more prominent resistance to soil pathogens and unfavorable abiotic conditions during production, most often have fruits (or productive parts) of lower quality and with no market value. Therefore, grafting represents an ideal way to make use of advantages of different genotypes or plants in modest conditions, in order to lower the costs of production, and increase the productivity and overall effects of vegetable production (Behmen *et al.*, 2021). In line with everything stated previously, the aim of this research was to establish whether a better root system development is achieved by planting grafted cucumbers as compared to ungrafted ones.

## MATERIALS AND METHODS

**Scion:** The studied hybrid is ‘CHARTA’ F1, marked by medium exuberance, dark leaves throughout the whole season, and long and juicy cucumber fruits. The fruits are usually 21 to 24 cm in length. The hybrid is also characterized by pronounced vitality and stress tolerance, which ensures success in a longer planting period.

**Rootstock:** The rootstock ‘TETSUKABATO’ F1 (*Cucurbita maxima* x *Cucurbita moschata*) was used for grafting. The unique parenthood gives it resistance and tolerance to the most important diseases, insects, humid weather, and pronounced droughts. The fruit is 4.4 to 5.5 kg in weight; the peel is knotty and round in shape. It grows from early autumn to early winter.

**Seedling production:** Graded seeds of a selected cucumber variety ‘CHARTA’ F1 and commercial rootstock ‘TETSUKABATO’ F1 (*Cucurbita maxima* x *Cucurbita moschata*) were sown in plastic cell trays with 112 drain holes, filled with peat compost and kept in a growth chamber (24-26 °C; 85-90% RH) until germination has started. After that, the seedlings were transferred in a greenhouse. Air temperature was maintained between 20 and 24°C during the day, while the night temperature was 15-18°C. Seventeen days after sowing, cucumber plants were grafted onto the rootstock by the common splice-grafting (SG) method (Balliu and Sallaku, 2017; Behmen *et al.*, 2021). After grafting, all plants were placed in plastic tunnel inside the greenhouse with the relative humidity of 85% and air temperature of 25°C. On the fifth day after grafting, plants were moved to a greenhouse under common natural conditions. Ungrafted seedlings were produced in greenhouse under natural conditions immediately after germination has finished.

**Experimental set up:** The research was conducted during the growing season 2019 in region of Sarajevo (Butmir) in greenhouse sized 100 m<sup>2</sup> (16.50 m long, 6.00 m wide and 3.70 m high). Before the experiment was conducted, the soil was analyzed and showed the following results: pH in H<sub>2</sub>O 7.8, humus content 2.6%, available phosphorus

37.06 mg/100 g and potassium 32 mg/100 g. In order to further improve soil fertility, organic fertilizer was used in amount of 120 kg/100 m<sup>2</sup>, as well as mineral fertilizer NPK 7:20:30 in the amount of 5 kg/100 m<sup>2</sup> of greenhouse area.

Based on the physical characteristics of the surface layer of the soil (0-20 cm), the soil contain approximately equal ratio of clay, silt and sand. According to the type, it is alluvial soil.

The seedlings were transplanted on June 8. The planting was done in four rows of two rows strips – i.e. walking space was also calculated in. The distance between plants was 0.50 m, the distance between rows was 0.70 m, and the walking space was 1.20 m wide. The experiment included 180 plants. During the production cycle, all standard cultivation measures of cucumber on foil were employed including pruning cucumber suckers. The observed parameters were: the number of lateral roots, the number of root hairs, the root mass, individual fruit size, leaf length and fruit yield. Plants were regularly harvested three times a week between July 6 and September 20. Harvest was carried out on randomly selected 15 plants of each repetition to determine fruit size and marketable yield. Cucumber fruits were weighed on digital scales. The analyses of morphological parameters - the number of lateral roots, the number of root hairs, the root mass and leaf length were performed after the last harvest.

The number of lateral roots and root hairs was determined by visual observation. By using the microscope, this method was used for determining the number of root hairs and counting. This method does not require reagent preparation any other steps.

Average values of the parameters in the study were statistically processed with computer, using Software Excel. Data analysis was performed using the independent t-test, as two samples were considered.

## RESULTS AND DISCUSSION

The average values and standard deviations for general indicators of morphological and productive parameters of grafted and ungrafted cucumber are shown in Table 1.

Table 1. General indicators of morphological and productive parameters of grafted and ungrafted cucumber are shown in Table 1.

Type of seedling	The number of lateral roots	The number of root hairs	Roots mass (g)	Leaf length (cm)	Fruit length (cm)	Fruit yield (kg/50 m <sup>2</sup> )
<i>Grafted seedling</i>	18.00±2.65	3.58±0.29	10.60±1.48	20.00±1.00	19.83±1.04	161.64±20.82
<i>Ungrafted seedling</i>	10.67±1.53 *	3.08±0.63	8.31±4.28	19.00±0.50	18.17±1.26	106.67±17.56 *

\* The mean difference is significant at the 0.05 level between grafted and ungrafted seedling

Based on the results, it can be concluded that there are significant differences between the number of lateral roots in grafted and ungrafted seedlings. There are no significant differences in the number of root hairs, which means that the number of root hairs in grafted and ungrafted seedlings is similar. Furthermore, there are also no significant differences between the root mass of grafted and ungrafted seedlings, although the grafted seedlings had a slightly higher root mass ( $10.60 \pm 1.48$ ) which was not statistically significant. There are also no significant statistical differences in the leaf length. While grafted seedlings have a slightly longer leaf length ( $20.00 \pm 1.00$ ) than ungrafted seedlings. Also, the leaf color, resistance and hardness were visually larger in grafted seedlings. The fruit length is also statistically insignificant, although the grafted seedlings have a slightly longer fruit length ( $19.83 \pm 1.04$ ). When it comes to fruit yield, there is a statistically significant difference between grafted and ungrafted seedlings. The grafted seedlings have an average value of  $161.64 \pm 20.82$  kg/50 m<sup>2</sup>, whereas ungrafted seedlings have an average value of  $106.67 \pm 17.56$  kg/50 m<sup>2</sup>.

## CONCLUSION

Based on the conducted research, it can be concluded that significantly higher crop yield and the number of lateral roots was determined at grafted seedlings. For the number of root hairs, root mass, leaf length and leaf mass, there were no significant differences, despite the fact that higher values were measured at grafted seedlings as compared to ungrafted ones. Also, the greater resistance and adaptation were determined at grafted cucumber.

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## MORFOLOŠKE OSOBINE I PRINOS KRASTAVCA U ZAVISNOSTI OD KALEMLJENJA

### Rezime

Kada se govori o rasprostranjenosti krastavca (*Cucumis sativus* L.), treba istaknuti koliko je rasprostranjen u našoj zemlji (Bosna i Hercegovina), kako u ishrani tako i u proizvodnji. Shodno tome, postoji značajna potreba za kvalitetnim i otpornim sortama/hibridima i tehnologijom proizvodnje koja smanjuje mogućnost pojave bolesti. Plastička proizvodnja kalemljenog krastavca u Bosni i Hercegovini posljednjih godina doživljava ekspanziju.

Kalemljene biljke hibrida krastavca 'Charta' komparativno su analizirane sa nekalemljenim, kako bi se zabilježile glavne, morfološke i produktivne razlike među njima.

Ispitani parametri bili su broj bočnih korijena, broj korijenskih dlačica, masa korijena, dužina lista i prinosi.

Rezultati ovog istraživanja pokazuju da kalemljeni krastavac u odnosu na nekalemljeni postiže veći prinos ( $161.64 \pm 20.82$  kg/50 m<sup>2</sup>), dok su morfološke karakteristike uglavnom slične. Značajne razlike uočene su samo u broju bočnih korijenova ( $18.00 \pm 2.65$ )

Ključne riječi: *Cucumis sativus* L., kalemljenje, masa korijena, tržišni prinos