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Original paper

Influence of some rootstocks on two Cucumis sativus genotypes cultivated in greenhouse

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Abstract This experience has been realized on grafted and ungrafted gherkins in two plastic and glass greenhouses from Horting Research Institute. Two scions (gherkins – Lenara F1 and Kybria F1) and two rootstocks (*Cucurbita maxima* x C. moschata interspecific hybrids – Shintoza F1 and TZ 148 F1) were used to obtain four grafted combinations. The grafting percentage in grafted gherkins has been from 94% to 97%. The rootstocks have influenced productivity of the grafted gherkins. The grafted gherkins have had a highest yield compared to ungrafted gherkins (2.69 kg per plant at Lenara x Shintoza, 2.56 kg per plant at Lenara x TZ 148 and 2.1 kg per plant at Lenara; 2.6 kg per plant at Kybria x Shintoza, 2.53 kg per plant at Lenara x Shintoza and 2.1 kg per plant at Kybria). Both rootstocks (Shintoza and TZ 148) have slightly influenced the content of the soluble dry substance and carbohydrates from the cucumber fruits. There is a positive dependence between gherkins yield and soluble dry substance content, gherkins yield and total carbohydrates at both scion hybrids (Lenara and Kybria).

Keywords Carbohydrates, dry substance, gherkins, grafting, yield.

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Introduction

Gherkins are a highly appreciated vegetable in Romania. After some Romanian researchers (V. LAGUNOVSCHI-LUCHIAN & al [1]), the cucumber fruits have a lot of water (95%), carbohydrates (2.6%), vitamins (A, B_1, B_2, C) and salts of important mineral elements (Na, K, Mg, Ca).

Cucumber grafting started in Japan around 1960 to strengthen low-temperature tolerance and fusarium wilt resistance (A. R. DAVIS & al [2]). Cucurbitaceous grafting is a vegetative multiplication realised for to obtain resistant plants to biotic factors (*Fusarium* and *Verticillium* pathogens, *Meloydogine* spp. nematodes) and to abiotic factors.

Grafting, an old plant propagation practice, is still widely used with fruit trees and in recent decades also with vegetables (E. E. GOLDSCHMIDT [3]).

The grafting is an another agronomic interest for vigor and production (N. TARCHOUT & al [4]).

Grafting can affect vegetative growth, flowering, fruit ripening date and quality, and provide higher yields; the rootstocks have such a drastic impact on the scion and scion fruit (A. R. DAVIS & al [2]).

The research in cucumber grafting domain onto resistant rootstocks is evolving in Romania.

Materials and Methods

This experience has been conducted in two greenhouses from Horting Research Institute between 2014 and 2018.

Obtaining grafted and ungrafted gherkins has had these steps: obtaining seedlings in polyethylene foil greenhouse and obtaining crop in glass greenhouse to analyze the yield and fruit quality.

The biological material used was represented by two cucumber F1 hybrids, *Lenara* (Figure 1) and *Kybria* (Figure 2), seed source – Rijk Zwaan company, Netherlands, were used as scions and two F1 *(Cucurbita maxima x C. moschata)* interspecific hybrids, *Shintoza* (Figure 3), seed source – *Nunhems* company, Netherlands and *TZ 148* (Figure 4), seed source – Harris Moran Seed Company, North America were used as rootstocks.

Figure 1. The *Lenara* scion

Figure 2. The *Kybria* scion

Figure 3. The *Shintoza* rootstock

Figure 4. The *TZ 148* rootstock

The experience has been realised with two grafting combinations (72 plants/variant) and two ungrafted control variants (72 plants/variant): V1 – *Lenara* × *Shintoza*; V2 – *Lenara* × *TZ 148*; V3 – *Lenara*, control (ungrafted); V4 – *Kybria* × *Shintoza*; V5 – *Kybria* × *TZ 148*; V6 – *Kybria*, control (ungrafted), in a randomized design.

Lenara and *Kybria* are gherkins early, suitable for fresh use and processing, fruit has cylindrical form, dark green coloring without yellowness and longitudinal strips, a thin skin and excellent taste without bitterness, uniform. This gherkins can be grown in a glasshouse and in the open field.

Shintoza and *TZ 148* are two rootstocks that prints force and resistance to pathogens and nematodes from the protected spaces.

Obtaining grafted and ungrafted gherkins

Obtaining grafted and ungrafted gherkins was realised by the grafting specific technology, in peat with a grain size up to 10 mm, pH 6, macroelements and microelements.

Both scions have been seeded at the same day and both rootstocks have been seeded 10 days after the scions.

Grafting has been made by the one cotyledon grafting: when both cotyledons and first true leaf start to develop, the rootstock plant is ready to graft (≈7 to 10 d after sowing). One cotyledon, along with the visible growing point, is cut with a razor blade following the angle of the leaf petiole. The hypocotyl of the scion is cut on a 35° to 45° angle on one side only. The two cut surfaces are matched and held together with a grafting clip or a silicone sleeve (R.L. HASSELL & al [5]), when scion and rootstock plants have had a true leaf (Figure 5).

scion *rootstock* *grafted plant*

Figure 5. Grafting method for cucumbers

After grafting, the plants have been grown in a microclimate with a temperature of 21-23°C and relative humidity to 98% for a week.

Cucumber plants have been cared by classical technology until to planted in the glass greenhouse. 150 plants/variant was analyzed.

Design for experimental culture

The plants was planted at the end of June in glass greenhouse, in a density of 20.000 grafted gherkins per hectare and 24.000 ungrafted gherkins per hectare.

General and specific works have been realized during the culture.

Gherkins were harvested from July to October.

Biometrical and biochemical investigations

The survival rate was calculated for the grafted variants.

Biometrical investigations followed the length and root volume, total fruit production per plant and per hectare.

Biochemical analyzes were performed with the WM-7 digital refractometer to determine the soluble dry substance and by the Bertrand method to determine the carbohydrate content. The samples for analyzes were composed of 7 gherkins per variant.

Statistical calculation

The variant analysis method (0.05, 0.01 and 0.001 levels) and the Duncan test (0.05 level) were the statistical calculations for to interpret the research results.

The correlation between fruit production and dry substance or carbohydrates has been calculated for gherkins.

Results and Discussions

Survival percentage

The survival percentage after grafting has been between 94% and 97 at the observations made after a week from callusing (Table 1).

Table 1. The survival percentage after a week from callusing (%)

Rootstock cultivars	**Scion cultivars**	
	Lenara	*Kybria*
Shintoza	97a	96a
TZ 148	94b	94b

(Duncan test, $p < 0.05$).

The survival rate has been 94% at both scions (*Lenara* and *Kybria*) onto *TZ 148* rootstock, 97% at *Lenara* and 96% *Kybria* onto *Shintoza* rootstock.

The survival rate of grafted plants depends on compatibility between scion and rootstock, quality and age of seedlings, quality of the joined section and post-grafting management (A. R. DAVIS & al [2]).

Root length and volume

The grafting have had a positive effect on the root length of grafted cucumber seedlings (Figure 6).

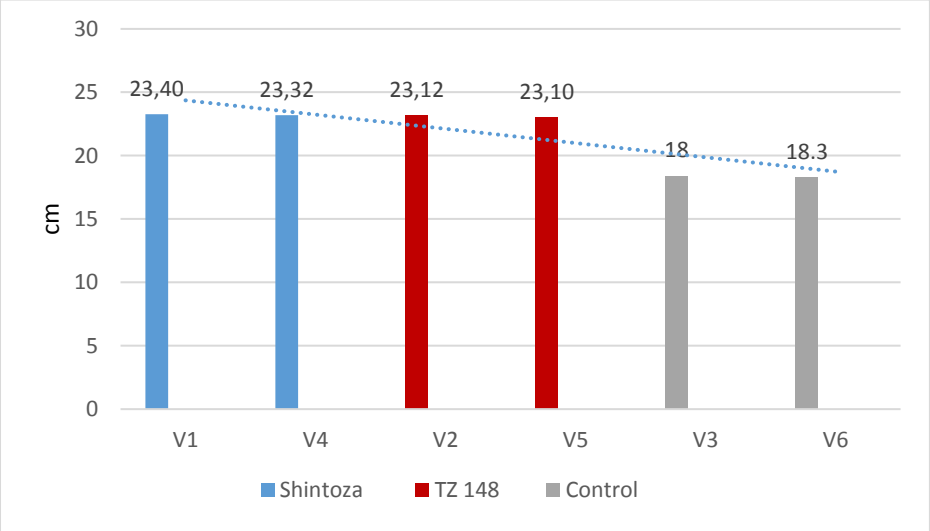

Figure 6. Effect of rootstock on root length of seedlings

The root length at the *Lenara* gherkins has been 23.4 cm onto *Shintoza* and 23.12 cm onto *TZ 148* in comparison to 18 cm at ungrafted plants, control and at the *Kybria* gherkins has been 23.32 cm onto *Shintoza* and 23.1 cm onto *TZ 148* in comparison to 18.3 cm at ungrafted plants, control.

The grafting have had a positive effect on the root volume of grafted cucumber seedlings (Figure 7).

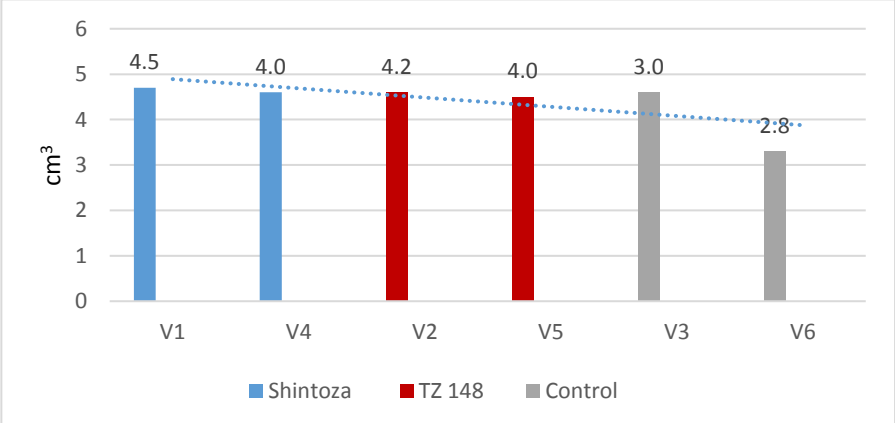

Figure 7. Effect of rootstock on root volume of cucumber seedlings

The root volume at the *Lenara* gherkins has been 4.5 cm^3 onto *Shintoza* and 4.2 cm^3 onto *TZ 148* in comparison to 3 cm^3 at ungrafted plants, control and at the *Kybria* gherkins has been 4 cm^3 onto *Shintoza* and 4 cm^3 onto *TZ 148* in comparison to 2.8 cm^3 at ungrafted plants, control.

Grafted plants (BH and BP) were more vigorous than the non-grafted ones in the greenhouse as well as in the open-field (E. M. KHAH & al [6]). Plants grafted onto 20-02, 31-09, 31-43, 35-01, and 46-03 were more vigorous than ungrafted control plants (F. KARAKA & al [7]).

Yield

The yield of gherkins studied has been influenced by the grafting (Tables 2 and 3).

Table 2. Fructification capacity of *Lenara* grafted on *Shintoza* and *TZ 148* rootstocks

Variants	Fructification (kg plant^{-1})	Difference per plant		Fructification (t ha^{-1})	Difference per ha	
		kg	%		t	%
V1	2.69***	0.59	128.10	53.8***	3.4	106.75
V2	2.56***	0.46	121.90	51.2***	0.8	101.59
V3 (C)	2.10	0	100	50.4	0	100
LSD 5%	0.10			0.5		
LSD 1%	0.31			0.9		
LSD 0.1%	0.24			1.3		

* = significant at 5%; ** = significant at 1%; *** = significant at 0.1%

Table 3. Fructification capacity of *Kybria* grafted on *Shintoza* and *TZ 148* rootstocks

Variants	Fructification (kg plant^{-1})	Difference per plant		Fructification (t ha^{-1})	Difference per ha	
		kg	%		t	%
V4	2.60***	0.50	123.81	52.0***	1.6	103.17
V5	2.53***	0.43	120.48	50.6***	0.2	100,40
V6 (C)	2.10	0	100	50.4	0	100
LSD 5%	0.15			0.2		
LSD 1%	0.29			0.7		
LSD 0.1%	0.33			1.8		

* = significant at 5%; ** = significant at 1%; *** = significant at 0.1%

Lenara gherkins:

- production (kg plant^{-1}) was from 2.69 to 2.56 at the grafted plants and 2.1 at the ungrafted plants, control. The difference has been between 0.59 kg for plants onto *Shintoza* and 0.46 kg for plants onto *TZ 148* rootstock or as a percentage, 28.1% for the *Shintoza* rootstock and 21.9% for the *TZ 148* rootstock,

- production (t ha^{-1}) was from 53.8 to 51.2 at the grafted plants and 50.4 at ungrafted plants, control. The difference has been between 3.4 tons for plants onto *Shintoza* and 0.8 tons for plants onto *TZ 148* rootstock or as a percentage, 6.75% for the *Shintoza* rootstock and 1.59% for the *TZ 148* rootstock.

Kybria gherkins:

- production (kg plant^{-1}) was from 2.53 to 2.60 at the grafted plants and 2.1 at the ungrafted plants, control. The difference has been between 0.5 kg for plants onto *Shintoza* and 0.43 kg for plants onto *TZ 148* rootstock or as a percentage, 23.81% for the *Shintoza* rootstock and 20.48% for the *TZ 148* rootstock,

- production (t ha^{-1}) was from 52 to 50.6 at the grafted plants and 50.4 at ungrafted plants, control. The difference has been between 1.6 tons for plants onto *Shintoza* and 0.2 tons for plants onto *TZ 148* rootstock or as a percentage, 3.17% for the *Shintoza* rootstock and 0.4% for the *TZ 148* rootstock.

The grafting has had a positive effect on the cucumber production.

Gherkins fruit quality

The content of some biochimical elements from the *Lenara* and *Kybria* cucumber fruits has had similar values beetween variants (Table 4).

Table 4. Content of some biochimical elements from cucumber fruits

Variants	Soluble dry substance (%)	Total carbohydrates (%)
V1	2.5a	1.9a
V2	2.5a	1.8a
V3 (C)	2.6a	2.1a
V4	2.4a	1.8a
V5	2.4a	1.8a
V6 (C)	2.6a	2.0a

(Duncan test, $p < 0.05$).

The content of the soluble dry substance and the carbohydrate content has been slightly higher in fruit from control in comparison the grafted plants.

A positive dependence was realised between yield and soluble dry substance at *Lenara* (r^2= 0.75) și *Kybria* (r^2= 0.75) (Figure 8).

A positive dependence was realised between yield and soluble dry substance at *Lenara* (r^2= 0.4286) și *Kybria* (r^2= 0.75) (Figure 9).

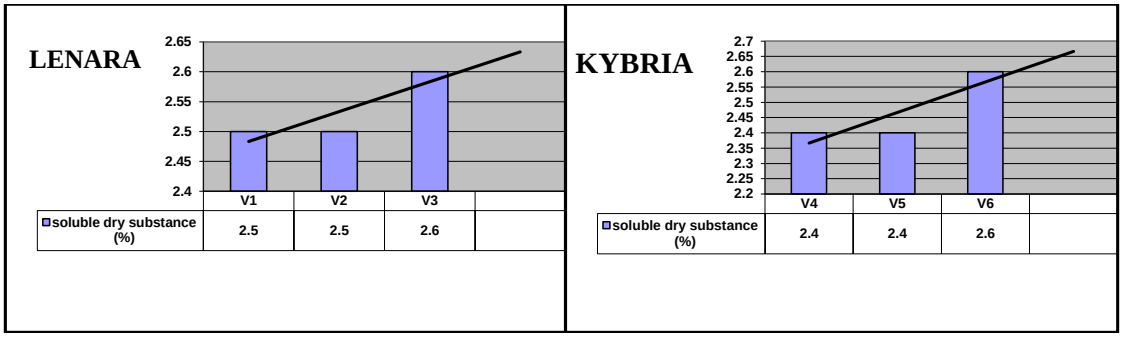

Figure 8. Positive dependence between yield and dry substance

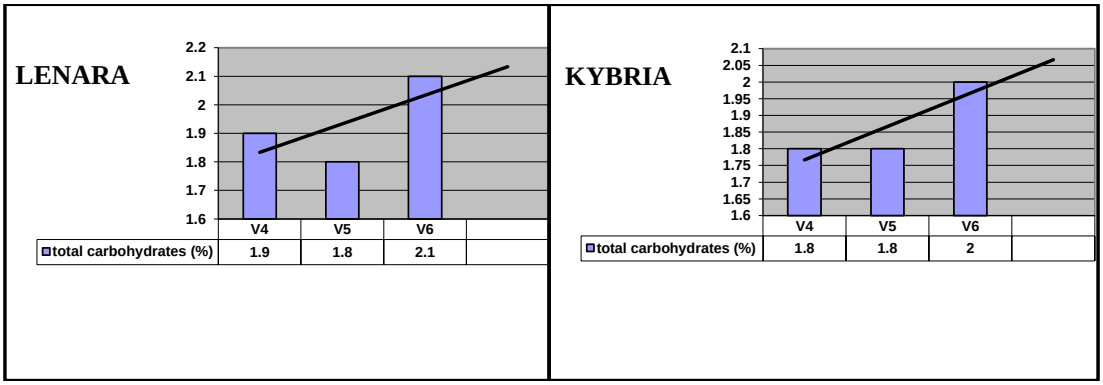

Figure 9. Positive dependence between yield and total carbohydrates

Conclusion

This research on the production and cultivation of grafted cucumbers (*Lenara* and *Kybria*) has shown that some rootstocks (*Shintoza* and *TZ 148*) has influence two *Cucumis sativus* genotypes (*Lenara* and *Kybria*) cultivated in greenhouse.

A good compatibility has been between *Lenara*, *Kybria* (scions) and *Shintoza*, *TZ 148* (rootstocks); the survival rate has been from 94% to 97%.

The grafting have had a positive effect on the root length and volume of grafted cucumber seedlings.

The grafting had a positive effect on the yield (on plant and hectare), onto the *Shintosa* rootstock and then onto *TZ 148* rootstock.

The fruit content of some biochemical elements has had similar values between the grafted and ungrafted variants. The grafting have had not influence on the dry substance and carbohydrate content.

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