

## THE RESPONSE OF SEVERAL TOMATO CULTIVARS FOR PROCESSING IN CENTRAL TRANSYLVANIA CONDITIONS. I. YIELD CAPACITY

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**Abstract.** Nine tomato varieties, hybrids F<sub>1</sub> and selection (Perla Clujului, Natalia, Chico Grande, Indiana, Red River, Event, Jet, Montego, Cluj 8-2002) have been tested for their yield characteristics and compared in order to experiment and control, at Fruit Research Station Cluj-Napoca (FRS Cluj-Napoca), Romania. All the cultivars presented a low height of the plants and a low number of sprouts, respectively multi-stage fruiting, which makes them fit for industrial exploitation. Of all the analysed cultivars, Chico Grande, Event, Jet, Montego and Line Cluj 8-2002 had the required characteristics, all expressed on a high level, which makes them possible genitors for future breeding programmes. The Early Fruit Yield (EFY), at least for the conditions from Central Transylvania, was quite high in all the cultivars. Besides the Chico Grande variety, early high productions were obtained from hybrid Jet, Line Cluj 8-2002, Red River and Natalia. The Total Fruit Yield oscillated between 58.0 tons per hectare (Indiana) and 63.0 tons per hectare (Natalia). Besides Natalia, high productions were also obtained from the other varieties created at Cluj-Napoca such as: Perla Clujului and Line Cluj 8-2002 (both of them had a production of 60.8 tons per hectare). Between Total Fruit Yield and Mature Fruit Yield there was registered a strong correlation, the two types of production increase and decrease together, all the time, both in the same direction. There is also a significant positive correlation between the Total Fruit Yield and the weight of the fruit.

**Key words:** tomato, breeding, cultivars, yield, Early Fruit Yield (EFY), Mature Fruit Yield (MFY), Total Fruit Yield (TFY), correlations

### INTRODUCTION

Yield capacity for tomatoes is one of the most important traits and it is an essential breeding objective. The yield capacity depends on the hereditary base of the cultivars and on the environmental conditions, including the conditions of culture (Gould, 1983; Sestraş, 2004). It also depends on the interaction between the genotype and the environmental conditions (Bletsos and Goulas, 2002; Susic et al., 2002; Apahidean, 2003; Ciofu et al., 2003; Apahidean and Apahidean, 2004). Simultaneously with the creation of the new varieties, The FRS Cluj-Napoca also effectuates the tests for some foreign and same native cultivars in order to identify which ones of them have the best results in production and also in quality. The best are to be recommended for culture on a large production (Sestraş and Jidavu, 2002; Jidavu et al., 2002).

## MATERIALS AND METHODS

The experiment has taken place at the Fruit Research Station Cluj-Napoca (FRS Cluj-Napoca), in the centre of Transylvania, Romania. Between 2003 and 2005, at the FRS Cluj-Napoca nine tomato cultivars were studied for processing. Their origin and main traits are presented in Table 1.

Table 1

Cultivars: their origin and characteristics

Nr. crt.	Cultivars (Variants)	Type of cultivar	Origin	Type of growth
1	Perla Clujului	Variety	FRS Cluj, 1999	Determinate
2	Natalia	Variety	FRS Cluj, 2003	Determinate
3	Chico Grande	Variety	SUA	Determinate
4	Indiana	Variety	SUA	Determinate
5	Red River	Variety	SUA	Determinate
6	Event	Hybrid F1	Italy	Determinate
7	Jet	Hybrid F1	Italy	Determinate
8	Montego	Hybrid F1	Italy	Determinate
9	Cluj 8-2002*	Line	FRS Cluj, in homologation process	Determinate

Cluj 8-2002\* = selection (line) created by pedigree selection in hybrids from Chico Grande x Event F1 combination

Distance between rows and plants: 70 x 33 cm.

Surface of repetition plot: 14 m<sup>2</sup>.

Number of plants per plot: 60.

Density: 43.290 plants/ha.

Model: Randomized blocks with three repetitions (Figure 1).

The technology of cultivation was standard, similar with industrial ones.

Bp	Bp	Bp	Bp	Bp	Bp	Bp	Bp	Bp	Bp	Bp	
Bp	1	2	3	4	5	6	7	8	9	Bp	B1
Bp	4	9	2	6	8	3	1	5	7	Bp	B2
Bp	8	7	5	1	9	2	4	6	3	Bp	B3
Bp	Bp	Bp	Bp	Bp	Bp	Bp	Bp	Bp	Bp	Bp	

Bp = Rows of protection.

B1, B2, B3 = blocks (repetitions).

Figure 1. Model of experiment in the field, with randomized blocks (v=9, r=3)

As a control variant it was utilized the mean of the experiment, and the data was calculated statistically by ANOVA test.

## RESULTS AND DISCUSSIONS

From the data presented in Table 2, it can be noticed that among tested cultivars significant differences have been recorded for the plant height and for the others characters of vigour and elements of productivity.

The plant height oscillated between 47.3 cm (Jet) and 82.7 cm (Natalia). As compared to the mean of experiment, as control (56.5 cm), it is worth mentioning Natalia and Red River cvs. with superior differences, but especially Chico Grande, Event F1, Jet F1, Montego F1, Line Cluj 8-2002 selection, for their rather short plants. The last ones have been noted as

being significantly shorter as compared to the mean of the experiment. They are proper for industrial exploitation in fields for processing tomatoes and can be used as genitors in tomato breeding.

Table 2

The main physical characteristics of tomato cultivars for processing, tested at FRS Cluj, 2003-2005

Nr. crt.	Cultivars	Plant height (cm)	Average of sprouts	Mean of fruits/ inflorescence	No. fruits/ plant	Fruit weight (g)
1	Perla Clujului	57.3 <sup>-</sup>	5.0 <sup>-</sup>	8.5 <sup>xx</sup>	107.0	148.7 <sup>xxx</sup>
2	Natalia	82.7 <sup>xxx</sup>	6.0 <sup>xxx</sup>	5.0 <sup>o</sup>	98.5	188.3 <sup>xxx</sup>
3	Chico Grande	47.7 <sup>ooo</sup>	3.0 <sup>oo</sup>	4.5 <sup>oo</sup>	97.2	93.7 <sup>-</sup>
4	Indiana	56.3 <sup>-</sup>	6.3 <sup>xxx</sup>	5.5 <sup>-</sup>	96.7	89.7 <sup>-</sup>
5	Red River	66.3 <sup>xxx</sup>	6.0 <sup>xxx</sup>	6.5 <sup>-</sup>	111.0 <sup>xx</sup>	85.0 <sup>o</sup>
6	Event F1	50.7 <sup>ooo</sup>	3.0 <sup>oo</sup>	7.5 <sup>-</sup>	104.2	80.7 <sup>o</sup>
7	Jet F1	47.3 <sup>ooo</sup>	3.0 <sup>oo</sup>	7.3 <sup>-</sup>	100.6	78.3 <sup>oo</sup>
8	Montego F1	50.3 <sup>ooo</sup>	3.0 <sup>oo</sup>	7.5 <sup>-</sup>	99.3	81.7 <sup>o</sup>
9	Cluj 8-2002	50.0 <sup>ooo</sup>	3.0 <sup>oo</sup>	7.5 <sup>-</sup>	104.7	89.7 <sup>-</sup>
Mean of experiment (Control)		56.5	4.3	6.6	102.1	104.0
DL 5% =		2.0	0.9	1.2	6.7	18.9
DL 1% =		2.7	1.1	1.7	8.9	25.2
DL 0.1% =		3.5	1.5	2.2	11.6	32.8

The number of sprouts per plant in the nine cultivars tested was comprised between 3.0 and 6.3 cm. The lowest value of this trait appeared in the following cultivars: Chico Grande, Event F1, Jet F1, Montego F1, Cluj 8-2002 and the highest value appeared in the American variety called Indiana.

As a conclusion, it can be sad that the tested genotypes have a determined growth, a reduced height of the plants, that they produce a small number of sprouts, respectively multi-stage fruiting, so this means that they are proper for the industrial culture in the field and also for the mechanized culture, including the mechanized ingathering. The desired characteristics, expressed on a high level, can be found mainly in the Chico Grande, at the hybrids F1 Event, Jet and Montego (all the plants have an average height of about 50 cm and each plant has three sprouts). The line created at the FRS Cluj 8-2002 (with an average height of 50.0 cm and with three sprouts per plant) can be added to the upper varieties.

The medium number of fruits per inflorescence has suffered a powerful oscillation, from 4.5 (Chico Grande) to 8.5 (Perla Clujului) and the variety with the most fruits per plant was Red River (111.0 fruits/plant). The smallest weight of the fruits was registered at the hybrid Jet (78.3 g) while the biggest at the variety Natalia (188.3 g). As a comparison with the average of the experiment (104.0 g), the differences of the weight of the fruits of the two sorts which were created at FRS Cluj-Napoca (Natalia and Perla Clujului) were clearly superior. For all the tested cultivars in the experiment, the production can be exploited in the industrial processing as well as through selling on the fresh fruits market, for daily consuming.

The synthesis of the production of fruits from tomato cultivars for industrialization, which were studied on a period of three years (2003-2005) at FRS Cluj is presented in Table number 3.

In the data, Early Fruit Yield (EFY) is represented by all fruits harvested until 10th August, Mature Fruit Yield (MFY) is represented by all ripen fruits harvested during every year, including the fruits cropped until 10 august, and Total Fruit Yield (TFY) including all fruits, even the ones which at the last harvest were technically not ripen.

Table 3

Yield capacity (t/ha) at nine tomato cultivars for processing, FRS Cluj-Napoca, 2003-2005

Nr. crt.	Cultivars	Early Fruit Yield (t/ha)	Mature Fruit Yield (t/ha)	Total Fruit Yield (t/ha)
1	Perla Clujului	21.6 <sup>ooo</sup>	56.4	60.8
2	Natalia	27.4 <sup>xx</sup>	59.1 <sup>xx</sup>	63.0 <sup>x</sup>
3	Chico Grande	29.9 <sup>xx</sup>	54.8	58.9
4	Indiana	21.4 <sup>ooo</sup>	51.2 <sup>ooo</sup>	58.0
5	Red River	29.0 <sup>x</sup>	56.0	59.9
6	Event F1	28.7	57.7	59.9
7	Jet F1	29.4 <sup>x</sup>	57.6	60.4
8	Montego F1	27.9	52.8 <sup>oo</sup>	59.2
9	Cluj 8-2002	29.7 <sup>xx</sup>	58.1	60.8
Mean of experiment (Control)*		27.2	56.0	60.1

DL 5% =

1.8

2.3

2.8

DL 1% =

2.4

3.0

3.7

DL 0.1% =

3.1

4.0

4.8

\*Yield differences between cultivars and the mean of the experiment are presented through the interaction between variants and years.

The obtained results show that the Early Fruit Yield (EFY), represented by all fruits harvested until 10th August, was quite high, at least for the environmental conditions from Central Transylvania.

This way, for the whole period of the experiment the Early Fruit Yield had the value of 27.2 t/ha and for the studied cultivars, the limits were between 21.4 t/ha for Indiana and 29.9t/ha for Chico Grande. Besides the variety of Chico Grande, the Early Fruit Yield had high values for the hybrid Jet (29.4 t/ha), the Line Cluj 8-2002 (29.7 t/ha), Red River (29.0 t/ha) and Natalia (27.4 t/ha).

The Mature Fruit Yield (MFY) for the studied cultivars had almost the same values. The limits were between 51.2 t/ha (Indiana) and 59.1 t/ha (Natalia). Besides the variety Natalia, there were also quite high Mature Fruit Yields obtained for the other cultivars created at Cluj, Perla Clujului (56.4 t/ha) and the Line Cluj 8-2002 (58.1 t/ha).

The total production, as an average per three years, oscillated between 58.0 t/ha (Indiana) and 63.0 t/ha (Natalia). Speaking of the production, Natalia was followed by the other creations obtained at FRS Cluj, Perla Clujului and the Line Cluj 8-2002 (both of them with a value of 60.8 t/ha).

Considering the obtained production data, a conclusion could be that, between the analyzed genotypes, there are higher or lower differences of production which is in accordance with the potential of production of each variety (hybrid or line) and with the way in which the respective potential could be obtained in the cultural and pedo-climatic conditions from Cluj-Napoca (Figure 2).

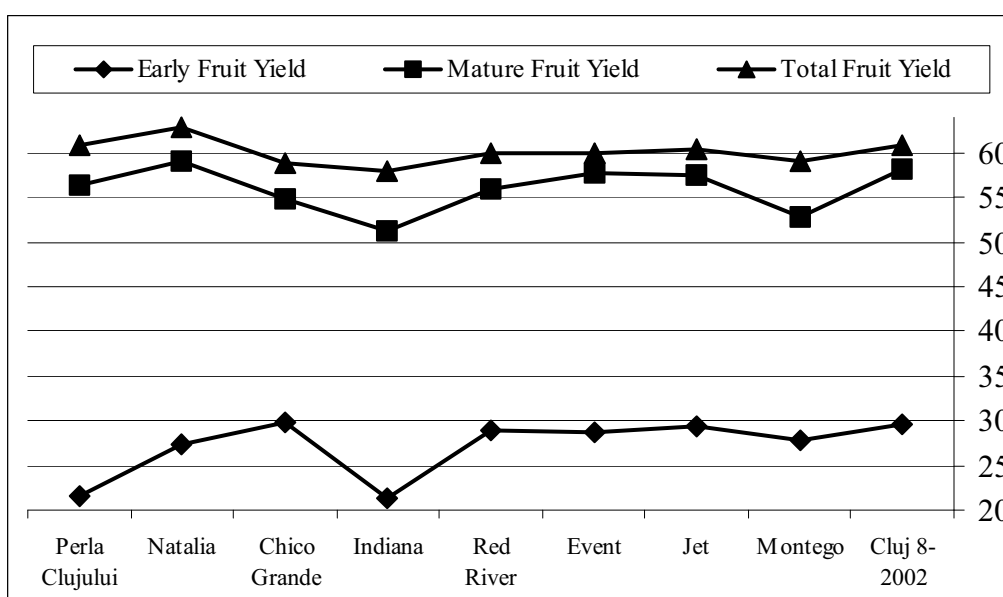


Figure 2. Differences of yield (t/ha) among nine cultivars of tomato for processing, FRS Cluj-Napoca, 2003-2005

From the data presented in the Figure number 2, the production differences between the nine cultivars which were tested at Cluj-Napoca can be noticed, but at the same time it can also be noticed a resemblance of the three graphic lines which illustrate the three analysed types of production: Early Fruit Yield (EFY), Mature Fruit Yield (MFY), Total Fruit Yield (TFY).

One can easily notice the lower values which appear in Indiana, even in the hybrid Montego, or the higher values from Natalia, Line Cluj 8-2002, Chico Grande (for the Early Fruit Yield).

In Figure 3, the production of fruits (t/ha) is illustrated as average value for the entire experiment, represented by the nine cultivars of tomatoes.

From the graphic representation one can realise the fact that from the Mature Fruit Yield (MFY), with an average of 56.0 t/ha of the nine cultivars, 27.2 t/ha is represented by the Early Fruit Yield, represented by all fruits harvested until 10<sup>th</sup> August. In the same way, from the Total Fruit Yield (TFY) of 60.1 t/ha, 56.0 t/ha is represented by all ripen fruits and the difference of 4.1 t/ha is represented by the fruits which at the last harvest, late in autumn (before the first white frost) are technically not ripen, which means that those fruits can be used only for pickles, such as pickled tomatoes. On the other hand, at FRS Cluj-Napoca, getting some early cultivars is an important objective of tomato breeding (Sestraş and Jidavu, 2002; Jidavu et al., 2002).

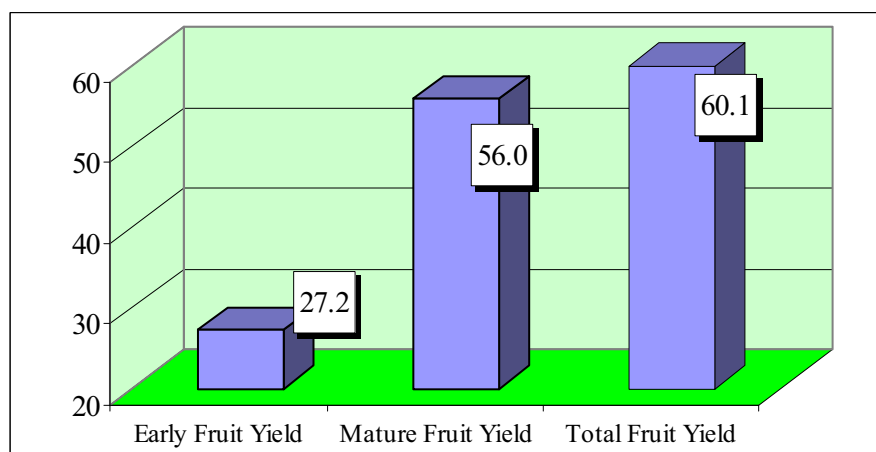


Figure 3. Early Fruit Yield, Mature Fruit Yield and Total Fruit Yield (in tons per hectare) as average for nine tomato cultivars, FRS Cluj-Napoca, 2003-2005

Figure number 4 presents the correlations between Early Fruit Yield (EFY), Mature Fruit Yield (MFY), and Total Fruit Yield (TFY) for the nine tested cultivars at FRS Cluj-Napoca.

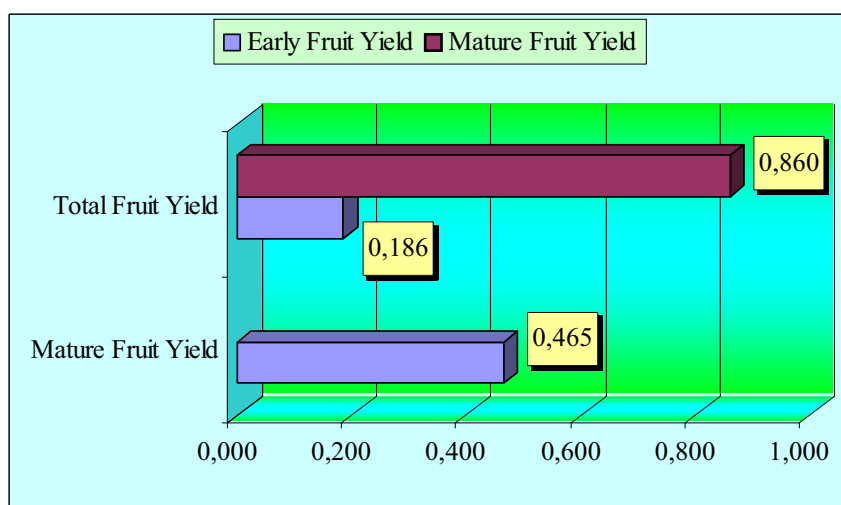


Figure 4. Correlations between Early Fruit Yield, Mature Fruit Yield and Total Fruit Yield at the nine tomato cultivars, FRS Cluj-Napoca, 2003-2005

Only the coefficient of correlation between TFY and MFY illustrated a strong relation, significant and positive ( $r = 0.860$ ). As a consequence, speaking of the varieties tested in the experiment, between the Total Fruit Yield and the Mature Fruit Yield, there is a positive and strong correlation, in this way the two types increase together or they decrease together.

A significant positive and strong correlation is also registered between Total Tomatoes Yield and the weight of the fruits ( $r = 0.753$ ) for the nine cultivars (Figure 5).

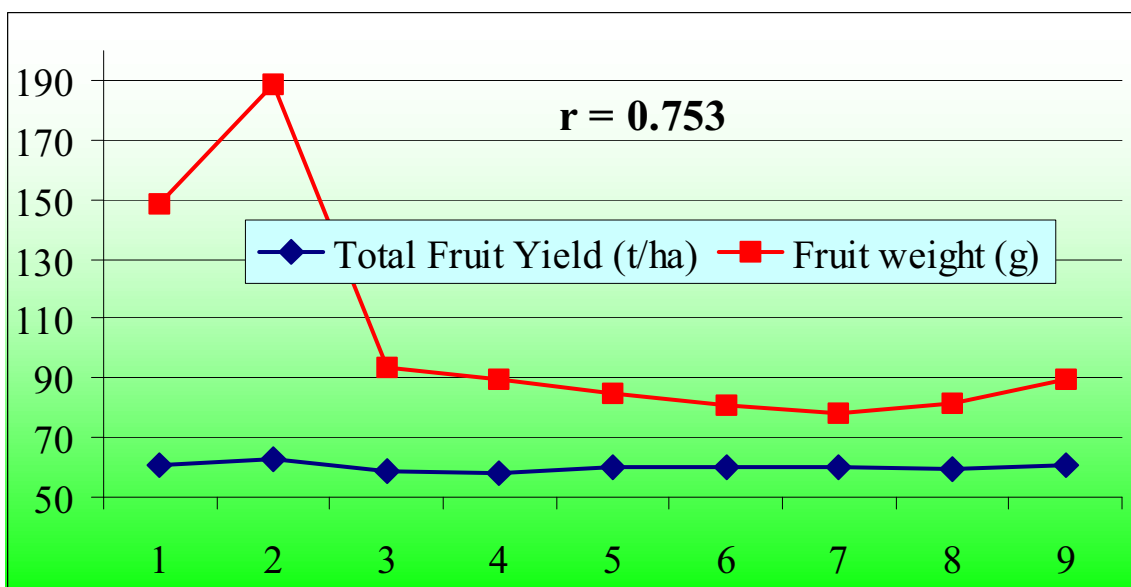


Figure 5. The correlation between the Total Fruit Yield and the weight of the fruits in the nine cultivars of tomatoes for industrialization at FRS Cluj, 2003-2005

Similar results for tomatoes were also obtained by Susic et al. (2002) who had identified important positive correlations between the production of fruits per plant and the weight of fruits, their height and their diameter.

In this experiment the Total Tomato Yield was strongly influenced by the weight of the fruits (the bigger was the value of the fruit weight, the bigger was the value of the Total Fruit Yield).

## CONCLUSIONS

The tested tomato cultivars from the FRS Cluj-Napoca had a low height of the plants and a low number of sprouts, respectively multi-stage fruiting, so in this way they are proper for the industrial exploitation. From the analysed cultivars, Chico Grande, Event, Jet, Montego, Line Cluj 8-2002 (all of them with a height of about 50.0 cm and three sprouts per plant) had proper characteristics, expressed on a high level, to this desideratum. The Early Fruit Yield was quite high for all the cultivars, at least for the environmental conditions from Central Transylvania. Besides Chico Grande, high Early Fruit Yield was obtained from the hybrid Jet, Line Cluj 8-2002, Red River and Natalia.

In the studied cultivars the production of ripen fruits was quite close to the values and the limits between 51.2 t/ha (Indiana) and 29.1 t/ha (Natalia). Besides Natalia, quite high productions of ripen fruits were also registered in the other cultivars created at FRS Cluj, Perla Clujului (56.4 t/ha) and Line Cluj 8-2002 which proves to be a good adaptability to the conditions in which they were created and in which the experiment took place.

The TFY oscillated between 58.0 t/ha (Indiana) and 63.0 t/ha (Natalia). The varieties Natalia, Perla Clujului and Line Cluj 8-2002 had the biggest production.

In this experiment, between the TFY and the MFY, there was a strong and positive correlation, these two types increase and decrease together. For the nine cultivars, there was also a strong and positive correlation between the TTY and the weight of the fruits.

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## REZUMAT

### COMPORTAREA UNOR CULTIVARURI DE TOMATE PENTRU INDUSTRIALIZARE ÎN CONDIȚIILE DIN CENTRUL TRANSILVANIEI. I. PRODUCTIVITATEA

La Stațiunea de Cercetare Dezvoltare pentru Pomicultură Cluj-Napoca au fost studiate într-o perioadă de trei ani (2003-2005), nouă cultivaruri de tomate pentru industrializare, dintre care două soiuri obținute la Cluj (Perla Clujului și Natalia), trei soiuri cu origine americană (Chico Grande, Indiana, Red River), trei hibrizi  $F_1$  cu origine italiană (Event, Jet, Montego) și o selecție de perspectivă obținută la SCDP Cluj-Napoca, Cluj 8-2002. Toate cultivarurile testate au prezentat o înălțime redusă a plantelor și un număr mic de lăstari, respectiv etaje fructifere, astfel că se pretează pentru cultura industrială. Dintre cultivarurile analizate, particularități adecvate acestor deziderate, exprimate la un nivel ridicat, au prezentat Chico Grande, Event, Jet, Montego, linia Cluj 8-2002 care pot fi utilizate ca genitori în noi lucrări de ameliorare. Producția timpurie de fructe a fost destul de ridicată la toate cultivarurile, cel puțin pentru condițiile din centrul Transilvaniei. Pe lângă soiul Chico Grande, producții timpurii ridicate s-au obținut la hibridul Jet, linia Cluj 8-2002, soiurile Red River și Natalia. Producția totală a oscilat între 58,0 t/ha (Indiana) și 63,0 t/ha (Natalia). Pe lângă Natalia, producții ridicate s-au înregistrat și la celelalte creații obținute la Cluj-Napoca, Perla Clujului și linia Cluj 8-2002 (ambele cu 60,8 t/ha). În experiență, între producția totală și producția de fructe coapte s-a determinat o corelație pozitivă strânsă, cele două tipuri de producție crescând, sau dimpotrivă, descrescând împreună, în același sens. De asemenea, o corelație pozitivă strânsă, semnificativă, s-a înregistrat și între producția totală de tomate și greutatea fructelor la cele nouă cultivaruri.