

THE RESPONSE OF SOME CHERRY TOMATO HYBRIDS TO FOLIAR FERTILIZATION

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Abstract

This study evaluated the response of some cherry tomato hybrids to foliar fertilizers. The experiment was carried out in protected space conditions (solar tunnel). As biological material were used four hybrids (factor A): Arielle F1 (a1), Ravello F1 (a2), Black Cherry F1 (a3) and Vespolino F1 (a4). The foliar treatments (factor B) were: unfertilized (b1), Kerafol Evo (b2), Plantfert U (b3). From the combination of factors, 12 experimental variants resulted. Physiological indices, productivity elements and yield were analyzed in relation to the experimental variants. In unfertilized conditions (b1), the yield (Y , kg plr^{-1}) recorded differentiated values in relation to the potential of the hybrids, $Y = 1.416$ kg plr^{-1} (a1), $Y = 1.632$ kg plr^{-1} (a2), $Y = 1.668$ kg plr^{-1} (a3) respectively $Y = 1.890$ kg plr^{-1} (a4). Through foliar treatments, the performance of the hybrids increased, but the Vespolino F1 hybrid (a4) remained with the highest yield, $Y = 2.538$ kg plr^{-1} (b3). The foliar fertilizer Plantfert U (b3) ensured the highest increase in yield (ΔY) in all the tested hybrids. Mathematical models described yield variation in relation to physiological indices and productivity elements.

Key words: cherry tomatoes, foliar fertilizers, mathematical model, physiological indices, productivity elements, yield.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.), *Solanaceae* Family, is a plant with high ecological plasticity, which is suitable for different crop systems, and is one of the most important plants in the vegetable category (Maboko and Du Plooy, 2017; Kai et al., 2020; Arshad et al., 2023; Aydi et al., 2023; Tsouvaltzis et al., 2023).

Tomato is an important crop plant, for fresh consumption and for industrialization, with high nutritional and economic value (Hita et al., 2007; Chapagain and Orr, 2009; Jerca and Smedescu, 2023; Nie et al., 2023; Petek et al., 2024).

Cherry tomatoes are highly popular worldwide, especially in modern markets, and attract different categories of consumers, through the variety of shapes, colors, aromas, attractive taste, content of nutrients and active principles and high flexibility to be integrated into different culinary menus (Hita et al., 2007; Kusumiyati et al., 2023; Chang et al., 2024).

Different cherry tomato genotypes were evaluated based on agronomic characters, physiological indices, productivity elements, yield, and fruit quality indices (Aguirre and Cabrera, 2012; Kusumiyati et al., 2023).

Tomato fruit quality was studied in relation to the position of the fruit on the plant and in the cluster, the harvest period, the duration and method of storage, as well as the interactions of these factors (Tsouvaltzis et al., 2023).

Cherry tomatoes involve considerably higher inputs than other crops (e.g. fertilizers, pesticides, irrigation water), which require optimization for crop profitability but also to reduce environmental risks (Guo et al., 2021; Ahmad et al., 2023).

Yield and certain quality indices were studied in cherry tomato genotypes in response to different types of organic fertilization (Murtic et al., 2018; Irfanulden Abdulhadi Qahraman et al., 2020). Duffaut et al. (2023) recorded a positive response in cherry tomatoes by fertilization with pigeon guano, under urban farming conditions.

The influence of different chemical and organic fertilizer resources, used in simple or combined fertilizations, was evaluated in cherry tomatoes, based on agronomic (vegetative) parameters, yield, and fruit quality indices (Kai et al., 2020; Stoleru et al., 2020; Tao et al., 2022; Badea et al., 2023).

Vegetative growth parameters, yield and quality indices of cherry tomatoes were quantified in relation to mixed fertilization (Rashid et al., 2022). Cherry tomatoes significantly increased yield with different nutrients applied through fertilization (Nie et al., 2023).

Agronomic characteristics of plants and fruits, yield and fruit quality indices of cherry tomatoes (popular local landraces) were evaluated in relation to different fertilization options (Nie et al., 2023).

The differential response of some cherry tomato hybrids, depending on the potential of the genotypes, was recorded in relation to the foliar application of NPK complex fertilizers (Hussein and Al-Tufaili, 2023).

The influence of fertilizers in conventional fertilization systems as well as in new, promising technological variants (e.g. associated with hydrogen gas) was evaluated in cherry tomatoes, with cost-effective effects on physiological indices, agronomic and fruit quality parameters and yield (Li et al., 2024).

This study evaluated the response of four cherry tomato hybrids, in relation to two foliar fertilizers, based on morphological parameters, productivity and yield elements, in a solar-type protected space cultivation system.

MATERIALS AND METHODS

The study was organized and conducted in the southern area of Timisoara Municipality, on a family farm, in the 2019 agricultural year. The experiment was located in a protected, solar-type space.

The study evaluated morphological parameters, productivity elements and yield of four cherry tomato hybrids, under the influence of foliar fertilization.

The biological material was represented by four cherry tomato hybrids (factor A): a1 – Arielle F1; a2 – Ravello F1; a3 – Black Cherry F1; a4 – Vespolino F1.

Foliar fertilization was provided with two fertilizers (factor B): b1 – Mt – unfertilized; b2 – Kerafol Evo (2-3 l ha⁻¹); b3 – Plantfert-U (1-2%). The combination of the two factors resulted in 12 experimental variants (a1b1, to a4b3), placed in repetitions.

The crop technology ensured uniform conditions for the experiment. For each genotype, the culture was established with 60-day-old seedlings on April 15. The planting distance was 80 cm between rows and 45 cm between plants per row. This resulted in a nutrient space of 0.36 m²/plant, a plant density of 2.5 plants/m² (25,000 plants ha⁻¹). Basic fertilization was done by uniformly applying and incorporating Cropcare and Fericare fertilizers, into the soil.

Morphological parameters, productivity elements and yield were determined for each experimental variant: plant height (PH, cm), cluster number on plants (CnP), flower number in cluster (FlnC), fecundated flower number in cluster (FFlnC), flower number on plant (FlnP), fecundated flower number on plant (FFlnP), fruits number in cluster (FrnC), mean fruit weight (FrW), fruit weight in cluster (FrCW), fruits number on plant (FrnP), yield on plant (YP, kg plt⁻¹).

The experimental results have been adequately analyzed by Anova Test, multivariate analysis, correlation analysis, and simple and quadratic regression analysis. The experimental results were analyzed in EXCEL, PAST and Wolfram Alpha (Hammer et al, 2001; Wolfram, 2020).

RESULTS AND DISCUSSIONS

The study analyzed the genetic potential of four cherry tomato hybrids, expressed in the conditions of the control variants (b1 – Ct – unfertilized), and the ability of the hybrids to capitalize on the applied fertilizations (b2, b3) through the crop technology.

The values of the morphological parameters, of the productivity and yield elements recorded presented in tabular format (Table 1).

The Anova test results confirmed the existence of variance and the statistical reliability of the experimental results ($F > F_{crit}$; $p < 0.001$).

The specific response of each hybrid for morphological parameters, productivity and yield elements was recorded, according to the values presented in Table 1.

Table 1. Mean values of cherry tomato parameters in relation to foliar fertilizers

Trial	Plant height	Cluster number on plant	Flower number on cluster	Fecuded flower number in cluster	Flower number on plant	Fecuded flower number on plant	Fruit number on cluster	Fruit weight	Fruit cluster weight	Fruit number on plant	Yield on plant
	PH	CnP	FlnC	FFlnC	FlnP	FFlnP	FmC	FrW	FrWC	FmP	YP
	(cm)	(no)						(g)		(no)	(kg)
a1b1	179.30	6.10	15.60	13.90	97.80	87.40	13.90	16.20	225.18	87.40	1.42
a1b2	184.70	6.10	16.50	15.20	103.20	95.20	15.20	18.50	281.20	95.20	1.76
a1b3	195.70	6.00	16.40	15.20	101.10	93.90	15.20	19.60	297.92	93.90	1.84
a2b1	187.40	6.40	15.20	13.40	99.30	88.20	13.40	18.50	247.90	88.20	1.63
a2b2	189.70	6.90	15.20	13.80	106.90	97.50	13.80	21.00	289.80	97.50	2.05
a2b3	190.50	6.70	15.30	14.20	105.20	98.30	14.20	22.10	313.82	98.30	2.17
a3b1	190.40	5.40	17.70	16.00	98.30	89.20	16.00	18.70	299.20	89.20	1.67
a3b2	194.80	5.70	17.80	16.40	104.20	95.90	16.40	21.90	359.16	95.90	2.10
a3b3	198.70	5.80	17.50	16.50	104.20	98.50	16.50	22.70	374.55	98.50	2.24
a4b1	182.80	5.80	15.80	14.70	94.20	87.50	14.70	21.60	317.52	87.50	1.89
a4b2	188.40	6.60	16.00	15.20	108.30	103.20	15.20	23.00	349.60	103.20	2.37
a4b3	189.70	6.50	16.10	15.50	107.60	103.60	15.50	24.50	379.75	103.60	2.54
SE	±1.58	±0.13	±0.27	±0.30	±1.27	±1.67	±0.30	±0.69	±13.99	±1.67	±0.10

The interdependence between the representative elements considered in the study, in the evaluation of the four cherry tomato hybrids, was evaluated through correlation analysis. The

correlation matrix in Figure 1 resulted, which presents the interdependence level at the level of the considered parameters.

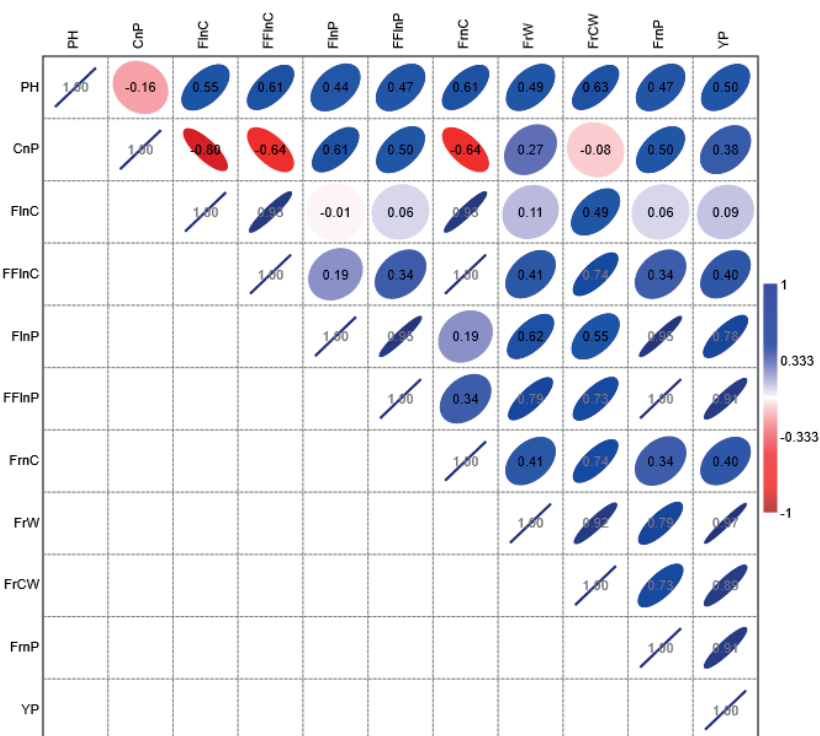
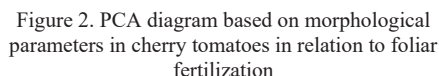
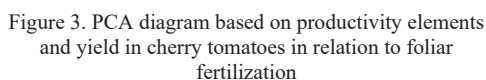


Figure 1. Correlation level between determined parameters in cherry tomatoes

In relation to morphological parameters, the main components explained 97.963% of variance, according to the diagram in Figure 2. Associated with FlnC and FFlnC parameters, the variants a3b2 and a3b3 were positioned. Associated with FlnP and FFlnP parameters, the variants a4b2 and a4b3 were positioned. Opposite positioning was presented by the variants a1b1, a2b1 and a4b1.



Based on the main productivity parameters (FrW, FrCW, YP) a cluster analysis was performed. The dendrogram in Figure 4 resulted (Coph.cor. = 0.772).



In horticultural production systems, in tomato crops, yield is an important indicator, along with fruits quality indices.

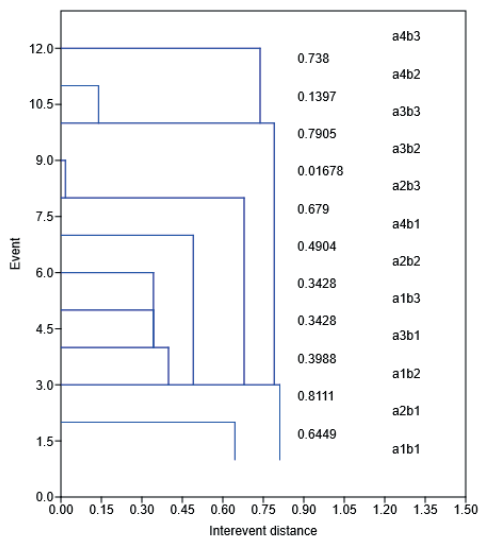


Figure 5. Ranking of variants based on productivity elements and yield

The yield is based on fruits (number, weight), and the number of fruits depends on the number of fecunded flowers. Under the study conditions, under the influence of foliar fertilization, the variation of FFLnC in relation to FlnC (variable x in the equation) was described by equation (1), with $R^2 = 0.914$, $p < 0.001$ (Figure 6).

$$\text{FFlnC} = -0.3078x^2 + 11.16x - 84.89 \quad (1)$$

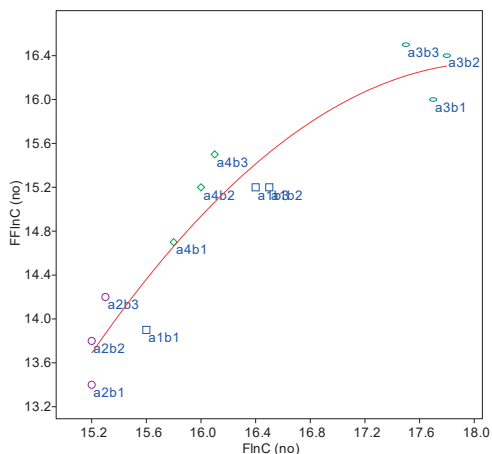


Figure 6. Variation of FFLnC in relation to FlnC in cherry tomato hybrids under the influence of foliar treatments

The yield on plant (YP) was analyzed in direct relation to the productivity elements in cherry

tomato crops, to find out the level of contribution of each parameter in the formation of the yield (YP).

Equation (2) described the variation of YP in relation to FrnC, with $R^2 = 0.193$, $p = 0.381$, $F = 1.0755$.

$$\text{YP} = -0.0612x^2 + 1.964x - 13.66 \quad (2)$$

Equation (3), with the graphical distribution in Figure 7, described the variation of YP in relation to FrW, $R^2 = 0.952$, $p < 0.001$, $F = 90.127$.

$$\text{YP} = 0.055489x^2 - 0.09005x + 1.458 \quad (3)$$

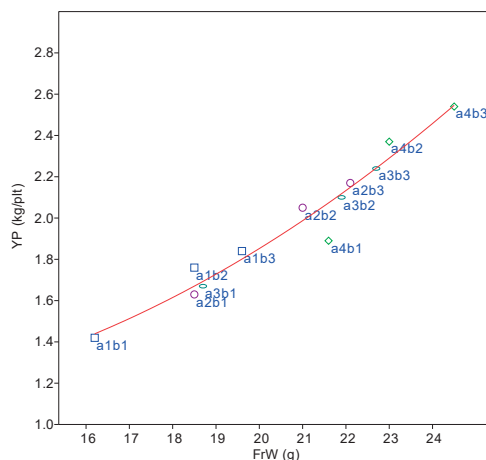


Figure 7. Graphical distribution of YP in relation to FrW in cherry tomatoes, under foliar fertilization conditions

Equation (4) described the variation of YP in relation to FrCW, $R^2 = 0.799$, $p < 0.001$, $F = 17.942$.

$$\text{YP} = 1.206 \text{E} - 06x^2 + 0.005368x + 0.127 \quad (4)$$

Equation (5), has described the variation of YP in relation to FrnP, $R^2 = 0.845$, $p < 0.001$, $F = 24.565$.

$$\text{YP} = 0.001552x^2 - 0.2427x + 10.99 \quad (5)$$

Regression analysis was appropriately used to describe the variation of yield (YP) in relation depending to the morphological parameters and productivity elements, as a direct and interaction effect. The result was equation

(6), as a general model, with different values of the variables x and y , depending on the parameters considered, and values of the equation coefficients, according to Table 2. The graphic representation of the YP variation, in relation to CnP and FrCW, as the most reliable result, according to the statistical parameters, is presented in Figure 8.

$$YP = ax^2 + by^2 + cx + dy + exy + f \tag{6}$$

where: YP – yield on plant (kg plt⁻¹);
 x , and y – the variables of equation (6), according to Table 2;
 a , b , c , d , e , and f – the coefficients of the equation (6), Table 2.

Table 2. Statistical values related to equation (6)

Experimental parameters		Values of the coefficients of equation (6)						Statistical parameters			
x	y	a	b	c	d	e	f	R^2	p	F	RMSE
PH	CnP	-0.00125330	-0.19205039	0.20033474	-7.20253236	0.05193695	0.13915401	0.492	0.4225	1.1629	0.2253
CnP	FlnC	2.01339206	0.35293950	-53.5978844	-22.2644936	1.84773638	339.2739735	0.794	0.0444	4.6346	0.1434
CnP	FFlnC	0.64710798	0.10396957	-14.5541236	-5.77429743	0.48953238	84.96469880	0.871	0.0119	8.1387	0.1133
FrnC	FrW	0.00157594	0.00753871	0.15617575	-0.02870534	-0.0097621	-0.36026190	0.953	0.0006	24.8775	0.0679
CnP	FrW	-0.07169783	0.00199852	0.16103264	-0.18939024	0.03852248	1.84680725	0.967	0.0002	35.6109	0.0571
CnP	FrCW	0.00293364	0.00000020	-0.08328623	-0.00103288	0.00117308	0.42549542	0.999	<0.001	6498.76	0.0043

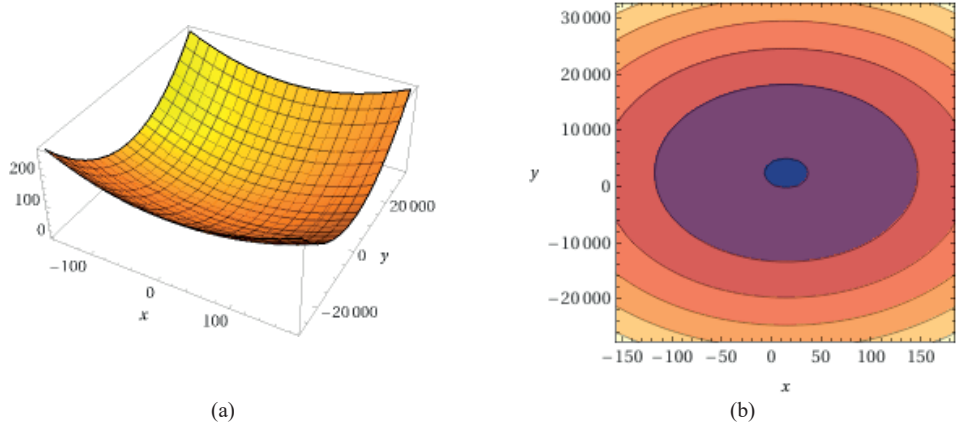


Figure 8. Graphical distribution of yield (YP) in cherry tomatoes in relation to parameters CnP (x – axis) and FrCW (y – axis); (a) – 3D model, (b) isoquants model

The studied cherry tomato genotypes presented differentiated values for determined parameters, in relation to foliar treatments. Regarding plant height, under unfertilized conditions (b1), the Arielle F1 genotype presented a lower value (PH = 179.3 cm), and the Black Cherry F1 genotype presented a higher value (PH = 190.4 cm). In response to the applied foliar fertilization, all variants recorded an increase in plant height, with values between PH = 184.7 cm (a1b2) and PH = 198.7 cm (a3b3). The number of clusters on plant, in relation to the genotype, presented the value CnP = 5.4 (Black Cherry F1) and CnP = 6.4 (Ravello F1). Under the influence of foliar fertilization, the

number of clusters increased to the highest value, CnP = 6.9, variant a2b2. The number of the flowers in the cherry tomato cluster (FlnC), varied according genotypes with values of FlnC = 15.20 (a2b1) and FlnC = 17.70 (a3b1). As an effect of the applied foliar fertilizers, the number of the flowers in the cluster increased in each hybrid, but within small limits. Positive effects were recorded in cherry tomatoes on some physiological indices, the number and size of fruits as well as on yield in relation to mixed fertilization (Rashid et al., 2022). The number of fertilized flowers in the cluster (FFlnC) increased under the influence of foliar fertilization, except for the Vespolino F1 (a4)

hybrid. The increase in the number of fertilized flowers, as a result of technological interventions, is important, and is reflected in the yield. In the present study, the variation of the FFlnC parameter in relation to FlnC was recorded, under conditions of $R^2 = 0.914$, $p < 0.001$.

The number of fruits in the cluster (FrnC) and the number of fruits per plant (FrnP) corresponded to the parameters FFlnC and FrnC, respectively.

Productivity parameters (e.g. number of fruits per plant, fruit diameter, yield, etc.) were analyzed in cherry tomatoes in relation to the watering regime (Ahmad et al., 2023).

Fruit shape and size were important characters for evaluating some cherry tomato genotypes, such as adaptability to certain growing conditions (Gaswanto, 2021).

The average fruit weight (FrW) varied among genotypes between FrW = 16.20 g (a1b1) and FrW = 21.60 g (a4b1). Under the influence of fertilizers, an increase in fruit weight was recorded for each hybrid, with the maximum value FrW = 24.50 g (a4b4).

Average fruit weight and yield per plant were important criteria for the selection of cherry tomato genotypes (Aguirre and Cabrera, 2012). Differential variation of fruit parameters, mineral element content and quality indices was recorded in cherry tomatoes in relation to organic and mineral fertilizers (Kai et al., 2020). The fruit cluster weight (FrCW) at the level of the genotype potential (factor A) presented the value FrCW = 225.18 g (a1b1) and FrCW = 317.52 g (a4b1). Under the influence of foliar fertilization, the values increased for each hybrid, up to the value FrCW = 379.75 g (a4b3).

CONCLUSIONS

The tested cherry tomato hybrids showed differentiated potential for the evaluated parameters. All hybrids responded positively to the application of foliar treatments for most of the evaluated parameters.

The Ravello F1 (a2) genotype showed an advantage for the CnP parameter, compared to the other hybrids. The Black Cherry F1 (a3) genotype showed an advantage for the FlnC and FFlnC parameters, and maintained the advantage over the other hybrids under the effect of foliar treatments.

The Vespolino F1 (a4) genotype showed an advantage in the FlnP and FFlnP parameters in the case of variants a4b2 and a4b3. The Black Cherry F1 (a3) genotype showed an advantage in the FrnC parameter. The Vespolino F1 (a4) genotype showed an advantage in the FrW and FrCW parameters, followed by the Black Cherry F1 (a3) genotype.

For yield (YP), the Vespolino F1 (a4) genotype ranked first, in the case of the a4b3 variant, followed by the a4b2 variant.

The next positions were occupied by the Black Cherry F1 genotype with the a3b3 variant, and the Ravello F1 genotype with the a2b3 variant, respectively.

Among the foliar products applied, the Plantfert-U (b3) product showed better efficiency in combination with the tested hybrids.

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