RESEARCH ON THE INFLUENCE OF SOME FOLIAR COMPOSITIONS ON THE QUANTITY AND QUALITY OF THE PRODUCTION OF TOMATO CULTURE IN TUNNELS

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Abstract

The tomato being a species with a high specific consumption, need a special attention for the creation of the fertilization programs, in order to improve the biologic potential of the hybrids with high productivity. The research was performed during the years 2011-2013, in a private tunnel from Oradea, the biological material used in the researches was hybrid Cristal F1.

The experimental protocol regarding the applying of the foliar fertilizers considered the using of the simple and complex organic and mineral resources especially in the conditions of the agro-chemical optimization of the soil as determinant factor in the increasing of the effect of the foliar compositions. Also, the studies performed underlined the complementary character that the foliar fertilization with complex and balanced sorts, materializing by increases of higher productions and quality classes. Significant productions were obtained for the fertilized versions with foliar compositions of the type Agroleaf Power Total, Basfoliar 20-20-20, Microfert Zn şi Agroleaf Power Ca.

Key words: tomatoes, foliar fertilizations, productions, quality classes, macro-micro elements

INTRODUCTION

The intensification of the tomato production implies, beside the utilization of some valuable productive hybrids, the applying of technologies that involve the usage of fertilizers with the purpose of maintaining the soil on an agrochemical optimization, because it is modified in time.

The biological potential of the plants and the chemical composition of the tomato fruits, genetically determined, are exploited only if all the factors of vegetation will be assured on optimum levels by a complex nutrition, from the quantitative and qualitative point of view.

The effect of the chemistry methods has to be found in the quality and quantity of the productions, but also in the qualitative evolution of the soil, with the purpose of preserving them and maintaining or increasing the fertility.

The studies regarding the culture of the tomatoes began from the finding of the demands of this species from the ecologic factors and from the demands of nutrition especially, with the purpose of obtaining high productions and with a superior quality.

The tomatoes are a species with a specific high consumption, especially in protected areas, where they are cultivated in the intensive system (R. Ciofu et al.,2004).

The culture of tomatoes in protected areas also presents some particularities compared with the culture of tomatoes in the field, particularities we should consider to establish the culture technology, especially the elaboration of programs of fertilization and the management of the climatic factors.

For the establishment of the fertilization programs for the cultures from the protected areas we should consider the degree of soil supply with nutritive elements, the vegetation phases of the plants, the climatic factors (light, temperature, humidity) and the planned production (Budoi., 2000). The ratios between the different nutritive elements also have to be balanced and correlated with the vegetation phases and the existent environmental conditions during the period of vegetation (Voican., Lăcătuş.,1998, Lăcătus. et al., 2006).

The cultures from the protected areas need much higher measures of nutritive elements compared to the cultures from the field, due to the much higher productivity (Heuvelink E., 2006; Apahidean Al.S., M. Apahidean, 2004).

Due to the intensive character of the culture system, it is necessary the administration of organic and mineral fertilizers to the basic fertilization, by this trying to obtain an optimum content of organic matter in the soil, which is in fact the main nutritive support of the culture (Tisdale S, 1993). During the period of vegetation, fertilizations are made on phases with mineral fertilizers administered in the soil and in the foliar feeding.

The differentiation of the nutrients' shots is established on the basis of a balance of the soil-plant system being given the multitude of "inputs" (vegetation factors - trophic and technologic) and of "outputs" (kg of product, kg etc., proteins, glucoses, lipids, vitamins, etc.) for which the soil is an essential dynamic component. The intervention system on the soil and plants by the chemistry means (amendments, fertilizers, pesticides) need to have as basis the detailed knowledge of their initial characteristics and of its method of evolution under this impact. (Davidescu D., Velicica Davidescu, 1992, 1999, A. Popa, 2007).

The foliar fertilization represents a part of the fertilization programs, which completes and stimulates it and is made with the purpose of meeting the needs of the plants during the vegetation phases with solutions of mineral fertilizers that contain macro – and microelements, that assure the intrusion of the nutritive ions especially through the leaves, stimulates the absorption, the translocation and assimilation of the nutrients from the soil, with favorable effect on the quantitative and qualitative level of the tomato production (Rusu et al.,2001,2005; Mărghitas M. et. al.,2003, 2005).

By the foliar fertilization it is intervened with low shots of nutrient, but the effects, the efficiency of the absorption and assimilation are high. It was observed that the extraradicular absorption is more efficient in relation with micro elements (Fe, Mn, Cu, Zn, etc.), which in the soil are disadvantaged because of the movability by complex processes of immobilization and physically chemically and physiologically by the sufficient high diameter of the hydrates ions (6,0- 9,0 × **10 -8** cm) and their reduced movability in the plants (Rusu M. et al., 2005). By the interaction of the effects of the radicular and extra radicular fertilization, the highest efficiency is obtained in quantitative and qualitative performance of the agricultural productions.

This type of fertilization is recommended especially for the cultures from protected areas, in the critical period of maximum consumption of the plants or of maximum efficiency, in the morning or evening, when the temperature is lower, so as the solution could enter slower in the leaves and the losses by evaporation would be reduced (Apahidean S.,M. Apahidean, 2000).

Generally, the foliar fertilizations are made together with the irrigation water. The mineral absorption and the consumption of nutritive elements is highly connected to the absorption of water and the consumption of water, so an increase of these consumptions is registered during the spring, high values are maintained during the summer and are decreasing in autumn (Rusu M., 2001).

The evaluation and control of the soil fertility and plant nutrition after DRIS-The Diagnosis and Recommendation Integrated System conceived in time for the control of nutrition and fertility, serves for the practice as a method of quantitative and qualitative determination of the crops with specific measures of increasing the soil fertility (Black, 1992; Borlan et al., 1994, 2000; Avarvarei et al., 1997; Mocanu, 2003). For explaining the connection of causality between the concentration and assimilation of a nutrient, the level of the crops and these concentrations or between the soil concentrations and those from the plant, principles were issued that allow for interpretations with integrated character and especially directions of the nutrition and fertilization (Black, 1992, Marschner H., 1993 etc.).

The research performed are part of this system with inbuilt character that will underline the effect of the foliar fertilizers on the quantity and quality of the production, on the number of fruits related to the tomato culture from tunnels.

MATERIAL AND METHOD

The research was performed during the years 2011-2013, in a private tunnels from Oradea. The field functioned as a vegetable garden of 6 years, so it benefited of annual organic mineral fertilizations.

The biological material used in the research was hybrid Cristal F1. It is a productive, early hybrid, with undetermined growth, intense and with a good resistance. The fruits have an average weight of 120-140 g, with a fleshy pulp, with three internal rooms, being resistant to transport and preservation.

The culture in tunnels was founded in continued cycle and led to 12 inflorescences.

The soil on which was settled the culture benefited of organic and mineral fertilizations in autumn with farm manure 50 t/ha, 400 kg/ha superphosphate and 150 kg/ ha potassium sulphate. In spring 300 kg/ ha of superphosphate were administered. The fertilizations on phases during the period of vegetation were administered to the soil in two intakes with ammonium nitrate. The fertilizations of the soil were supplemented by foliar fertilizations. The foliar sorts used in the research made their own mineral substances with macro elements (N, P, K, S, Ca, Mg) and micro elements (Fe, Mn, Cu, Zn, B, Mo) in assimilating forms.

In this regard the influence of some sorts of foliar fertilizers was studied on the production of tomatoes obtained for the culture of tomatoes in the tunnel (table 1).

Table 1

The sort of foliar fertilizers applied to the culture of tomatoes in the tunnel from Oradea (2011, 2012, 2013)

No. var.	Foliar sort	Concentration of solution %
1	Control sprinkled with water	-
2	Plantfert U	0.5%
3	Plantfert F	0.5%
4	Agroleaf Power Total	0.4 %
5	Agroleaf Power Ca	0.3 %
6	FoliMax Calcium Plus	0.4 %
7	Microfert Zn	0.5%
8	Basfoliar	1%
9	Cropmax	0.2 %

Statistical analysis

For each year, data was subjected to one-way analysis of variance (ANOVA) (P=0.05, N=3), in order to compare the differences generated by foliar treatments. Duncan’s post-hoc test (P=0.05) was applied in the case of significant differences.

RESULTS AND DISSCUSIONS

During the years 2011-2013, the experimental protocol included eight foliar sorts applied on a soil that benefited of organic mineral support by the fertilizations performed according to the culture technology.

These foliar sorts have a great differentiation in the effects on the production, respectively in the number of fruits related to this culture (table 2).

The effect of the foliar compositions with significant differences of production assures a better exploitation in the plants of the nutrients from the soil. We can mention that in the three years of study, the complex balanced sorts of the type Agroleaf Power Total, Basfoliar 20-20-20, Microfert Zn and Agroleaf Power Ca, which beside the content of macro elements contain also micro elements (Fe, Mn, B, Zn, Cu, Mo) and active biologic substances (amino acids and growth stimulators), were efficient. These foliar compositions, (NPK) rich in phosphorus, calcium and potassium sustain a better exploitation of the nitrogen compounds from the organic mineral underlayer of the soil.

Significant results were also obtained regarding the total number of fruits related between the layers I-VIII, with the same foliar compositions, which can be explained by the infusion of phosphorus and boron, elements involved in the evolution of the fructification organs, in the viability of the pollen and in the synthesis of the carbon hydrates.

The interpretation of the effect of the foliar sorts on the quality of the tomato fruits leads without reserves to the unanimous conclusion that in the most frequent cases the effect of these treatments consists in a substantial improvement of their quality and a preponderance of the upper classes of quality (Extra and 1st Quality).

It is possible that the effect of improving the quality would come from the additional and corrective character of the foliar fertilization, but also from the continuation process of maturing, of the vegetation and of course of the tomato riping. In this regard, as we know, the nitrigen acts, but especially the determinant elements of the quality: Phosphorus, Calcium, Potassium and micro elements.

Sorting of tomato crop yield (t/ha) was performed for each year, in order to compare foliar treatment effects (table 3) – control was excluded from this comparison. The lower the ordinal value, the greater the treatment effect, thus it has better yield performance. In the next step, for all years, the L^p norm (Hilma E. et al., 2011) was calculated for each parameter value. This metrics classifies over all years the treatments effects on tomato crop yield, thus it can be found out which foliar treatment displays the best effect (i.e. the smallest value in column five from table 3, for p =2.5).). However, this metric has ordinal values, in order to be able to carry out quantitative comparisons between years. For all the parameters, the relative ratios of the treatments effect with the control was performed (figures 1, 2, 3).

Table 2

The effects of foliar fertilizers on the quantity and quality of the production and number of fruits of the culture of tomatoes in the tunnels from Oradea (2011, 2012, 2013)

	CTRL	**Plantfert U**	**Plantfert F**	**Agroleaf Power Total**	**Agroleaf Power Ca**	**FoliMax Calcium Plus**	**Microfert Zn**	**Basfoliar 20-20-20**	**Cropmax**	**P**
2011										
Yield (t/ha)	88.867 a (0.153)	94.300 c (0.100)	93.467 b (0.252)	124.100 g (0.625)	102.400 e (0.100)	96.800 d (0.100)	110.867 f (0.153)	125.933 h (0.115)	93.233 b (0.153)	< 0.0001
FruitNO	27.100 a (0.100)	29.500 c (0.100)	29.267 b (0.058)	38.667 g (0.058)	32.133 e (0.058)	30.167 d (0.058)	33.867 f (0.058)	39.167 h (0.058)	29.500 c (0.100)	< 0.0001
Qextra (%)	61.767 a (0.058)	69.167 d (0.058)	69.033 c (0.058)	99.133 h (0.058)	76.733 f (0.153)	70.333 e (0.058)	80.833 g (0.058)	99.733 i (0.058)	67.367 b (0.058)	< 0.0001
Q1 (%)	16.367 b (0.058)	16.833 d (0.058)	16.500 c (0.000)	19.000 i (0.000)	16.933 e (0.058)	15.833 a (0.058)	17.800 g (0.000)	18.233 h (0.058)	17.167 f (0.058)	< 0.0001
Q2 (%)	10.733 d (0.115)	8.267 b (0.115)	7.933 b (0.252)	5.967 a (0.569)	8.767 c (0.058)	10.633 d (0.153)	12.200 e (0.173)	7.967 b (0.153)	8.700 c (0.265)	< 0.0001
2012										
Yield (t/ha)	91.700 i (0.100)	94.967 g (0.153)	96.067 f (0.153)	125.867 b (0.153)	105.233 d (0.153)	98.233 e (0.153)	112.767 c (0.153)	127.033 a (0.153)	93.100 h (0.100)	< 0.0001
FruitNO	28.633 h (0.058)	29.067 g (0.058)	29.933 f (0.058)	39.100 a (0.100)	32.867 d (0.058)	30.500 e (0.100)	35.267 c (0.058)	38.433 b (0.058)	29.967f (0.058)	< 0.0001
Qextra (%)	63.967 i (0.058)	71.100 f (0.100)	69.767 g (0.115)	98.000 b (0.100)	78.967 d (0.058)	73.400 e (0.000)	82.933 c (0.058)	106.033 a (0.058)	67.333 h (0.058)	< 0.0001
Q1 (%)	18.733 b (0.058)	15.467 g (0.058)	14.600 i (0.000)	20.133 a (0.058)	17.767 d (0.058)	18.067 c (0.058)	16.900 f (0.100)	15.333 h (0.058)	17.633 e (0.058)	< 0.0001
Q2 (%)	9.033 c (0.115)	8.400 d (0.173)	11.733 b (0.115)	7.733 f (0.058)	8.533 d (0.153)	6.767 g (0.208)	12.967 a (0.153)	5.667 h (0.208)	8.100 e (0.100)	< 0.0001
2013										
Yield (t/ha)	90.133 i (0.153)	95.667 f (0.153)	94.033 g (0.208)	124.083 b (0.015)	100.133 d (0.153)	97.500 e (0.100)	110.033 c (0.153)	125.040 a (0.020)	92.800 h (0.100)	< 0.0001
FruitNO	27.100 h (0.100)	29.533 f (0.058)	29.233 g (0.058)	38.733 b (0.058)	32.133 d (0.058)	30.233 e (0.058)	33.967 c (0.058)	39.100 a (0.100)	29.467 f (0.115)	< 0.0001
Qextra (%)	61.700 h (0.100)	69.167 f (0.058)	69.067 f (0.058)	99.267 b (0.058)	76.733 d (0.058)	70.233 e (0.058)	80.867 c (0.058)	99.633 a (0.058)	67.467 g (0.058)	< 0.0001
Q1 (%)	16.400 f (0.000)	16.900 e (0.100)	16.433 f (0.058)	18.967 a (0.058)	16.933 e (0.058)	15.900 g (0.000)	17.833 c (0.058)	18.267 b (0.058)	17.267 d (0.058)	< 0.0001
Q2 (%)	10.767 b (0.058)	8.233 d,e (0.058)	8.000 e (0.265)	5.867 f (0.666)	8.733 c (0.058)	10.700 b (0.173)	12.200 a (0.173)	8.000 e (0.000)	8.500 c,d (0.173)	< 0.0001

CTRL = control (i.e. no treatment). Results are expressed as mean (standard deviation). Mean values along rows with different letters are statistically different as consequence with Duncan's pair-wise comparisons (P=0.05).

One-way analysis of variance (ANOVA) performed, for each year and for each parameter, P-values less than 0.0001, thus enabling the post-hoc test due the presence of significant differences between treatment effects.

Table 3

Classification (with L^p-norm) of foliar treatments for variable Yield (t/ha), over 2011, 2012 and 2013 years.

Yield (t/ha)	**2011**	**2012**	**2013**	**Classes (by L^p-norm, p = 2.5)**
CTRL	-	-	-	-
Basfoliar 20-20-20	1	1	1	1
Agroleaf Power Total	2	2	2	2
Microfert Zn	3	3	3	3
Agroleaf Power Ca	4	4	4	4
FoliMax Calcium Plus	5	5	5	5
Plantfert U	6	7	6	6
Plantfert F	7	6	7	7
Cropmax	8	8	8	8

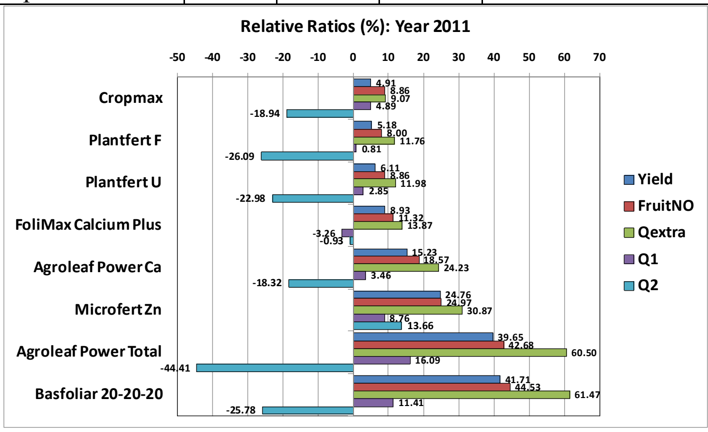

Fig. 1 The effect comparisons of foliar fertilizers on the quantity and quality on the production and number of fruits of the culture of tomatoes in the tunnels from Oradea (2011)

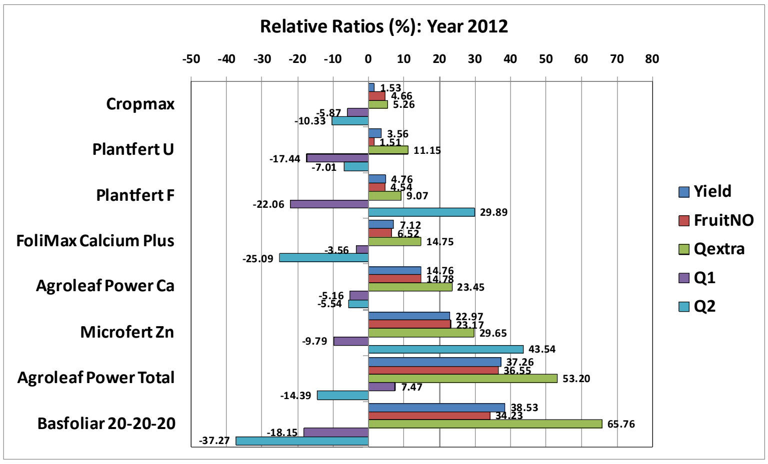

Fig. 2 The effect comparisons of foliar fertilizers on the quantity and quality on the production and number of fruits of the culture of tomatoes in the tunnels from Oradea (2012)

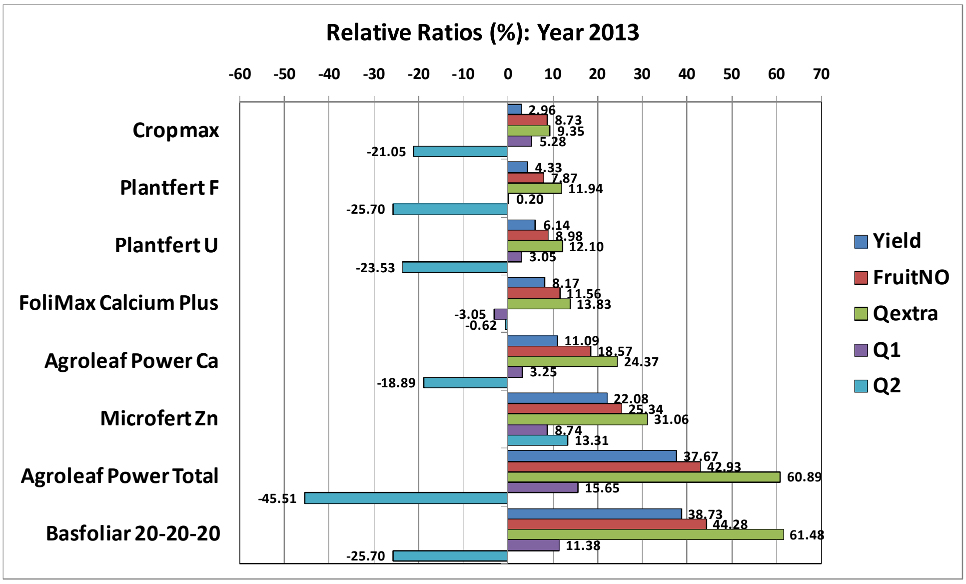

Fig. 3 The effect comparisons of foliar fertilizers on the quantity and quality on the production and number of fruits of the culture of tomatoes in the tunnels from Oradea (2013)

CONCLUSIONS

The foliar fertilizations are justified economically for the intensive cultures from protected areas, on soils optimized agro-chemically by organic mineral fertilizations, in vegetative phenophases with maximum consumption of nutritive elements.

The foliar fertilizations which proved their efficiency are those with fertilizers with a balanced and complex composition of macro elements (N, P, K) and micro elements (Fe, Mn, B, Zn, Cu, Mo). Some of these foliar fertilizers contain also active biological substances that replenish their role of physical and biochemical stimulation of the vegetal metabolism, having an essential implication in the regulation and sustaining of the photosynthesis (Fe, Mn, Cu).

The studies performed on the total productions underlined the foliar compositions rich in phosphorus, calcium, potassium which proves that these elements sustain and stimulate a better absorption of the components with nitrogen from the organic mineral underlayer of the soil. Significant productions were obtained for the fertilized versions with foliar compositions of the type Agroleaf Power Total, Basfoliar 20-20-20, Microfert Zn and Agroleaf Power Ca.

The productions obtained in the three years of research confirmed the effect of the foliar compositions, against an agrochemically-optimized soil by organic mineral fertilization, on the quality of the tomato fruits; it is observed an improvement of their quality, being obtained fruits with extra quality and 1st quality. In this regard, the versions fertilized with foliar compositions of the type Agroleaf Power Total, Basfoliar 20-20-20, Microfert Zn and Agroleaf Power Ca were remarked.

The research performed underlined the additional and correctional character of the foliar fertilizers on the production and quality of the fruits, by the continuation of the period of vegetation, of the maturity and reaping, effects that are due to the nitrogen, phosphorus, calcium, potassium and micro elements.

The severe experimentation of the foliar fertilizers, in the conditions of some technologies with intensive character for tomatoes, underlines that these compositions with extra radicular application can be placed in the context of the measures of soil fertilization, as a measure with “integrated” and complementary character.

The continuing of the research is recommended.

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