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Study on vegetative and generative manifestations as well as yield from glasshouse tomatoes when foliar fertilizers are applied

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Abstract. *With aim optimization of nutritive regime of glasshouse tomatoes supplementing the mineral nutrition by using foliar fertilizers an experiment was carried out in which on the background of basic fertilization with double superphosphate, potassium sulphate and ammonium nitrate through the vegetation, tomatoes were foliar fertilized with Hortigrow, Phytona-Pheromag, Phytona 1, Solifid Universal and Solifid Fructo. It was found out that foliar fertilization improves vegetative development of tomatoes, stimulates flower formation and increases fructification of the plants. The highest effect was obtained in fertilization with Hortigrow (3 kg/ha), or a mixture of Solifid Fructo (3,5 kg/ha) and Solifid Universal (3,5 kg/ha). In comparison with the plants which were not foliar fertilized, the number of flowers was increased by 20 – 24.3% and fructification by 5.5 – 6.5%. Both were increased tomato yield by 36.5 – 41.6% and the content of nitrogen, phosphorus and potassium in the fruits.*

Keywords: tomatoes, foliar fertilizers, development, yield

Introduction

Tomatoes are the most widely spread vegetable crop in the world which is cultivated in over 170 countries in all continents. The intensive character of tomato glasshouse production, their economic importance, long vegetation period and high yields obtained from them (exceeding couple of times the yields from field vegetable crops) determine the necessity of comparatively high fertilization rates. Besides for obtaining 1t of produce tomatoes remove from soil large amounts of nutrients: 3.4 kg N, 1.1 kg P_2O_5 and 4.7 kg K_2O (Rankov et al., 1983). Optimal plant nutrition during the whole vegetation period could not provided only with basic fertilization. The necessity of supplementing and correction plant nutrition arises and one of the opportunities is this to be done by foliar fertilization. Foliar fertilization can be applied during the whole vegetation as the assimilation of nutrient solution through the leaves is much greater and nutrients are included in plant cells very quickly (Granberry, 1990; Taiz and Zeiger, 1998). Foliar fertilization increases root activity and nutrient assimilation from soil (Alston, 1979; Kerin and Berova, 2003). By it can be overcome quickly physiological interference caused from non-balanced fertilization of insufficiency of some trace elements. Foliar fertilization provides all elements in accessible for the plants form, has prompt visible effect, can be applied together with pesticides as in many cases improves their efficiency (Pavlova and Bachvarov, 1992).

Foliar fertilizers found larger application after 1990 as from then till now the number of different substances and formulations incessantly increases. Their action on some vegetable crops is studied but a considerable part of the newer foliar fertilizers are poorly investigated. It is found out (Rankov, 1992; Suvandjiev et al., 1992) that in cultivation of tomatoes, eggplant, cabbage crops, onions and garlic the best effect of foliar dressing is achieved with Lactafol "O". The fertilization during vegetation of cucumbers, watermelons, melons, vegetable marrow, pumpkins and spinach with Lactofol "Fe" leads to yield increase (Shaban et al., 1993). According to Velev et al. (1995), Rankov (2001) foliar dressing with Lactofol increases the yield and improves produce quality in cucumbers, carrots, salads. By data of Junior et al. (1997) carrot development is the best after leaf fertilization with Cofermol and Plantin II. Vancheva et al. (1990), Slavenova et al. (1993) have investigated nitrate accumulation in radishes and potatoes after dressing with Lactofol. Doikova and Rankov (2003) have received very good results in foliar fertilization of vegetable marrow with combined fertilizer Solifid. According to Panayotov and Stoeva (2005) pepper fertilization with Masterbland leads to changes in leaf gas exchange and plastid pigment content. Foliar dressing stimulates vegetative plant manifestations of eggplant as the effect is the most strongly expressed when Crystalon is applied. Fruit quality is increased with growth of dry substance content, total sugars and raw protein (Penchev, 2009).

The purpose of the study is to be optimized the nutritive regime of glasshouse tomatoes, supplementing the mineral nutrition with foliar fertilizers.

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Material and methods

For realization the purpose of this study an experiment was carried out in glasshouse with the variety Mondial and application of various foliar fertilizers on the background of basic fertilization with double superphosphate in a rate of 500 kg/ha, potassium sulphate 50kg/ha and ammonium nitrate 200kg/ha. The experiment was set up by block design in four replications and size of the harvesting plot 9.6 m² in the following treatments: 1. Control; 2. Hortigrow – 3kg/ha; 3. Phytona-Pheromag – 3kg/ha; 4. Phytona 1 – 3kg/ha; 5. Solifid Universal – 3.5kg/ha; 6. Solifid Fructo – 3.5kg/ha; 7. Solifid Universal – 3.5 kg/ha + Solifid Fructo – 3.5 kg/ha. The foliar fertilizers were applied five times during the vegetation over an interval of ten days. The first dressing was made two weeks after tomato planting. For studying the effect of foliar fertilizers on the growth and development of tomato plants we performed morphological analysis in which were recorded plant height, leaves number and mass of ten plants from each treatment. We calculated data received in development index (Velev, 1984). We recorded the generative plant manifestations as flower number, fruit number and percentage of fruiting in dynamic during the vegetation. The earliness was determined from the first five harvests. Harvests were made twice weekly. On the basis of fruit number and size we determined the total yield and the index of productivity (Velev, 1984). We established the content of nitrogen, phosphorus and potassium in the fruits by chemical analysis.

Results and discussion

The results from morphological plant analysis are shown in Table 1. In all treatments in which are used foliar fertilizers during the vegetation plant height is bigger compared to the height of the plants in the control as the difference is from 4.1 to 12.5%. The highest are the values in dressing with Hortigrow in a rate 3 kg/ha. In application of Solifid Universal (3.5 kg/ha) and Solifid Fructo (3.5 kg/ha) independently or in a mixture plant height is 5 – 9.1% bigger compared to the control. In foliar fertilization with Phytona-Pheromag (3kg/ha) and Phytona 1 (3kg/ha) we do not observe differences in the case of this indicator. In both treatments plants are 4.1% higher than these in the control.

Plant foliation is the highest in off-root fertilization with Hortigrow or a mixture of Solifid Universal and Solifid Fructo 23.6 pcs followed by independent application of Solifid Fructo – 22.9 pcs. The increase towards the control is by 13.6% and 10.2%, respectively. Leaves number is the lowest in plants fertilized with Phytona 1. There is no difference in foliation in them compared to the plants of the control. Foliar fertilization exerts an influence also on plant mass. It is the highest in dressing during the vegetation with Hortigrow exceeding the mass of control plants by 26.1%. The values are close in application of a mixture of Solifid Fructo and Solifid Universal. The general plant development in all treatments is better than in the control. The values of development index are positive and are within 3.5 – 17.4. As summarizing feature the index of development shows that foliar fertilization with Hortigrow has the most favourable effect on tomato plants.

Data for dynamic of tomato flower formation and fruiting (Table 2) show that in August are not observed substantial differences between the control and the treatments in which are applied foliar fertilizers, which is due to the fact that till the moment of reading are made only two foliar dressings. The fruiting is poor, from 58 to 65%, as a reason for that are high temperatures in the glasshouse, impeding flower pollination. At the second term of reading the number of flowers increases as the highest are the values in foliar fertilization with Hortigrow – 34.8%, more compared to the control. The fruiting in all treatments is considerably better and is within 91 – 98%.

The same trends of flower formation and fruiting are observed in October. The results for the whole period show that leaf dressing exerts a positive effect for an increase the number of flowers as the

Table 1. Morphological indices and development of tomato plants

Treatment №	Average per plant					Index of development toward the control	
	Height /sm /	Relative value	Leaf number	Relative value	Mass of a whole plant (kg)	Relative value	
1	170	100.0	20.8	100.0	2.10	100.0	-
2	191	112.5	23.6	113.6	2.65	126.1	+ 17.4
3	177	104.1	22.6	108.8	2.34	111.8	+ 8.2
4	177	104.1	20.8	100.0	2.23	106.3	+ 3.5
5	178	105.0	22.6	108.8	2.40	114.7	+ 9.5
6	184	108.3	22.9	110.2	2.48	118.5	+ 12.3
7	185	109.1	23.6	113.6	2.57	122.8	+ 15.2

Table 2. Dynamic of flower formation and fruiting of tomatoes / average per plant /

Treatment №	August			September			Oktober			For the period August - Oktober		
	Fowers number	Fruits number	Fruiting %	Fowers number	Fruits number	Fruiting %	Fowers number	Fruits number	Fruiting %	Fowers number	Fruits number	Fruiting %
1	14.5	8.7	60	21.5	19.6	91	8.8	7.5	85	44.8	35.8	79.9
2	16.4	9.5	58	29.0	28.4	98	10.3	9.5	92	55.7	47.4	85.1
3	15.7	9.7	62	27.7	25.2	91	9.6	9.0	94	53.0	43.9	82.8
4	14.8	8.4	57	25.2	24.2	96	8.3	7.4	89	48.3	40.0	82.8
5	15.5	9.4	61	26.5	24.6	93	9.1	8.2	90	51.1	42.2	82.5
6	13.7	8.2	60	27.5	26.1	95	10.5	9.7	93	51.7	44.0	85.1
7	16.5	10.7	65	26.5	24.9	94	10.8	9.8	91	53.8	45.4	84.3

difference with the plants which are not nourished out of root is from 14 to 24.3%. Fruiting is the highest in foliar fertilization with Solifid Fructo or Hortigrow.

Foliar fertilizers used exert different effect on the early yield from tomatoes (Table 3). In fertilization with Hortigrow the early yield is by 10% lower compared to that in the control. A reason for this could be the lengthening of vegetative plant development at the expense of ripening. The early yield is the highest in foliar dressing with Phytona-Pheromag. The relative yield as a result of foliar fertilization is increased from 17.6 to 41.6% compared to the yield from plants in which are applied fertilizers only with the basic fertilization. In application of Hortigrow or a mixture of Solifid Fructo and Solifid Universal the yield is the highest. In these treatments is observed also higher index of productivity.

Foliar dressing affects also on fruit composition. An increased content of nitrogen, phosphorus and potassium is observed in the fruits of fertilized plants compared to plants which are not foliar fertilized. The content of nitrogen and phosphorus is the highest when Hortigrow is used while that of potassium in fertilization with Solifid Universal.

Degree of distribution of the yield (Figure 1) indicates that early production of variants with application of foliar fertilizers to control tends to decrease as the differences are mathematically proven to options №2, №3, №5 and №7. In terms of total production volume of distribution is in an upward direction when the options are used to control foliar fertilizers.

Table 3. Effect of foliar fertilization on productivity and chemical composition of the fruits

Treatment №	Early yield kg/ha	Total yield kg/ha	Relative yield %	Index of productivity	Composition of the fruits		
					N %	P_2O_5 mg/100g	K_2O mg/100g
1	10499	64985	100	4.2	2.19	0.90	4.35
2	9457	92018	141.6	5.4	2.75	1.31	5.22
3	11019	83700	128.8	5.1	2.64	1.11	4.47
4	10688	76422	117.6	4.2	2.33	0.92	4.65
5	9509	78696	121.1	4.8	2.65	0.96	5.28
6	10107	81816	125.9	4.6	2.37	1.01	4.60
7	9688	88704	136.5	5.1	2.56	1.05	4.92

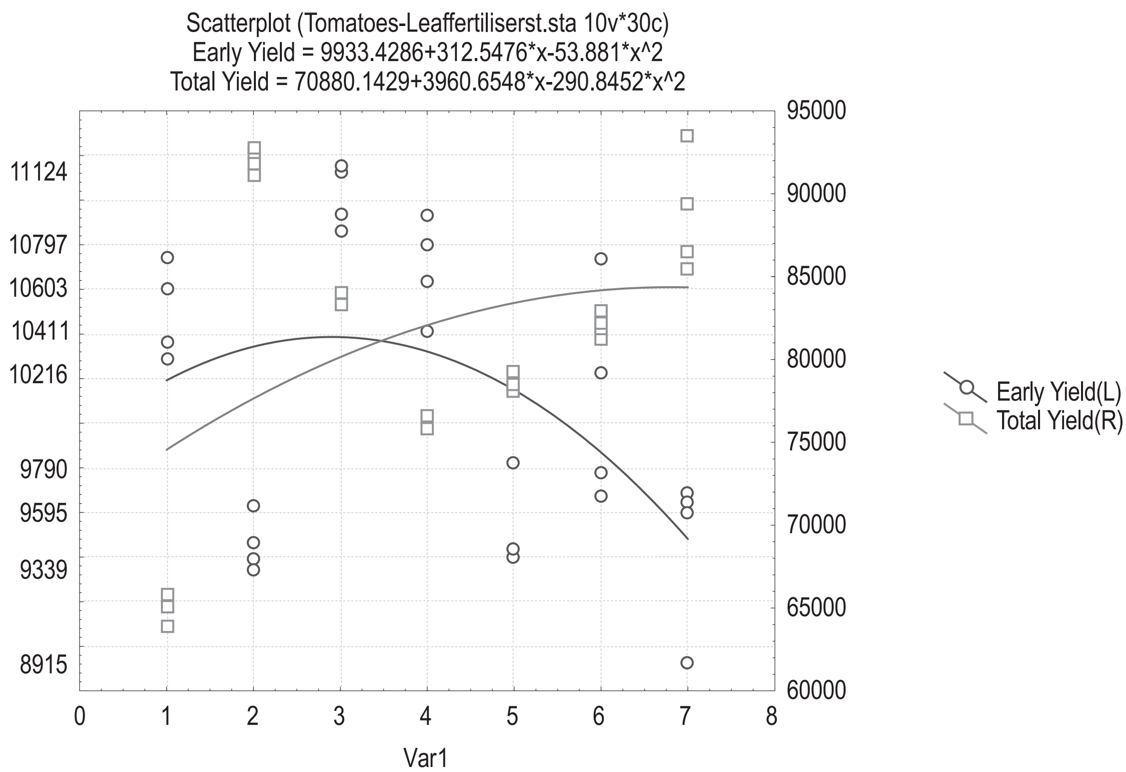

Figure 1. Degree of distribution of the yield

Conclusion

Foliar fertilization improves the vegetative tomato development, stimulates flower formation and increases the fruiting of the plants. The best effect is obtained in dressing with Hortigrow (3kg/ha) or a mixture of Solifid Fructo (3.5 kg/ha) and Solifid Universal (3.5 kg/ha). The index of plant development is positive, being higher by 15.2 – 17.4% in comparison with plants which were not fertilized, flower number is higher by 20 – 24.3%, while the fruiting is up by 5.5 – 6.5%. Foliar dressing with these fertilizers increases both tomato yield by 36.5 – 41.6% and the content of nitrogen, phosphorus and potassium in the fruits.

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