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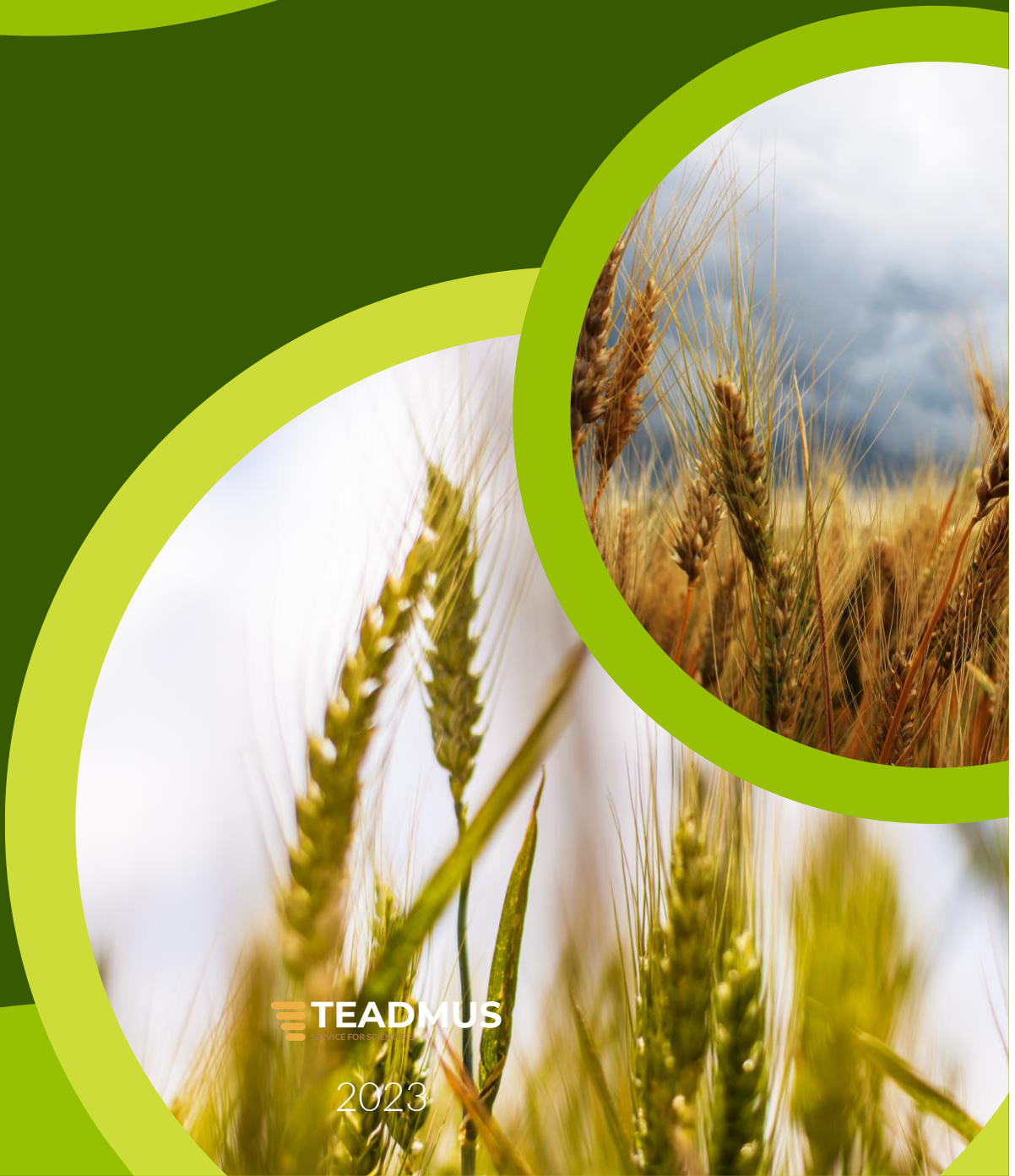
MODERN TRENDS IN AGRICULTURE SCIENCE: PROBLEMS AND SOLUTIONS



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MODERN TRENDS IN AGRICULTURAL SCIENCE: PROBLEMS AND SOLUTIONS

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The monograph is a collection of the results of actual achievements of domestic agricultural scientists, obtained directly in real conditions. The authors are recognized experts in their fields, as well as young scientists and postgraduate students of Ukraine. Research is conceptually grouped at 7 sections: Plants protection and quarantine; vegetable growing in open and closed ground; horticulture, fruit growing, viticulture; breeding and seed production; agrochemistry and soil science; agriculture and modern agricultural technologies; management and strategies for future development. The monograph will be interesting for experts in plant breeding, economics, plant protection, selection, agrochemistry, soil science, scientific workers, teachers, graduate students and students of agricultural specialties of higher education institutions, and for all those who are interested in increasing the quantity and quality of agricultural products.

Keywords: agriculture, modern technologies, plants protection, quarantine, vegetable growing, horticulture, fruit growing, viticulture, breeding and seed production, agrochemistry, soil, management, strategies, development.

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THE TOMATO YIELD DEPENDING ON THE METHOD OF PLANT FORMATION

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Modern studies of tomato culture are diverse, and now much attention is paid to the improvement of cultivation technology. From a biological point of view, tomatoes are annual herbaceous plants with a very good ability to form shoots, which has led to numerous studies on increasing production per plant and per unit area without compromising product quality. The purpose of the research was to determine the influence of different methods of plant formation on biometric indicators and yield of the indeterminate hybrid tomato Toivo F1. When conducting research, it was found that tomato plants show an increased reaction to growing conditions in the period from flowering to fruiting. The duration of the periods from the emergence of seedlings and from the beginning of flowering to the beginning of mass fruiting was the smallest when forming plants with an additional stem with pinching of the central stem above the fourth tassel. Tomato plants have the best ratios of vegetative mass, plant height and leaf surface area. The maximum yield of tomato (18.3 kg/m^2) was obtained precisely according to this variant of the experiment. Thanks to the effective method of plant formation, an increase in the level of tomato yield by 0.8-1.8 kg/m^2 was obtained compared to other options.

Key words: *tomato, protected soil, hybrid, technology, production, productivity.*

Tomatoes are one of the leading vegetable crops, both in the world and in Ukraine. The general task of growing vegetable crops in spring film

greenhouses is to produce high-quality vegetable products in the off-season. Research results show that the biodiversity of tomatoes can contribute to meeting the nutritional needs of an ever-growing population, minimizing the negative impact on the environment (Sievidova, 2013). As can be seen from the above, tomato is an important vegetable plant and its production and consumption are of great importance. These issues are receiving considerable attention around the world.

Cultivation of vegetable crops in protected soil, in order to provide the population with fresh vegetable products, is of crucial importance, especially in the spring, when the need for vitamins is extremely acute. In general, vegetables are one of the main suppliers of biologically active substances necessary for human nutrition. They provide the body with many vitamins, fiber, hemicellulose, pectin substances, organic acids, various carbohydrates, mineral salts and a number of other biochemical compounds (José, at al. 2009). Vegetables are rich in vitamins, minerals, amino acids and pigments and are low in calories, so they are considered very useful for the human body (Lhamo, at al. 2022). The overall taste of a tomato is largely determined by the concentration of sugars and acids (Hoza, Chiorean, & Drăguşin, 2011). The biochemical composition of tomato vegetables is influenced, among other things, by the position of the vegetables in the inflorescence. The vegetables in the middle has the highest content of polyphenols. Sugar content increases simultaneously for vegetables from the base to the apex of the inflorescence, while vegetables size decreases (Dinu, Hoza, & Becherescu, 2017).

In culture, tomatoes are usually grown on one stem; however, numerous studies have been conducted in which plants with two, three, and even four stems were grown. Multiple stems can be obtained by pinching the plant above the cotyledon leaves (Hoza, & Stanciu, 2012), pinching above the first pair of true leaves (Mourão, at al. 2014), pinching above the second inflorescence (José, at al. 2009) or by removing the growth peak of the seedling at planting and using the first two shoots at the base of the plant (Hoza, Chiorean, & Drăguşin, 2011; Rahmatian, Delshad, & Salehi, 2014). Studies have shown that two-stemmed plants produced higher yields (~27 kg/m2) compared to multi-stemmed plants, which produced less (~20 kg/m2). When comparing the products from the stems of the same plant formed with two stems, the differences were not significant (Mourão, at al. 2014).

When analyzing the correlation between the number of stems and tomato yield, it was observed that plants with two stems had higher productivity and number of vegetables, but the average vegetables weight

and marketable production were slightly lower for plants with two stems compared to single stems (Mbonihankuye, Kusolwa, & Msogoya, 2013). Tomatoes with two and three stems formed from shoots resulted in increased vegetables and marketable production compared to single-stemmed plants (Dinu, Hoza, & Becherescu, 2017). However, according to other studies, in this case, their vegetabless were slightly smaller, and the plants did not have significant differences in the quality and number of stems; plants grown with three stems also extend the harvest period (Coyago-Cruz, at al. 2017; Ece, & Darakci, 2007).

To solve the problem of increasing crop productivity in scientific and practical vegetable growing, the issue of improving the elements of tomato growing technology in film greenhouses, according to the new, adequate to the modern market, paradigm of the activities of enterprises in the vegetable growing industry (Sievidov, 2016; Leshchenko, & Sevidov 2015) is relevant.

To determine the potential for realizing productivity, in unheated spring film greenhouses, depending on the method of stem formation, Toivo F1 tomato hybrid plants were studied. Indeterminate hybrid Toivo F1 of the Dutch company "Bejo Zaden", with unlimited growth of the stem, which is characterized by sparse arrangement of tassels (every 2-3 leaves), the formation of side shoots, non-simultaneous ripening of vegetables. hybrid plants are easily formed into one stem, high-yielding, mostly mid- and late-ripening. The fruits have high marketability and taste. Resistant to cracking and diseases. Designed for growing in closed soil.

Scientific research was conducted during 2018-2022 on the basis of the "Vegetable Slobozhanshchyna" farm in the Kupyan district of the Kharkiv region. The experimental site is located in the southeast th part of the Left Bank Forest Steppe of Ukraine. The climate is a temperate continental climate with warm summers and moderately cold winters. Index of continentality according to Ivanov M.M. - about 150. The average long-term sum of active temperatures is 2669°C. The average annual temperature is +7.2°C. the maximum air temperature for the annual period in some years reaches 37°C, and the minimum temperature in the winter months is -34°C.

The research was conducted in accordance with generally accepted standards and methods: DSTU 6008:2008, DSTU 4138:2002, "Methods of research in vegetable growing and melon growing", "Basics of scientific research in agronomy". During the vegetation period of the plants, phenological and microclimatic observations, biometric measurements, productivity records were carried out, and the average weight of the fruit,

marketability, and the main biochemical indicators of the fruits were determined.

Scheme of the experiment: 1) formation of a plant into one stem (control); 2) forming a plant with an additional stem with pinching of the central stem above the fourth tassel; 3) formation of a plant in two stems.

For all variants of the experiment, the research program included: phenological observations of the timing of the vegetation phases of tomato plants, determination of plant biometric indicators (plant height, number of leaves, leaf surface area, number of tassels and fruit weight), yield accounting. Biometric measurements were carried out before planting seedlings in the greenhouse, and during the phase of mass flowering and fruiting of plants. Accounting for the productivity of tomato fruits was carried out separately according to variants and repetitions.

The seeds of the investigated hybrids were sown in the cassette in the third decade of February. After the emergence of seedlings, the plants were transferred to the greenhouse, then the seedlings were dived into cups (volume - 500 cm^3), watering and loosening of the soil was done once a day, and in the third decade of April - the first decade of May, they were planted in the greenhouse. Seedlings at the age of 3-5 real leaves were planted in a permanent place on an experimental plot in a film greenhouse without heating. Variants of experiments were placed by the method of complete randomization. The total area of the plot is 8 m^2, the area of the accounting plot is 5 m^2, repetition is four times, the total number of plants is 480 pcs. Scheme of planting seedlings in a permanent place in a film greenhouse 90+50×35 cm.

The conducted phenological observations show that the first single seedlings appeared in all variants equally six days after sowing. And general (75%) after two days from singles. At the beginning of the growing season, the tomatoes grew slowly, because they had a weakly branched root system, but after diving, more intensive growth was observed. The single appearance of the first true leaf was noted 4 days after the general emergence, and the general appearance after 6 days. The analysis of the phenological observations of the Toivo F1 tomato hybrid on the plants showed that the change in the method of formation of their stems had little effect on the terms and pace of the stages of organogenesis in plants, i.e., in all variants of the experiment, the phases of development in the plants were quite uniform. Observations show that over the years of research, tassel formation was recorded in all hybrids at almost the same time, 47-48 days after sowing, and the mass appearance of the tassel took place after another

two days. The general flowering of the hybrid occurred on average 58 days after sowing. The first harvest of tomato fruits began in the first decade of July. Mass fruiting in all variants of the experiment began in the third decade of July. The period from germination to the beginning of fruiting was 119-123 days, and from flowering to fruiting was 66-71 days. Thus, in the period from flowering to fruiting, plants showed an increased reaction to growing conditions.

In the phase of mass flowering, the average height of the plant was from 109 cm according to the variant of the experiment with the formation of the plant by an additional stem with pinching of the central stem to 129 cm in the control. However, plants according to the variant of the experiment with the formation of a plant in two stems with pinching had the largest mass - 1422 g, which is 15.5% more than the control, and the lowest mass of plants according to the variant with the formation of a plant in two stems - 1148 cm, by 6.7 % less control. In terms of the number of leaves and the area of the leaf surface, the lowest results were obtained with the control variant. The largest indicator of the number of leaves was according to the option with the formation of a plant in two stems - 24 pieces, which is 41.2% more than the control, and the indicator of the leaf surface area in the option with the formation of a plant in two stems with pinching - 4337 cm^2, which is 33.4% more than control (Table 1).

Table 1

The influence of the method of plant formation on biometric indicators, in the flowering phase, (2018-2022)

Experience Variant	Vegetative mass, g	Plant height, cm	Number of sheets, pcs.	Leaf surface area, cm^2/plant.
in one stem (control)	1231	129	17	3252
in two stems with pinching	1422	109	23	4337
in two stems	1148	118	24	3542

The study of biometric indicators in the fruiting phase showed better development according to the variant of the experiment with the formation of a plant in two stems with pinching. Plants according to this variant had the largest vegetative mass of the plant – 2860 g, which is 14.5% more than the control, and the assimilation surface area – 12382 cm^2, which is 7.7% more than the control. According to the control variant, an increase in plant height was noted – 297 cm, but the smallest number of leaves – 28 pcs. Plants according to the

variant with the formation of a plant in two stems had the largest number of leaves – 33 pieces, which is 17.9% more than the control (Table 2).

Table 2

The influence of the method of plant formation on biometric indicators, in the fruiting phase, (2018-2022)

Experience Variant	Vegetative mass, g	Plant height, cm	Number of sheets, pcs.	Leaf surface area, cm^2/plant.	Average weight of 1 fruit, g
in one stem (control)	2497	297	28	11914	129
in two stems with pinching	2860	273	30	12832	150
in two stems	2548	283	33	12044	108

One of the most important indicators determining the effectiveness of any element of tomato growing technology is yield and early maturity. Our research established that the highest yield in the first month of fruiting was formed in 2018 – 6.0-11.7 kg/m^2, and in 2021 – 6.0-11.5 kg/m^2 (Figure 1).

Plants according to the variant of the experiment with the formation of plants in two stems with pinching were characterized by the highest yield of the early harvest - on average 10.9 kg/m^2, 75.8% more than the control. The lowest level of early harvest was noted for the variant of the experiment with the formation of a plant in two stems of 5.9 kg/m^2, which is 4.8% less than the control (Table 3).

Table 3

The dynamics of yield formation, depending on the method of plant formation, kg/m^2 (2018-2022)

Experience Variant	Productivity			
	July	August	September	October
in one stem (control)	6,2	5,8	4,9	0,8
in two stems with pinching	10,9	4,8	2,4	0,3
in two stems	5,9	5,7	4,5	0,6
HIP_{05}	1,08	0,21	0,52	0,07

The results of the conducted research show that by influencing the processes of plant formation with the help of the formation of an additional stem, it is possible to influence the yield of the tomato crop (Table 4).

According to the variant with the formation of a plant in two stems with pinching, the yield was obtained at the level of 18.3 kg/m^2, which is 4.6% higher compared to the control. It was established that among the researched variants of the Toivo F1 hybrid tomato growing technology, the most effective, compared to the control, was the use of the variant with an additional stem with pinching of the central stem above the fourth tassel for plant formation.

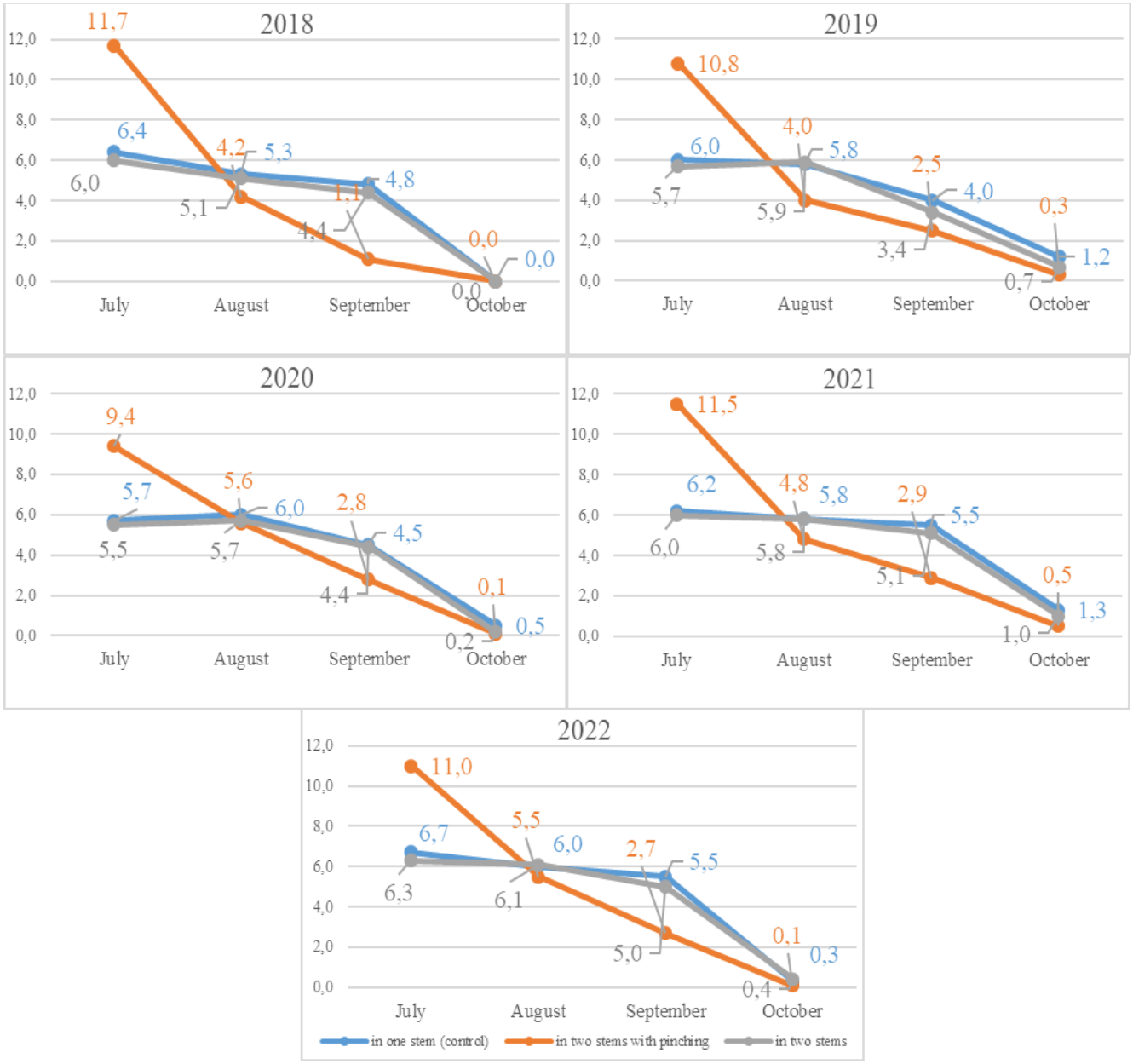

Fig. 1. Formation of an early crop of tomatoes by month, depending on the method of plant formation, kg/m^2

It is worth noting that in the researches of Ilyuk N.A. similar results were obtained in conditions of extended tomato culture in winter hydroponic greenhouses of the IV light zone. For the cultivation of the Rice F1 hybrid,

the application of the method of forming a plant into two trunks made it possible to obtain the highest yield, 13.4% more than the control [15]. A study conducted with four tomato cultivars and two plant formation systems, single-stemmed and double-stemmed, showed that tomato plants respond very well to multiple stems. From a vegetative point of view, no significant differences between plants with a single stem and plants with a double stem were recorded. However, on average, double-stemmed plants produced 80% more fruits per plant and 45% more fruits per square meter than single-stemmed plants [16].

Table 4

The influence of the method of plant formation on the yield of the tomato hybrid Toivo F1, kg/m^2, (2018-2022)

Experience Variant	Year					In average	± % to control
	2018	2019	2020	2021	2022		
in one stem (control)	16,5	17,0	16,7	18,8	18,5	17,5	–
in two stems with pinching	17,0	17,6	17,9	19,7	19,3	18,3	0,8
in two stems	15,5	15,7	15,8	17,9	17,8	16,5	-1,0
$HIP_{0,95}$	0,67	0,85	0,92	0,79	0,66	–	–

Modern studies of tomato culture are diverse, and now much attention is paid to the improvement of cultivation technology. From a biological point of view, tomatoes are annual herbaceous plants with a very good ability to form shoots, which has led to numerous studies on increasing production per plant and per unit area without compromising product quality.

The basis of our hypothesis of obtaining high productivity of tomato in early terms was the consideration of the biological features of the culture, its reaction to the method of formation of the stem of the plant as a factor in the formation of yield and quality of fruits. The study of the indeterminate tomato hybrid Toivo F1 with two plant management systems, in two stems with pinching of the main stem above the fourth tassel and in two stems without pinching, in comparison with the control variant in one stem, showed that tomato plants respond very well to the presence of several stems.

From a vegetative point of view, no significant differences between plants with a single stem and plants with a double stem were recorded. The study of biometric indicators of plants, both in the flowering phase and in

the fruiting phase, showed some positive influence of the method with the formation of the plant by an additional stem with pinching of the central stem above the fourth panicle, in which the vegetative mass of the plant and the area of the assimilation surface exceed both the control and the option with two stems. The influence of the investigated technology options determines the dependence of the studied biometric indicators on the method of plant formation. In general, during the entire vegetative period, with different methods of forming tomato plants, the difference in the value of biometric indicators was from -41 to +19%.

The conducted studies give reason to conclude that the greatest positive effect from the applied method of plant formation was obtained by forming the plant with an additional stem with pinching of the central stem above the fourth tassel - the yield increase according to this option was 0.8 kg/m^2. Thus, in the conditions of the Left Bank Forest Steppe of Ukraine, in order to obtain the maximum possible level of tomato yield in unheated spring film greenhouses, it is recommended to form the plant into two stems with pinching of the main stem above the fourth tassel.

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