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THE STUDY OF THE BIOLOGICAL CHARACTERISTICS AND PESTS OF STRAWBERRY VARIETIES IN THE CONDITIONS OF ANAU'S GREENHOUSE

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In a hydroponic greenhouse such fruit and vegetable crops are cultivated that have the ability to produce a double crop during the vegetation period. Strawberry (Fragaria ananassa Duch.) is such crop and we chose it for our research. Strawberry varieties grown in hydroponic greenhouses ensure a long-lasting, continuous, high quality and quantity harvest thanks to the created and controlled microclimate, regulated norms and timings of irrigation and nutrition. The period of fruit blossoming, ripening, and the formation of inflorescences occurs quickly. Monitoring is carried out, the dynamics of the development of pests and diseases is controlled, and the pest and disease control measures are implemented at the right times.

According to product evaluation indicators the varieties Albion and San Andreas outperformed Malga and Murano varieties.

Strawberry - varieties - yield - phenotyping - pests - diseases

Ուսումնասիրության համար մեր կողմից ընտրվել է ելակը (Fragaria ananassa Duch.), որը հենց այդպիսի մշակաբույս է։ Յիդրոպոնիկ ջերմատանը մշակվող ելակի սորտերն ապահովում են բարձր որակի և քանակի բերք՝ շնորհիվ արհեստականորեն ստեղծվող և վերահսկվող միկրոկլիմայի, ոռոգման և սնուցման կարգավորվող նորմերի և ժամկետների, պտղի ծաղկման, հասունացման, ծաղկակիրների առաջացման կարճ ժամանակահատվածի և այլն։ Կատարվում է մոնիթորինգ, վերահսկվում է վնասատուների և հիվանդությունների զարգացման դինամիկան, և ճիշտ ժամկետներում իրականացվում են պայքարի միջոցառումներ։

Ըստ ապրանքային գնահատման ցուցանիշների՝ Ալբիոն և Սան Անդրեաս սորտերը գերազանցել են Մալգա և Մուռանո սորտերին։

Ելակ – սորտեր – բերքատվություն – ֆենոտիպավորում – վնասատուներ – իիվանդություններ

Для нашего исследования была выбрана земляника (Fragaria ananassa Duch.), которая является именно такой культурой. Сорта земляники, выращенные в гидропонных теплицах, обеспечивают высокое качество и количество урожая за счет искусственно созданного и регулируемого микроклимата, регулируемой нормы и сроков, цветения, созревания плодов, короткого периода формирования цветоносов и др. Проводится мониторинг, контролируется динамика развития вредителей и болезней, своевременно реализуются меры борьбы.

Сорта Альбион и Сан-Андреас превзошли сорта Мальга и Мурано по показателям оценки продукции.

Земляника – сорта – урожайность – фенотипирование – вредители – болезни

At the global level, hydroponic food production has a unique place in solving food security issues, food production, optimal utilization of resources and developing sustainable agriculture. It has a number of advantages compared to agricultural products grown in other different environments.

In our experiments, the cultivation of strawberries in a hydroponic environment compared to the cultivation in the open field has the following advantages:

1.Strict control of nutrient solution,

2.Water saving,

3.Efficient use of nutrients, because they are not absorbed into the soil, but are mostly absorbed by plants,

4.Lack of need to fight against soil-dwelling harmful organisms and weed plants,

5. Production of ecologically safe food thanks to the exclusion of residual amounts of heavy metals and pesticides in the fruit.

The relevance of the study lies in the fact that the selected varieties of strawberries - San Andreas, Malga, Albion and Murano – have been introduced relatively recently in the fruit growing production of the RA, they are hardy, transportable, storable, produce high quality and quantity crop, and have the ability to produce double crop. The importance of our study is conditioned by the fact that based on the results of the experiments, the stakeholders are offered to produce those strawberry varieties whose growth and biological characteristics are more appropriate to their production requirements.

Materials and methods. The following tasks were set during the research of San Andreas, Malga, Albion and Murano strawberry varieties in the conditions of ANAU's greenhouse:

• To study the phenotypic characteristics of selected varieties [11],

• To investigate the course of transition of phenophases of selected varieties and the amount of harvest [9],

• To justify the economic efficiency of cultivation of selected varieties [5],

• To identify the species composition of pests and diseases developing on strawberries under greenhouse conditions, which will further allow developing an effective system of control measures [4; 7],

• To assess the quality of the crop with organoleptic method based on the requirements specified in the interstate normative documents [12].

The morphological characteristics of leaf and fruit of the above mentioned strawberry varieties were determined according to the international description (UPOV, 2012) [1; 2; 3; 11]. The course of transition of phenphases was determined according to methods adopted in Michurinsk State Agrarian University, and the diagnosis of pests and diseases and the clarification of their species composition were carried out in accordance with the methods accepted in entomology, acarology and phytopathology [4; 7; 8; 9; 10].

Cocovit (coconut fiber) served as a substrate for the cultivation of strawberry varieties in the conditions of the ANAU greenhouse. It should be noted that coconut fiber has a number of advantages compared to soil such as good aeration, ability to retain moisture, antibacterial properties that prevent damage of the plants' roots by bacteria.

The cocovit intended for the experiment was filled in food bags. Each bag was one meter long and contained 10 planters where the strawberry seedlings were placed. The length of the test rows was 4 meters and 40-45 plants were placed in one row. In one bag, the plants were planted in a two-line checkered pattern. A distance of 20 cm was left between the lines and another 20 cm between the seedlings. The feeding area for one plant was 0.04 m2. The experiment was performed with 3 repetitions, and during each repetition 6 plants were selected [3]. Irrigation and fertilizing of plants was carried out by drip method.

Data of the amount of harvest was subjected to statistical analysis by the method of dispersion analysis. Was determined the smallest significant difference - SSD₀₅ = 1.45 kg/m² and the error of the experiment – percentage = 0.45 %, AET₀₅ = 1.45 kg/m², which are intended for vegetation experiments [6]. In order to determine the economic performance of the options offered

to the production, the total monetary investments and the received incomes were taken into account [5].

Results and Discussion. Studies have shown that in the case of Albion, Malga and Murano, the emergence of leaf bearers and rapid growth was observed as early as 7-9 days after seedling. In the case of San Andreas, the emergence of leaf bearers was observed after 11 days of seedling (tab. 1).

Flowering lasted 10 days. Flowering here started 10-15 days earlier compared to open field cultivation. Full ripening of the fruits began 24-25 days after flowering.

Table 1. The process of transition of strawberry varieties phenophases after seedling

V ariety name	Time of seedlings	The period of emergence of leaf bearers	The period of emergence of inflorescences	Blooming	Fruit formation	Beginning of fruit ripening	Full ripening of fruits
San Andreas	02	19.02.	27.02.	08.03.	18.03.	26.03.	02.04.
Murano	2.2	15.02.	22.02.	03.03.	13.03.	20.03.	26.03.
Malga	8.0	17.02.	24.02.	05.03.	15.03.	22.03.	28.03.
Albion	0	17.02.	25.02.	06.03.	16.03.	24.03.	30.03.

Regarding the biological characteristics of strawberry, it was found that the Murano variety has a largest leaf area of 1725 cm^2 , and the Malga variety has a smallest leaf area of 1188 cm^2 (tab. 2). In the result of observations, it was revealed that up to 10 leaves are required for the formation of one strawberry fruit.

It was also revealed that the San Andreas variety has an advantage in terms of the number of flowers and leaves, while the Murano and Albion varieties are in second and third place. The Malga variety has the fewest leaf-bearing and flower-bearing stems.

Variety names	The number of leaves per plant, pcs	The number of leaf- bearing stems per plant, pcs	The number of inflorescences per plant, pcs	The area of one leaf, cm^2	Leaf area per plant, cm ²
San Andreas	78	26	12	20,0	1560
Murano	75	25	10	23,0	1725
Malga	54	18	8	22,0	1188
Albion	66	22	10	25,0	1650

Table 2. Biological characteristics of strawberry varieties

In the hydroponic cultivation of strawberries, the regulation of the temperature factor is important. After completing the seedling, the temperature should be $+5-7^{0}$ C. From the beginning of plant growth up to flowering, the necessary daytime temperature for early-maturing varieties is 18-23.5^oC, for varieties with an average ripening period – 22.3-27.6^oC, and for late-maturing varieties – 25.5-35.3^oC. The relative humidity of the air should be 65-75 %. Usually, the length of the daytime for strawberries should be 12-18 hours per day.

We recorded 5 waves of strawberry harvest until summer (tab. 3), after which the yield decreased sharply due to the decrease in relative humidity of air in the summer months (due to the absence of cooling systems in the greenhouse).

	1 st v of ha	wave urvest	2 nd w of har	vave rvest	3 rd of h	wave arvest	4 th v of ha	vave rvest	5 th w of har	vave rvest
Variety name	Date	Amount per plant, grams	Date	Amount per plant, grams	Date	Amount per plant, grams	Date	Amount per plant, grams	Date	Amount per plant, grams
San Andreas	02.04.	80	06.05.	90	30.05.	100	28.06.	80	25.07.	50
Murano	26.03.	80	23.04.	130	20.05.	120	18.06.	60	15.07.	50
Malga	28.03.	100	27.04.	100	23.05.	100	22.06.	100	18.07.	70
Albion	30.03.	100	01.05.	100	26.05.	100	25.06.	100	22.07.	100

Table 3. The number of harvests of strawberry varieties by waves

According to the data of tab. 4, it was revealed that the Albion and Malga varieties provided a high yield of 11.75-12.5 kg, while the Murano and San Andreas varieties stood out with a relatively low yield of 10.0-11.0 kg.

Table 4. Average yield of strawberry varieties per 1m²

Variety name	Amount of harvest per plant, grams	The average yield per plant, grams	Average yield per 1m ² , kg
San Andreas	400	80	10,0
Murano	440	88	11,0
Malga	470	94	11,8
Albion	500	100	12,5

The results of phenotyping of strawberry varieties were also studied. From the data in tab. 5, it is clear that in all 4 investigated strawberry varieties, the plant's growth strength is average, the foliage is dense, and the formation of leaf bearers and flower heads is balanced. The plant has a vertical growth habit, the number of tendrils is small, which is characteristic for varieties that have high yields and are mostly large-fruited.

Table 5. Phenotyping of strawberry cultivars by codes

Variety name	Nature of plant growth	Foliage density	The strength of plant growth	Number of tendrils
San Andreas	Vertical -1	Average-5	Average-5	Few -3
Murano	Vertical -1	Average-5	Average-5	Few -3
Malga	Vertical -1	Average-5	Average-5	Few -3
Albion	Vertical -1	Average-5	Average-5	Few -3

Tab. 6 shows the characteristics of fruit and leaf phenotypic traits of strawberry cultivars. According to research results, the Albion variety is distinguished by its cylindrical fruit, it has a medium-sized fruit, the leaf is medium-sized, the flowers and leaves are at the middle level, equally placed to each other.

In the case of the Murano variety, the leaf bearers and the peduncles are equal, the fruit shape is conical, small in size, and in the Malga variety, the peduncles are higher than the leaf bearers, the fruit shape is conical, medium in size. In the San Andreas variety, the peduncles are low, the fruit is medium-sized, cylindrical.

Variety names	The position of the peduncle relative to the foliage	Leaf size	Fruit size	Fruit shape
San Andreas	Low -1	Average-5	Average-5	Cylindrical -5
Murano	Average-2	Average-5	Small-3	Conical-2
Malga	High-3	Average-5	Average-5	Conical-2
Albion	Average-2	Average-5	Average-5	Cylindrical -5

Table 6. Characterization of phenotypic traits of fruits and leaves of strawberry varieties by coding method

The characteristics of the strawberry fruits are presented in tab. 7. From the data in the table, it can be stated that the sepals on the fruit of the San Andreas variety are twisted outwards, the fruit is 25-30 grams, the flesh is white-reddish.

The Murano variety has outwardly twisted sepals, yellowish red-dark flesh, the fruit is 20-25 grams. The Malga variety has upward pointed sepals, fruit is dark red-white, and weighs 40 grams. The Albion variety has outwards twisted sepals, the fruit is 30-60 grams and reddish-white.

Variety name	The position of the sepals on the fruit	Fruit color	Fruit weight, grams
San Andreas	2- twisted outwards	white-reddish	25-30
Murano	2- twisted outwards	yellowish red-dark red	20-25
Malga	1- pointed upwards	dark reddish white	40
Albion	2- twisted outwards	reddish-white	30-60

Table 7. Characterization of strawberry fruit

In the conditions of hydroponic cultivation, it is advisable to carry out plant pollination by hand, during which the pollen is transferred with soft brushes, once every 2-3 days, during the daytime hours (in production conditions, this method is not economically efficient).

In order to increase the efficiency of the pollination process, we used buton at 4 liters per 100 m² and megafol at 150-200 ml/100 liters. During seedling, the EC of the nutrient solution was 0.5-0.6 ms/cm, during flowering and fruiting – 1.5-1.6 ms/cm, and the pH was 5.7. Drainage in cloudy weather was around 40-45 %, the EC of drainage was 1.8-2 ms/cm, pH was 5.7-5.8. In sunny, hot weather, drainage was about 35 %, the EC of drainage was 1.7-1.8 ms/cm and pH was 5.5-5.6.

In the greenhouse, Tobacco thrips (Thrips tabaci Lind.) and Common spider mite (Tetranychus urticae Koch., 1836) were found among the strawberry pests, and among the diseases, the Powdery mildew (Erysiphe communis) and Gray rot (Botrytis inereal Pers.) were found (tab.8).

Section/ Type	Class	Order	Family	Genus	Species
ıropoda	Arachnidea	Acarina	Tetranichydae	Tetranychus Dufour., 1832	Tetranychus urticae Koch., 1836
Arth	Insecta	Thysanoptera	Thripidae	Thrips Lin.	Thripstabaci Lind.
ota	Euascomycetes	Erysiphales	Erysiphaceae	Erysiphe	Erysiphecommunis
Ascomyc	Leotiomycetes	Helotiales	Sclerotiniaceae	Botrytis	Botrytis cinerea Pers.

Table 8. Species composition of harmful organisms of strawberry and their distribution according to taxonomic units

After each harvest, product evaluation of the fruits was done by organoleptic method. It was based on the interstate standard GOST 33953-2016. According to the requirements specified in the normative document, the following indicators of strawberries were evaluated: appearance, smell and taste, degree of ripeness, size, in addition, the weight portion of berries that did not meet the normative requirements, the number of fruits with injuries, diseases and pests and foreign mixtures were determined.

According to the indicators of the product evaluation, the berries were divided into the corresponding commodity groups: high, first and second. The number of berries included in the high group according to the average indicators was 68.4 %, in the first and second product groups – 26.2 and 4.2 %. 1.2 % of the total harvest did not meet the normative requirements. The discussed indicators are presented in the tab. 9.

From the data presented in the table, it can be seen that Albion and Sandreas varieties correspond to the quality indicators of the high commodity group. These varieties registered 76.2 and 71.9 % indicators of the number of berries. The indicators of the first product group varied between 19.2-33.4 %, and the indicators of the second product group were 3.9-6.5 %. It is also noteworthy that the non-commercial harvest was 1.2 %, and the harvest was assessed as non-commercial in the case of small and twisted fruits.

Stroughorny variation	Commodity groups				
Strawberry varieties	High	First	Second		
San Andreas	71.9	21.4	6.5		
Murano	65.1	30.7	3.9		
Malga	60.2	33.4	5.9		
Albion	76.2	19.2	4.4		

 Table 9. Crop commodity groups of strawberry varieties according to GOST 33953-2016

Strawberries of all commodity groups were well-formed, of appropriate maturity, healthy, fresh, whole, clean, but not washed (standard requirement), typical for the pomological variety, without mechanical and pest damage, without excessive surface moisture, with fruit pulp. Albion and San Andreas varieties outperformed Malga and Murano varieties according to product evaluation indicators.

Conclusions

We suggest to the production to cultivate all four varieties of strawberries, as all four of them were distinguished by fruit high storage capacity, transportability, and Albion, Malga varieties were distinguished by large fruits and high yield. According to product evaluation indicators the varieties Albion and San Andreas outperformed Malga and Murano varieties. In addition, constantly keeping in focus the species composition of diseases and pests in the greenhouse is necessary, as it will allow timely development and implementation of effective control measures.

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