Improvement of technology in the cultivation of strawberries hybrid Soraya F1 during a vegetative trial

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Abstract. The Strawberry (*Fragaria x ananassa Duch*.) is a favorite dessert crop, which is in great demand and ranks first among fruit and berry crops. The principle of growing strawberries directly from seeds gives the advantages of obtaining clean, reliable plant material and improving phytosanitary conditions. The aim of the research was to introduce innovations in the technology of growing high-quality planting material of garden strawberries (*Fragaria x ananassa Duch.)* of the Superelite class based on healthy hybrid seeds of the first generation of strawberry hybrid Soraya F1 under artificial lighting conditions in hydroponic culture. As a result, innovations in the artificial lighting regime, hydroponic culture conditions, substrate composition, irrigation regime and composition of the nutrient solution for root nutrition of plants were introduced, the flow of phytohormones, phytosanitary condition and quality of strawberry crop were analyzed.

1 Introduction

Strawberries (*Fragaria x ananassa Duch.*) are a favorite berry crop, ranking first among other fruit and berry crops and undoubtedly in great demand. This is due to the high taste properties of the berries and the source of various vitamins and nutrients (vitamins C and A, K, Mg, Fe, antioxidants, organic acids, easily digestible sugars, polyphenols and bioflavonoids) [1].

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Since fresh strawberries are in high demand throughout the year, one of the priority areas of its breeding in the world is to extend the fruiting period for the consumption of fresh berries [2, 3].

The period of consumption of fresh strawberries is limited to several months, and the taste of imported strawberries is often low due to early harvesting and long delivery time to consumers. It is extremely important to study the possibility of extending the fruiting period and out-of-season cultivation of strawberries in our country and selling domestically produced berries on Ukrainian markets. The use of various types of shelter and structures that allow for the production of fresh berries in winter and spring provides ample opportunities to extend and expand the period of berry supply. Under the shelter, strawberry growth processes begin earlier, ripening is faster and more efficient [4, 5].

At the end of the last century, the first varieties of F1 hybrid strawberries propagated by seeds appeared on the market. The principle of growing strawberries directly from seeds, the benefits of clean, reliable plant material and efficient logistics were only adopted by the international strawberry industry on a limited scale.

Therefore, our chosen research topic, namely the introduction of innovative technologies in the cultivation of strawberries of the Soraya F1 hybrid from seed material under artificial lighting in hydroponic culture, is quite relevant today, because the market demand for a good tasty off-season strawberry.

Crop throughout the year requires the search for new scientifically and economically sound growing conditions that can be created both on a personal plot and on an industrial scale [6].

The aim of the research was to introduce innovations in the technology of growing high-quality planting material of garden strawberries (*Fragaria x ananassa Duch.*) of the Superelite class based on healthy hybrid seeds of the first generation of strawberry hybrid Soraya F1 under artificial lighting conditions in hydroponic culture.

In accordance with this goal, the following tasks were set:

1. To obtain high-quality planting material (healthy seedlings) from the seeds of the first generation of strawberry hybrid Soraya F1 using the method of hydroponic culture and artificial lighting.
2. To improve the artificial lighting regime taking into account the biological characteristics of the crop.
3. To select the optimal conditions of hydroponic culture, substrate composition, watering regime and composition of the nutrient solution for root nutrition of plants.
4. To investigate the effect of phytohormones on growth processes and berry formation during foliar spraying of strawberries grown from seeds at different stages of development.
5. To conduct phenological observations and evaluate the quality of strawberry crop grown from seeds by the main physicochemical parameters.

2 Material and method

2.1 Research material

Strawberry seeds of Soraya F1 hybrid for professional cultivation from the company of Dutch breeders ABZ Seeds were used as planting material. The hybrid characteristics are given in Table 1.

Table 1. Characteristics of strawberry variety Soraya F1 hybrid.

Species	**Fragaria x ananassa Duch**
Genus/Family	Rosaceae/North and South America
Life cycle	Constant fruiting/neutral day
Plant type	Open, vigorous, long stem, fruits clearly visible
Plant diameter	30-40 cm
Stem length	20 cm
Berry type	Bright red, firm, sweet, conical
Fruit yield	1250-1500 grams per plant
Fruit weight	16-30 g
Sugar content	8-11° Brix
Seed shape	Pure professional seeds, regular shape
Number of seeds in 1g	1500-2000 pcs in 1g
Seed germination	90% + germination energy
Diameter of the seat	2 cm
Seeds per seat	1 pc
Germination temperature	22°C
Germination period	10-12 days
Seedling growing temperature	D/N 20/16°C
Growing temperature of young plants (Tray)	Day: 14-23°C Night: 8-12°C
Relative humidity	60-75%
The level of lighting	Is high

2.2 Characteristics of the experimental conditions

The research was conducted in 2020-2021 in a private farm (Avangard village, Odesa region) in mixed conditions. Strawberry seedlings were grown for 3 months in a conditionally clean closed ventilated room on a metal rack under light culture conditions on a coconut substrate, and eventually transplanted to an artificial nutrient substrate in open conditions on a personal plot.

2.3 Research methods

The work was based on the methods and recommendations for growing strawberries in hydroponic culture from sources, methods for creating artificial lighting, and methods for calculating nutrient solutions, which were modified and adapted to specific conditions during the experiment. For lighting, we used special lamps for seedlings and measured the illumination using a CE-113 luxmeter.

3 Results and discussion

3.1 Features of garden strawberry propagation

Year-round strawberries are characterized by excellent taste properties of berries, which leads to an increase in market demand around the world. In winter, strawberries from the Mediterranean or subtropical regions are supplied to world markets. «In order to provide the market with fresh, flavorful strawberries through local production in the winter season, we have developed a special breeding program

focused on growing in greenhouses with assimilation lighting. In the coming years, we will develop a protocol for growing F1 hybrid strawberries in greenhouses in winter/spring [7].

According to the traditional technology, rooted rosettes (seedlings) are the main way to propagate strawberries and grow planting material of recommended and promising varieties in production conditions [8]. Strawberry planting material is seedlings grown on special mother liquors from Elite class plants. Elite A is a high-quality strawberry seedling obtained from Superelite mother plants. Superelite is a high-quality pure strawberry seedling grown by propagation of superelite plants in isolation in horticultural research institutions, which has typical morphological characteristics and high economic and biological qualities inherent in this variety, free from quarantine objects, viral and other diseases and pests. It is intended for establishing mother plantations in basic fruit nurseries [9].

3.2 Dangerous pests of garden strawberry

The main problem of purchased strawberry seedlings is the presence of harmful organisms, among which fungal diseases prevail: gray rot, white and brown spot, powdery mildew, fruit rot, late blight, Fusarium and Verticillium wilt). Among viral diseases there are: mottling, wrinkling, marginal yellowing of leaves, phytoplasmosis – greening of petals (phyllody). Viral and phytoplasmic diseases on strawberries are usually chronic and are transmitted with planting material, which worsens the quality of the crop. Eggs or larvae of thrips, spider mites, cicadas, whiteflies, etc. are often found on strawberries [10, 11, 12].

When buying certified seedlings from well-known European nurseries, the risk of obtaining plants infected with pathogens and pests cannot be ruled out. Analyzing all the dangers posed to strawberries by harmful organisms, it becomes clear that it is necessary to combat them with a set of measures (agrotechnical, biological, chemical), but the most important thing is the use of healthy, high quality planting material [13].

3.3 Market analysis of hybrid strawberry seeds production

From 1995 to 2015, ABZ Seeds created more than 25 F1 strawberry hybrids (Elan, Milan, Tarpan, Beltran, etc.) that inherit well the traits of mother plants when propagated by seeds [14].

In 1976, a strawberry breeding program was launched to develop varieties for seed propagation. Initially, the diploid species Fragaria vesca L. (2n = 14) was studied. The octoploid species Fragaria x ananassa Duch. (2n = 56) showed the most promising genetic variations. Experimental F1 hybrids also showed a high level of homogeneity. Depending on the time of year and climatic conditions in the nursery, F1 hybrids bear fruit 16 to 26 weeks after sowing. These features make the concept of seed-propagated F1 hybrids an attractive product for professional greenhouse and open field cultivation [15].

3.4 Application of innovative technologies for growing and obtaining high-quality planting material for garden strawberries

The issue of developing an effective technology for the mass production of high-quality planting material of remontant varieties of garden strawberries characterized by low sap-forming capacity is of undoubted interest and is relevant. There is also a

method of in vitro propagation, but obtaining planting material using this method takes a lot of time [16].

The use of reproductive propagation by means of seeds allows to accelerate the process of obtaining clean, healthy planting material of the Superlative category, ready for flowering, up to three months from the moment of sowing seeds. The method of seed propagation is mainly used for breeding work in the development of new varieties, as well as for the propagation of remontant, beardless varieties.

The use of advanced strawberry cultivation technologies in Western European countries ensures harvesting at any time of the year, one of these technologies is the so-called «regulated» cultivation with frigo seedlings [17].

To grow plants from seeds, the method of hydroponic plant cultivation is used, which is one of the most advanced technologies. The best results in hydroponics are obtained by using a neutral substrate, for example, rockwool slabs, coconut substrate, expanded clay. Hydroponic solutions should be balanced in terms of macro- and microelements and controlled in terms of concentration and acidity. The use of hydroponic culture makes it possible to automate all technological processes as much as possible and to control the humidity of the substrate, air and lighting, as well as to program the yield. If all the requirements are met, the plants grow and develop well.

According to the research of Chinese breeders, strawberry seedlings (*Fragaria ananassa Duch. 'Yueli'*) were irrigated with a nutrient solution with the following concentrations of macronutrients: N – 160 mg/kg, P – 88.5 mg/kg, and K – 167 mg/kg, respectively. The level of organic matter was 3.27%, the pH value was 5.56 [18]. According to the recommendations of «Plant Nutrition of Greenhouse Crops», the EC values of the nutrient solution for strawberries should not exceed 2.4 mS/cm.

The author of the book «Nutrient Solutions for Greenhouse Crops» gives the following recommendations on the concentration of elements in the nutrient solution: the concentration of NH_4 should be 14 mg/l, NO_3 – 168 mg/l, P – 31 mg/l, K – 188 mg/l, Ca – 144 mg/l, Mg – 36 mg/l, S – 48 mg/l. At the same time, the EC values of the irrigation solution should be within 1.6 mS/cm, pH 5.5-6.0 [19].

3.5 Technology of sowing strawberry seeds of Soraya F1 hybrid by innovative method

The best for sowing strawberry seeds is coconut substrate, which has a high moisture capacity – it retains moisture 7-8 times more than its weight, is a pure organic material – does not contain harmful microorganisms and viruses, is characterized by optimal pH (5,5-6.5) and high buffering capacity, has good hydrophobic properties – it easily absorbs and gives the plants a nutrient solution without making changes to its composition, compared to peat, which at a moisture content of less than 40% begins to show hydrophobic properties – it absorbs water with difficulty. Coconut substrate is a porous material, due to its structure it has high air permeability, which allows to achieve an optimal ratio of nutrient solution and air in the root zone of plants. Due to its porosity, the root system of the seedling remains with minimal damage during the transplantation, and continues to develop its root. Coconut substrate is also compatible with any substrates – both inert (rockwool slabswool, etc.) and peat, peat-based substrates, and ordinary garden soil [20].

Pour the pre-washed and squeezed coconut substrate into the strawberry growing container with a layer of 1 to 2 cm, spread it evenly and lightly tamp it down. With a pencil, make small depressions at a distance of 1 cm from each other and put 1 seed in them. Do not sprinkle the seeds on top, because they germinate in the light.

Then moisten them with a nutrient solution using a spray bottle, cover the container with the sown seeds with cling film or a transparent lid and put them in a dark place for a day. Important! The temperature during seed germination should not exceed +22 C, the optimum temperature for seed germination is +20 C, otherwise the embryos will simply die.

In a day, the seeds will absorb enough moisture from the coconut substrate and will be ready to germinate. Starting from 2 days, transfer the container with the sown seeds under bright white light. At this stage, it is better to set the light mode on the timer to 16/8 (16 hours a day, 8 hours a night). For the first two weeks after planting the seeds, it is necessary to keep the container with the sprouts under the film, but remove the film every 3-4 days to allow excess moisture to evaporate and provide fresh air to the plants. Remove the film completely from the end of the second week after sowing. You can start watering the seedlings from the 3rd week, because through the greenhouse that we have arranged in the growing container, the evaporating moisture condenses on the film and returns back to the coconut. Water carefully so that the nutrient solution does not get on the leaves of the seedlings. You can use a syringe for this purpose. Seeds germinate on the 3rd day. Out of 121 seeds, 118 seeds germinated on the 3rd day. Seed germination rate was 97.5%.

3.6 Technology of picking seedlings of strawberry hybrid Soraya F1

Seedlings were transplanted 30 days after seed germination. Transplanting should be carried out in a substrate on which it is planned to carry out a full cycle of strawberry cultivation – it can be rockwool slabs, coconut substrate or peat. Strawberry seedlings are carefully removed from the container with tweezers, with a small lump of coconut, and placed in the selected substrate, while the seedling must be deepened into the substrate to the first leaves. If necessary, coconut substrate can be added to the recess with the transplanted seedling.

In our experiment, part of the seedlings: 21 pieces – were transplanted into Grodan rockwool cubes for further hydroponic cultivation on rockwool slabs. The remaining 97 seedlings were transplanted into 500 ml pots with coconut substrate. The substrate consists of 70% washed fine coconut fiber, 20% agroperlite and 10% vermiculite. These plants are intended for trial cultivation in the open field on the hills (Figure 1).

Fig. 1. Transplanting Soraya F1 hybrid seedlings on coconut substrate and rockwool cubes

Transplanted seedlings are spilled abundantly with nutrient solution and placed under bright white light, with a minimum illumination of about 20,000 lux at the level of the leaves. A week after transplanting into a small rockwool cube, the seedling sprouts roots, and the small cube can be inserted into a large one if the transplante was carried out into intermediate rockwool cubes. Then the seedlings grow without transplanting for two months until they are full-grown seedlings ready to generate flower stalks.

During these two months, the seedlings will intensively generate a mustache, which must be cut off so that the plant does not waste its energy, but concentrates on its development, and is ready to release flower stalks on about the 100th day after germination, which, after flowering and pollination, will set a wonderful tasty berry.

3.7 Technology of growing strawberries of Soraya F1 hybrid in light culture

Strawberry seedlings were grown for 3 months in a conditionally clean ventilated room on a metal rack under light culture conditions. Conditional cleanliness was ensured by the operation of a 15 Watt ozone-free ultraviolet recirculator for 14 hours a day. The parameters of strawberry cultivation under light culture conditions are shown in Table 2.

Table 2. Main indicators of light culture conditions

Parameter	Air humidity	Tempe-rature	Light hours, day/night	Watering
Seed germination from 2 days	100%	+20C	16 hours a day/8 hours a night bright white led light with a color temperature of 4000 K	Moistening of coconut substrate before sowing, greenhouse conditions, watering within 10 days after sowing as it dries
Vegetation up to 3 months	55-65%	+22C day +20C night	16 day/8 night White led light with a color temperature of 4000 K	Manual, as the substrate dries until 30% drainage appears

Starting from the second day, place the container with the sown seeds under bright white light. At this stage, it is better to set the light mode on the timer to 16/8 (16 hours of artificial LED light and 8 hours of complete darkness per day). After the seeds germinate, from day 10, we switch to the following regime: relative humidity 55-65%, daytime temperature +22°C, night-time temperature +20°C, light regime 16/8 (16 hours of artificial day, 8 hours of night).

Watering the plants at this stage is manual, as the substrate dries until 30% drainage appears. To grow strawberries from seeds, you need bright white light with a color temperature of 4000 K. There are many different options for lamps, but we have tested and recommended using LED lamps consisting of LEDs with high light output – this parameter should not be lower than 150 Lm/W for better energy efficiency. Such light output is provided, for example, by Samsung or Osram LEDs. In our study, we used LED lamps with a power of 50 W, 60 cm long, based on Samsung LEDs, with a light output of 170 Lm/W. To automate the plant lighting mode, a timer socket is required.

3.8 Technology of irrigation mode for strawberry seedlings of Soraya F1 hybrid with root feeding

Watering in the conditions of open trays was automatic, drip, 2 droppers of 1 liter/min per 1 plant. Watering was carried out 3 times a day at 8:00, 14:00 and 21:00 daily with the addition of nutrient solution. The amount of nutrient solution poured per 1 plant varied, depending on the ambient temperature, and averaged from 500 ml to 3 liters. On the hottest days, about 21 liters of nutrient solution was used per 1 mat. The EC of the drainage was also monitored – if the drainage exceeded the EC of the injected nutrient solution by more than 0.4 mS/m, additional flows were made to rinse the substrate from excess salts.

Flushing was continued until the difference between the EC of the drainage and the EC of the nutrient solution did not exceed 0.1 mS. Seedlings should be watered as the substrate dries, so that approximately 30% of the nutrient solution goes into the drainage. The electrical conductivity of the solution depends on the phase of strawberry cultivation (Table 3).

Table 3. Electrical conductivity (ES) of the nutrient solution

Phases of vegetation	EC, **mS**
I month of cultivation (before transplanting)	1,1-1,2
II month of cultivation (after transplanting)	1,2-1,3
III month	1,3-1,4
After 3 months	1,5-1,6

The electrical conductivity (EC) of the nutrient solution should be from 1.1 to 1.2 mS in the first month (before transplanting), from 1.2 to 1.3 mS in the second month (after transplanting), from 1.3 to 1.4 mS in the third month, and after three months, the concentration can be increased to 1.5 to 1.6 mS, which corresponds to 100% of the nutrient solution concentration.

To prepare 1 liter of nutrient solution for root feeding with irrigation, it is necessary to prepare the components:

1. Calcium nitrate (Yara Calcinit).
2. Potassium nitrate (potassium nitrate).
3. Potassium monophosphate (MFP).
4. Magnesium sulfate (pharmaceutical, in crystals).
5. Valagro Master 13:40:13.
6. Magnesium nitrate (magnesium nitrate).
7. Brexil Combi+ (This is a cocktail of trace elements).

To provide strawberry seedlings with a «balanced diet», it is necessary to prepare a nutrient solution from the listed components and dissolve them according to the instructions given (Table 4).

This solution should be diluted with water to the required concentration for each stage of seedling development. Store the prepared solution in a cool place for up to two weeks. Shake the solution before use. For different stages of strawberry ontogeny, we recommend using nutrition profiles modified by us by increasing nitrogen and phosphorus and decreasing calcium (Table 4).

Table 4. Instructions for preparing a nutrient solution for growing strawberry seedlings

Step	Components				Recommendations
I	0.66g Calcinite	0.4g Potassium nitrate	0.1g Magnesium nitrate		Add these ingredients to 0.5 liters of water and shake until they are completely dissolved.
II	0,1g MFP	0.27g Magnesium sulfate	0.14g Valagro 13:40:13	0,03g Brexil combi	Add these ingredients to 0.5 liters of water and shake until they are completely dissolved.
III	Combine our two solutions, shake them lightly and get 1 liter of nutrient solution with EC 1.67 mS				

At the beginning of flowering (97 days), the nutrition profile includes the following substances: N (total) – 176 mg/l, NH_4 – 11.8 mg/l, P – 47 mg/l, K – 212 mg/l, Ca – 127 mg/l, Mg – 36 mg/l, S – 36 mg/l, as well as trace elements: Fe – 2.7 mg/l, Mn – 1.4 mg/l, Zn – 0.3 mg/l, B – 0.28 mg/l, Cu – 0.18 mg/l, Mo – 0.06 mg/l.

During the flowering phase (105 days), it is necessary to reduce the level of NH_4 and increase the calcium content in the solution. You can also increase the concentration of boron once – up to 1 mg/l. Boron stimulates the development of the root system and is a necessary element during flowering.

The nutrition profile during the flowering period includes the following substances: N (total) – 170 mg/l, NH_4 – 5.7 mg/l, P – 47 mg/l, K – 213 mg/l, Ca – 137 mg/l, Mg – 36 mg/l, S – 38 mg/l, as well as trace elements: Fe – 2.6 mg/l, Mn – 1.4 mg/l, Zn – 0.3 mg/l, B – 0.28 mg/l, Cu – 0.18 mg/l, Mo – 0.06 mg/l.

In the fruiting phase (123 days), the nutritional profile includes the following substances: N (total) – 169 mg/l, NH_4 – 3.7 mg/l, P – 47 mg/l, K – 232 mg/l, Ca – 137 mg/l, Mg – 37 mg/l, S – 44 mg/l, as well as trace elements: Fe – 2.8 mg/l, Mn – 1.48 mg/l, Zn – 0.34 mg/l, B – 0.3 mg/l, Cu – 0.18 mg/l, Mo – 0.06 mg/l.

3.9 Technology of biostimulants application on strawberry seedlings of Soraya F1 hybrid

To stimulate the growth processes, flowering and ovary formation at different stages of growing strawberry seedlings, plants were sprayed with growth stimulants based on phytohormones from Valagro.

MC Cream is a phytohormone-based stimulant in the form of a suspension, characterized by excellent effectiveness in recovering from stress and increasing photosynthetic activity. Benefit PZ increases the rate of cell division and new cell formation after ovary formation and during the period of active fruit growth, which leads to an increase in the number of cells and, accordingly, the size of the fruit.

At the stage of growing seedlings and before the appearance of peduncles, plants were sprayed once a week with MC Cream stimulant, at the rate of 2.5-3 ml of the drug per 1 liter of working solution.

The scheme of phytohormones application is shown in Table 5.

Table 5. Scheme of application of biostimulants on strawberry seedlings

Vegetation stage	Product	Consumption rate per 1 liter of solution	Recommendations
Growing seedlings	The stimulator of recovery from stress and increase of photosynthetic activity MC Cream	2.5 – 3 ml	Before the appearance of flowertrusses 1 time per week
During flowering	The flowering stimulator MC Set	2.5 – 3 ml	Was periodically sprayed until flowering
During berry filling	Benefit PZ + MC Cream	3 + 3 ml	Was sprayed twice, with an interval of 7 days, with the Benefit PZ + MC Cream stimulant

During flowering, a single spraying with the flowering and ovary formation stimulator MC Set was periodically carried out at the rate of 2.5-3 ml of the preparation per 1 liter of working solution. During the berry filling, the plants were sprayed twice, with an interval of 7 days, with the Benefit PZ stimulant, at the rate of 3 ml of Benefit PZ + 3 ml of MC Cream per 1 liter of working solution.

Stimulants based on phytohormones were actively used during the first wave of fruiting. The berries of the first harvest were large, bright red in color, weighing up to 30-45 g and with a sugar content of 8-11° on the Brix scale. During the second wave of fruiting, no stimulants were used, the average weight of the berry became smaller, within 22-30 g, the sugar content in the berry increased on the Brix scale – 11-16°.

The analysis of the first harvest showed that the strawberries are characteristically shaped, dense, bright red in color, with a strawberry flavor with notes of sweet caramel. The weight of the first-order berries was 30-45 grams, which is almost 50% more than the manufacturer stated. The sugar content in the berry on the Brix scale is 8-11°. The fifth-order berries were very small, weighing no more than 5 grams, with a Brix of 8-11°. Waves of fruiting were observed. During the second fruiting wave (180 days), phytohormone-based stimulants were not used. The average weight of the berry became smaller, the weight of the first-order berries was in the range of 22-30 g. The sugar content in the berry increased and amounted to 11-16° on the Brix scale. In total, during the fruiting period from June to November, an average of 647 grams of berries were obtained from 1 strawberry bush with a sugar content of 8-16° on the Brix scale.

4 Conclusions

1. The best substrate for growing strawberries from seeds is coconut substrate, which has a high moisture capacity, is a pure organic material, is characterized by optimal pH (5.5-6.5) and high buffering capacity, has good hydrophobic properties – it easily absorbs and gives plants a nutrient solution compatible with any substrates, does not injure the root system of seedlings. Coconut substrate is a porous material with high air permeability, which allows to achieve an optimal ratio of nutrient solution and air in the root zone of plants.

2. For growing Soraya F1 strawberry seedlings from seeds, the optimal light regime is 16 hours of artificial LED light and 8 hours of complete darkness per day (16/8), bright white light with a color temperature of 4000K. To maintain energy efficiency, use lamps consisting of LEDs with high light output of at least 150 Lm/W. For example, Samsung or Osram LEDs.

3. For growing Soraya F1 strawberry seedlings from seeds in hydroponics, the optimal mode of moisture supply and root feeding with watering the seedlings as the substrate dries, so that approximately 30% of the irrigation solution goes into the drainage. We recommend the electrical conductivity of the solution depending on the phase of strawberry cultivation: before picking – from 1.1 to 1.2 mS, after picking from 1.2 to 1.3 mS, flowering – from 1.3 to 1.4 mS, then increase the concentration to 1.5 to 1.6 mS, which corresponds to 100% of the concentration of the nutrient solution. We recommend using the following components for the nutrient solution for root dressing with irrigation: Calcium nitrate (Yara Calcinit), Potassium nitrate (potassium nitrate), Potassium monophosphate (MFP), Magnesium sulfate (pharmaceutical, in crystals), Valagro Master 13:40:13, Magnesium nitrate (magnesium nitrate), Brexil Combi+ (cocktail of trace elements). For different stages of strawberry ontogeny, we recommend using nutrition profiles modified by us by increasing nitrogen and phosphorus and decreasing calcium.

4. To activate growth processes, flowering and ovary formation when growing strawberry seedlings, we recommend using plant growth stimulants based on phytohormones from Valagro by spraying them: at the stage of growing seedlings MC Cream, during flowering MC Set, during berry filling Benefit PZ.

5. The analysis of the first harvest showed that the strawberries were characteristically shaped, dense, bright red in color, with a strawberry flavor with notes of sweet caramel. The weight of the first-order berries was 30-45 grams, which is almost 50% more than the manufacturer stated. The sugar content in the berry on the Brix scale is 8-11°. The fifth-order berries were very small, weighing no more than 5 grams, with a Brix of 8-11°.

Two waves of fruiting were observed. During the second wave of fruiting (180 days), phytohormone-based stimulants were not used. The average weight of the berry became smaller, the weight of the first-order berries was in the range of 22-30 g. The sugar content in the berry increased and amounted to 11-16° on the Brix scale. In total, during the fruiting period from June to November, an average of 647 grams of berries were obtained from 1 strawberry bush with a sugar content of 8-16° on the Brix scale.

6. A sample of strawberries of the Soraya F1 hybrid from the first wave of fruiting was analyzed in the laboratory of the State Enterprise «Odesa Standard Metrology» for physicochemical parameters, the presence of toxic substances, pesticides and mycotoxins. The test report confirmed that the sample meets all sanitary standards and requirements in force in our country, so we believe that the technology we have improved with elements of innovation in growing strawberries of the Soraya F1 hybrid from seeds can be recommended to agricultural producers and farmers engaged in strawberry cultivation.

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