IMPACTO CIENTÍFICO EDITORA

INITIAL DEVELOPMENT OF STRAWBERRY PLANTS (FRAGARIA × ANANASSA DUCH.) IN A HYDROPONIC SYSTEM IN THE COASTAL REGION OF THE STATE OF RIO GRANDE DO NORTE

DESENVOLVIMENTO INICIAL DE PLANTAS DE MORANGUEIRO (FRAGARIA X ANANASSA DUCH) EM SISTEMA HIDROPÔNICO NA REGIÃO LITORÂNEA DO ESTADO DO RIO GRANDE DO NORTE

DESARROLLO INICIAL DE PLANTAS DE FRESA (FRAGARIA × ANANASSA DUCH.) EN SISTEMA HIDROPÓNICO EN LA REGIÓN COSTERA DEL ESTADO DE RÍO GRANDE DEL NORTE

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ABSTRACT

The strawberry plant (*Fragaria x ananassa Duch*) is a crop not so much explored in Brazil, and its largest production is concentrated in the South and Southeast regions. In the Northeast region, the crop is not widespread and in the Rio Grande do Norte State the production is nearly nonexistent. The study was carried out at the Academic Unit Specialized in Agricultural Sciences, Jundiai Agricultural School, Federal University of Rio Grande do Norte, located in the county of Macaíba-RN and had the purpose of evaluating and monitoring the early growth of two neutral day strawberry cultivars (Albion and San Andreas) in hydroponic system using Nutrient Laminar Flow Technique – NFT, on what the mortality rate was the most relevant result, the San Andreas cultivar had the highest percentage, 20%, and Albion with the lowest percentage, 8,5% presenting the best result. In addition to the mortality rate, the San Andreas cultivar showed to be more susceptible to attack by pests and diseases, being the only cultivar to show attack by thrips, fungus and nutritional deficiency. In relation to the problems that occurred during the initial growth, the factors as worm attack and importation transportation conditions were the ones that most affected the initial growth of the seedlings and also caused injuries to them. In general, the seedlings presented good

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performance and a low mortality rate, of 14.4% in the initial development in the coastal region of the Rio Grande do Norte State.

Keywords: Cultivar. Hydroponics. Strawberry.

RESUMO

O morangueiro (*Fragaria x ananassa Duch*) é uma cultura pouco explorada no Brasil, onde sua maior produção se concentra nas regiões Sul e Sudeste. Na região Nordeste, a cultura é pouco difundida e no estado do Rio Grande do Norte a produção é quase inexistente. O trabalho foi realizado na Unidade Acadêmica Especializada em Ciências Agrárias, Escola Agrícola de Jundiaí, pertencente a Universidade Federal do Rio Grande do Norte, localizada no município de Macaíba – RN com o objetivo de avaliar o desenvolvimento inicial de duas cultivares de morangueiro de dia neutro (Albion e San Andreas) em sistema hidropônico NFT (Técnica de Fluxo Laminar de Nutrientes), sendo a taxa de mortalidade o resultado mais relevante, onde a cultivar San Andreas apresentou a maior porcentagem, 20%, e a Albion a menor porcentagem, 8,5%, e consequentemente o melhor resultado. A cultivar San Andreas mostrou-se mais suscetível ao ataque de pragas e doenças, sendo a única cultivar a apresentar ataque por tripes, fungo e deficiência nutricional. Quanto aos problemas que ocorreram durante o crescimento inicial, os fatores; ataque por lagarta e condições de transporte na importação foram os que mais afetaram o crescimento inicial das mudas e causaram injúrias nas mesmas. No geral, as mudas apresentaram um bom desempenho e uma baixa taxa de mortalidade, de 14,4%, em seu desenvolvimento inicial na região litorânea do estado do Rio Grande do Norte.

Palavras-chave: Cultivar. Hidroponia. Morango.

RESUMEN

El cultivo de la fresa (Fragaria × ananassa Duch.) es poco explorado en Brasil, donde su mayor producción se concentra en las regiones Sur y Sudeste. En la región Nordeste, el cultivo es poco difundido y en el estado de Rio Grande do Norte la producción es casi inexistente. El estudio se realizó en la Unidad Académica Especializada en Ciencias Agrarias, Escola Agrícola de Jundiaí, perteneciente a la Universidad Federal de Rio Grande do Norte, ubicada en el municipio de Macaíba–RN, con el objetivo de evaluar el desarrollo inicial de dos cultivares de fresa de día neutro (Albion y San Andreas) en un sistema hidropónico NFT (Técnica de Película de Nutrientes). El resultado más relevante fue la tasa de mortalidad, donde la cultivar San Andreas presentó el mayor porcentaje, 20%, y Albion el menor, 8,5%, mostrando así el mejor desempeño. La cultivar San Andreas se mostró más susceptible al ataque de plagas y enfermedades, siendo la única en presentar daños por trips, hongos y deficiencia nutricional. En cuanto a los problemas ocurridos durante el crecimiento inicial, los factores como el ataque de orugas y las condiciones de transporte durante la importación fueron los que más afectaron el desarrollo inicial de las plántulas y les ocasionaron lesiones. En general, las plántulas presentaron un buen desempeño y una baja tasa de mortalidad, de 14,4%, en su desarrollo inicial en la región costera del estado de Rio Grande do Norte.

Palabras clave: Cultivar. Hidroponía. Fresa.

1 INTRODUCTION

People are changing their eating habits in order to have a healthier life, which results in the search and demand for healthier foods, giving preference to those from organic production or cultivated with the rational use of pesticides (Costa, 2009).

The producer who cares about the next generations and wishes to remain in the production unit must seek the use of nutrient sources that do not cause environmental degradation, aiming at the preservation of the local fauna and flora (Pacheco and Silva, 2020).

Hydroponic systems encompass a set of techniques that do not use the soil for plant cultivation, having a fundamental importance for research, being widely used in commercial crops due to the various advantages provided by these techniques (Bezerra Neto and Barreto, 2012). For the authors, all plant species can be cultivated hydroponically, but, in agronomic and economic terms, the most suitable species for this type of cultivation are small ones, such as vegetables.

The cultivation of vegetables out of the ground, whether hydroponic or semi-hydroponic, has become a widely used option by producers, especially those who grow vegetables, presenting advantages such as high productivity and efficient use of water, with greater phytosanitary control, when compared to traditional systems. Therefore, off-ground cultivation is an alternative to be increasingly explored, either because of its adaptation to marginal areas, or because of the more efficient use of water, allowing the use of brackish and reused water, or because it results in better phytosanitary control (Sausen et al., 2020).

The strawberry tree (*Fragaria* x *ananassa* Duch.) is a plant belonging to the rosaceae family, native to the temperate regions of Europe and the Americas. The species of strawberry currently produced for commercial purposes is a natural hybrid, resulting from a chance cross between two American species brought to France. The strawberry is a pseudofruit as it originates from a single flower with multiple ovaries. The development of each ovary produces a fruit. Each of the small dark spots of the strawberry (popularly called seeds) is scientifically known as an achene, which is actually the true fruit (Antunes et al., 2011).

In Brazil, strawberry cultivation plays an important socioeconomic role. In addition to being present in several states, it is usually developed in small properties, with the need for a large amount of labor throughout its cycle (Gouvea et al., 2009).

The cultivation of strawberry is extremely important as a diversification of income in rural properties, with a preponderant scope in family farming. In the classification of small fruits, it is the species with the highest expression in cultivated area and volume produced (Carvalho, 2011).

In Brazil, strawberry is cultivated in various forms: in the ground, with or without plastic cover, in low tunnels or in greenhouses, or in the hydroponic system, with or without substrate (Bortolozzo et al., 2007). As strawberry is one of the vegetables in which pesticides are most applied, cultivation in an NTF hydroponic system (laminar flow of nutrients technique) reduces the use of agrochemicals and is already a well-known and used technique in Brazil, in which plants are kept in channels of corrugated sheets of asbestos cement (tiles) or PVC or polypropylene pipes. through which the nutrient solution circulates. The plant develops with two-thirds of its root system submerged in nutrient solution supplied to the plant in the form of an intermittent flow, from which it extracts nutrients, while the remaining portion of the root system develops outdoors for oxygen absorption (Furlani and Júnior. 2004).

According to Antunes et al. (2020), with the technological advances recorded in recent decades, consumers can find strawberries in the market at any time of the year.

The cultivars indicated for cultivation outside the soil are those belonging to the group of neutral days, which are defined as such due to their insensitivity to photoperiod variations. The cultivars in this group have the ability to produce quality fruits throughout the year and even for two consecutive years, allowing producers to obtain a greater economic return (Gonçalves et al., 2016).

Because it is a vegetable in which its fruits are rich in vitamin C, they have high acceptance and demand in the market and its cultivation can be carried out in regions of higher temperatures, the basis for the realization of the present work, which was to analyze the initial development of strawberry plants in a hydroponic system NFT (Laminar Nutrient Flow Technique) in a coastal region of Rio Grande do Norte.

2 MATERIAL AND METHODS

The work was carried out at the Academic Unit specialized in Agricultural Sciences of the Agricultural School of Jundiaí – EAJ/UFRN, located in the municipality of Macaíba (Geographic coordinates of 5º53'02" south latitude and 35º21'53" west longitude). The municipality is located in the coastal region of the State of Rio Grande do Norte, with an altitude of 26 m, a tropical rainy climate, average relative humidity of about 76% and an average temperature of 27.1ºC with maximum and minimum values of 32.0ºC and 21.0ºC, respectively. (IDEMA, 2013).

The experiment was conducted in an oven with a polyethylene cover, which has treatment against ultraviolet rays and a thickness of 150 microns, and the side is closed with a 30% white screen. The cultivation system used was the active hydroponic NFT (Laminar Nutrient Flow Technique), without using the soil, consisting of a bench with a height of 1.0 m

and six rows (channels); each row 0.20 m apart and the plants spaced 0.20 m apart. The crop implemented was strawberry, which in an NFT hydroponic system the roots are completely inside the channels and are nourished by the nutrient solution slide that passes through them.

The seedlings were acquired in the state of São Paulo, Brazil, from two day-neutral cultivars, the San Andreas cultivar and the Albion cultivar. The seedlings were sent to the Aluízio Alves airport located in São Gonçalo do Amarante - RN, packed in Styrofoam boxes and sealed with plastic, thus preserving the temperature, since the plants were subjected to cooling. The next day they were taken to the Agricultural School of Jundiaí and immediately taken to the greenhouse. The seedlings came grouped with the use of alloys, with 10 plants on average, and there may be one or two more in each package. As the plants contained many roots, they were trimmed with the use of pruning pliers, as well as the necrotic parts or in the initial state of necrosis to then be implanted in the channels (Figure 1).

Figure 1

Thinning of seedling roots and implantation in the gutters

(a) (b)

The water used is classified as C1S1 (low salinity and low sodium content), coming from the dam located in the area of the Agricultural School of Jundiaí and stored in a reservoir with a capacity of 2,000 liters, and this supplies water to a smaller reservoir containing 1,000 liters of water, where the base fertilizer was added, this being the nutrient solution used,

conducted to the channels through a centrifugal pump with 1/2 Cv (half horsepower). For the fertilization of strawberry plants, soluble fertilizer was regularly added to the reservoir according to the nutritional needs of the plants; obtained from the measurement of electrical conductivity (EC) carried out through a digital conductivity meter with values maintained between 1.2 and 1.5 dS/m.

The water-soluble nutrients present in the fertilizer are: nitrogen (65.0 g/L), iron (1.3 g/L) and calcium (78.0 g/L); the density is 1.3 g/ml; salt index: 39%; electrical conductivity: 0.1% - 0.8 mS/cm; pH: 4.8; raw materials: nitcal, FFM itself and iron chelate.

To control the application of the nutrient solution, a time regulator was installed so that the pump would be in operation during the day, at 15-minute intervals and stopped for 60 minutes and at night four 15-minute irrigations at 3-hour intervals. According to the literature, irrigation time varies greatly between systems, benches, regions, types of cover, cultivated variety and time of year. After planting, as the plants grow, the first flowers should be thinned until the plants have at least five leaves. Stolons and old leaves or those that show symptoms of disease should also be periodically removed.

For analysis, 97 seedlings were used, all implanted on the same date and on the same bench; 47 of the Albion cultivar and 50 of the San Andreas cultivar, arranged in three rows on the same side of the benches. A brush demarcation was made in the gutters regarding the arrangement and numbering of the seedlings of each cultivar. Each plant received a number according to its location in the gutter.

The following parameters were evaluated: live and dead plants; plants attacked by pests or diseases; plants with nutritional deficiency; plants that had flowers; and finally the mortality rate, calculated through the number of dead plants multiplied by 100 and divided by the number of live plants, being the result in percentage (%).

3 RESULTS AND DISCUSSION

A total of 47 seedlings of the Albion cultivar and 50 seedlings of the San Andreas cultivar were evaluated, as shown in Figures 2.1 and 2.2. The EC value, measured immediately after fertilization, was maintained as a standard value equal to 1.4 dS/m, indicated for the strawberry crop. After seventeen days, the total number of dead plants, plants with pest or disease attack, nutritional deficiency, total number of flowers per plant were evaluated, and thinning them were performed.

Figure 2

Distribution of seedlings of the Albion (A) and San Andreas (SA) varieties on the benches

(1)

A 1	The 32	The 33
A 2	The 31st	The 34
The 3	At 30	A 35
The 4	The 29	The 36
The 5th	The 28	The 37
The 6	The 27	The 38
The 7	The 26	The 39
The 8	The 25	At 40
A 9	At 24	The 41
The 10	The 23	A 42
The 11	The 22	A 43
The 12	The 21st	The 44
The 13th	At 20	A 45
The 14	The 19	The 46
The 15th	The 18	The 47
The 16th	The 17	

(2)

SA 1	SA 34	SA 35
SA 2	SA 33	SA 36
SA 3	SA 32	SA 37
SA 4	SA 31	SA 38
SA 5	SA 30	SA 39
SA 6	SA 29	SA 40
SA 7	SA 28	SA 41
SA 8	SA 27	SA 42
SA 9	SA 26	SA 43
SA 10	SA 25	SA 44
SA 11	SA 24	SA 45
SA 12	SA 23	SA 46
SA 13	SA 22	SA 47
SA 14	SA 21	SA 48
SA 15	SA 20	SA 49
SA 16	SA 19	SA 50
SA 17	SA 18	

According to Figure 2.1, referring to the Albion cultivar, four dead plants were identified, represented by the dark green color and identified as A8, A16, A20 and A37. There was a caterpillar attack on plant A8, and the other three did not resist the injuries they went through before being implanted in the greenhouse. Plants A13 and A29 suffered caterpillar attacks while plant A33 represented in the Figure in red, apparently very vigorous and developed, contained three well-developed flowers, it was necessary to thin them because the plant did not yet have a well-developed structure to support the fruits.

In the analysis carried out in the gutters with the seedlings of the San Andreas cultivar, Figure 2.2, a total of 10 dead plants were detected, represented in dark green, namely: SA1, SA20, SA22, SA32, SA33, SA37, SA39, SA46, SA49 and SA50; the SA20 plant was diagnosed with caterpillar attack and the others were unable to recover from the injuries they had previously suffered. The SA2 plant presented very yellowish leaves, with symptoms of nutritional deficiency, represented in the figure in yellow, while the SA3 and SA38 plants, represented in violet, presented injuries caused by caterpillar and thrips and the SA4 plant, represented by the blue color, by fungus. Plants SA8, SA9, SA14, SA34, SA40 and SA43 showed injuries due to caterpillar attack. Plants SA15 and SA18 showed flowers, and two flowers were thinned on SA15 and one on SA18; with emphasis on red color.

Figure 2 shows the situation of the seedlings; where it is perceived that in addition to the injuries caused by the travel time and conditions of the transport of the seedlings, the incidence of pests, especially the attack by caterpillar, were the two factors that most affected the performance and caused the death of the seedlings.

Henz (2010), through a survey carried out in 2009 with strawberry producers in the Federal District, cites the main difficulties encountered by producers in order of importance, with a total of five, where the incidence of pests and diseases is in first place and in second place the acquisition of seedlings. For the two problems mentioned, the author suggests: "local production of seedlings with sanitary quality and adequate cost, to minimize dependence on propagative material from other states".

Gomes et al. (2013), in a similar research carried out in the Federal District, concluded that there are two main problems in strawberry production in the region, and one of them is the lack of local production of seedlings, which increases the cost of the inputs.

The two works cited demonstrate the reality of strawberry production in a certain region of the country, which is the Midwest. As much as the country is very large in territorial area with enormous differences in each region, the main problems reported in the Federal District were the same as those that occurred in the present work: mandatory importation of seedlings and incidence of pests and diseases.

The greenhouse used for the implementation of the experiment had ruptures in the protective screen, which caused the problems with pests, especially with caterpillars. To avoid problems with pests, an inspection of the greenhouse should be carried out to detect ruptures in the protective screen, and if they are detected, they should be obstructed so that pests do not gain access to the plantation. If carelessness occurs and butterflies are present, they must be eliminated, and later if there is the presence of caterpillars, as it is a cultivation in a hydroponic system, their manual removal becomes feasible and efficient.

Comparing the problems identified in the present study with the problems described in the two studies carried out in the Federal District, the one that most affected the initial development of the seedlings was the importation of seedlings. Although a low number of dead plants was presented, as previously reported, the plants had several dead parts and few green leaves when they were transplanted, this is due to the fact that the seedlings were brought from another state, stored in a Styrofoam box, resulting in injuries to the seedlings, and were unable to absorb nutrients and water, as well as without contact with sunlight, making it impossible to carry out photosynthesis, which is fundamental for the development of plants.

Table 1 shows the number of live and dead plants of the Albion and San Andreas cultivars, the total number of cultivars and the mortality rate of each one. The San Andreas cultivar had more than twice as many dead plants compared to the Albion cultivar, this time the mortality rate follows the same pattern, with the San Andreas cultivar presenting a higher percentage of dead plants than the Albion cultivar, equal to 20%. As for the sum of the two cultivars, the number of live plants was much higher than the number of dead plants, presenting a mortality rate of about 14.4%.

Table 1

Total of live and dead cultivars and percentage of mortality

Cultivate	Total	Live	Dead	Mortality (%)
SA	50	40	10	20
The	47	43	4	8,5
SA+A	97	83	14	14,4

Figure 3

Total cultivars, live plants and dead plants

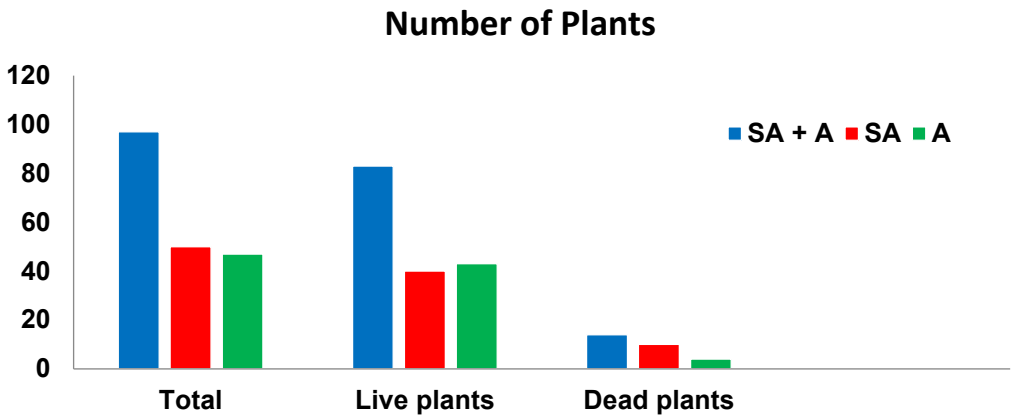

Figure 3 is a graphic representation of the results shown in table 1, and reinforces that the San Andreas cultivar presented the highest number of dead plants, with a total of ten dead plants. Consequently, the Albion cultivar presented the best result, with only four dead plants. With the sum of the two cultivars, of the total of 97 plants, 14 plants died.

Cocco (2014), evaluating the production and quality of strawberry seedlings and fruits in a conventional cultivation system, using two short-day cultivars, Camarosa and Camino Real, after 20 days of planting, obtained results regarding mortality rate higher than those obtained in the present study, being 26.0% for the cultivar Camarosa and 30.2% for Camino Real. Comparing the author's results with those obtained in the present study, they presented better results in terms of mortality rate.

In order to avoid such a large amount of injuries and reduce expenses in the acquisition of seedlings, it would be important for the producer to form his own seedlings in the following productions or in the increase of production, giving more adaptability to the seedlings and reducing the costs of the following productions.

4 FINAL CONSIDERATIONS

Through the monitoring and evaluation of the two cultivars, it was found that the San Andreas cultivar was more susceptible to attacks, mainly by caterpillars, as well as being the only cultivar to present attack by thrips, fungus and nutritional deficiency, presenting the highest mortality rate. The Albion cultivar showed better results, with a lower mortality rate, as well as less attack by pests and diseases.

The implementation of strawberry cultivation on the coast of Rio Grande do Norte has great potential and a huge chance of success, especially with the use of the Albion cultivar, where the NFT hydroponic system in a protected environment has many advantages for strawberry plants. It is worth noting that it is essential that other work is carried out to evaluate the performance of plants at a more advanced stage, as well as productivity and economic viability.

REFERENCES

Antunes, L. E. C., Bonow, S., & Reisser Júnior, C. (2020). Morango: crescimento constante em área de produção. Campo & Negócio. Anuário HF 2020.

Antunes, L. E. C., Carvalho, G. L., & Santos, A. M. dos. (2011). A cultura do morango (2a ed. rev. e ampl.). Embrapa Informação Tecnológica. (Coleção Plantar, 68)

Bezerra Neto, E., & Barreto, L. P. (2011/2012). As técnicas de hidroponia. Anais da Academia Pernambucana de Ciência Agronômica, 8 e 9, 107-137.

Bortolozzo, A. R., & et al. (2007). Produção de morangos no sistema semi-hidropônico (Circular Técnica 62). Embrapa.

Carvalho, S. P. de. (2011). História e evolução da cultura do morangueiro no Brasil nos últimos 50 anos. Horticultura Brasileira, 29(2).

Cocco, C., Gonçalves, M. A., & Antunes, L. E. C. (2013). Morango: como podar. Revista Cultivar Hortaliças e Frutas, (80).

Costa, F. B. da. (2009). Fisiologia e conservação de cultivares de morangos inteiros e minimamente processados [Tese de doutorado, Universidade Federal de Viçosa]. https://www.locus.ufv.br/bitstream/123456789/972/1/texto%20completo.pdf

Furlani, P. R., & Júnior, F. F. (2004). Cultivo hidropônico de morango em ambiente protegido. In Palestras do II Simpósio Nacional do Morango (I Encontro de Pequenas Frutas e Frutas Nativas do Mercosul). Embrapa Clima Temperado.

Gomes, K. B. P., & et al. (2013). Diagnóstico da cadeia produtiva do morango dos agricultores familiares do Distrito Federal. Revista Eixo, 2(2), 3-12.

Gonçalves, M. A., & et al. (2016). Produção de morango fora do solo (Documentos / Embrapa Clima Temperado). Embrapa Clima Temperado.

Gouvea, A., Kuhn, O. J., Mazaro, S. M., Mio, L. L. M., Deschamps, C., Biasi, L. A., & Fonseca, V. C. (2009). Controle de doenças foliares e de flores e qualidade pós-colheita do morangueiro tratado com Saccharomyces cerevisiae. Horticultura Brasileira, 27(4), 527-533.

Henz, G. P. (2010). Desafios enfrentados por agricultores familiares na produção de morango no Distrito Federal. Horticultura Brasileira, 28(3), 260-265.

Instituto de Desenvolvimento Sustentável e Meio Ambiente do Rio Grande do Norte. (2013). IDEMA.

Pacheco, H. R., & Silva, M. J. F. (2020). Produção de tomate em estufa de forma sustentável. Cadernos de Agroecologia, 15(2).

Sausen, D., & et al. (2020). Cultivo fora do solo: uma alternativa para áreas marginais. Brazilian Journal of Development, 6(3), 14888-14903.