



GROWING BASIL IN AQUAPONICS

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Abstract

In recent years, certain work has been carried out in Uzbekistan to introduce resource-saving technologies in the cultivation of agricultural products, as well as to provide agricultural producers with modern equipment.

However, not only in Uzbekistan, but also as a result of climate change in the world, that is, various natural disasters (drought, warming of the aerial part, floods, heavy rainfall, etc.) bring great losses to crops and land. As a result, agriculture causes a decrease in the fertility of land and a violation of their structure.

Thus, it is necessary to develop land plots not used in agricultural land (stony, sandy, etc.), in particular, the introduction of innovative and resource-saving technologies into production.

These innovative and resource-saving technologies, that is, are the direction of aquaponics - the method of hydroponics. In the aquaponics method, plants are grown without a substrate in various capacious containers, into which an aqueous solution of mineral salts is poured. Plant roots are soaked in a nutrient solution.

At present, the cultivation of agricultural products by the aquaponic method is carried out in countries such as Europe, the United States, Canada, Japan, South Korea, China, where agriculture developed. In these countries, the aquaponic method is given great attention today and as an innovative technology of the future to accelerate the cultivation of agricultural products.

Therefore, in Uzbekistan, the introduction of the aquaponic method in the cultivation of vegetable crops requires the development of scientific foundations, in particular, taking into account the climatic conditions of the republic.

Introduction

The experience of world science, as well as the implementation of the production of their results, shows that, with the right combination of vegetable growing in protected and open ground, it is possible to achieve the same intensity of the production process throughout the year, which makes it possible to equalize the need for labor and the flow of the crop.





At the same time, practice has proven the introduction of innovative or advanced growing technologies gives its high efficiency in the production of vegetable products. Uzbekistan is characterized by a large influx of solar radiation, which provides sufficient lighting for 10 months a year. This creates good conditions for growing vegetables in open and protected ground at a lower cost.

According to world forecasts, in the third millennium crop production in developed countries will move under protected ground. The reason for this is called climate change, various natural disasters and lack of land resources.

Therefore, the world is conducting extensive research work on growing crops not by traditional methods, but on the basis of innovative technologies.

Therefore, the most important way to increase the production of agricultural products, improve their quality, reduce the cost of their production is the use of new energy-saving growing technologies and the creation of a modern scientific and technical base.

One such technology is low-volume hydroponics. Growing on low-volume substrates has become more and more widespread in the world in the last decade. In the Scandinavian countries, more than 80% of the greenhouse area is occupied by this technology, in the Netherlands - more than 50%. This technology is replacing the old ways of growing, both in subtropical and tropical areas of the globe.

In this regard, the world is conducting extensive research work on growing crops using non-traditional methods, but based on innovative technologies.

In many countries of the world in the twentieth century, research work was carried out on the cultivation of crops, in particular vegetable crops, using the hydroponic method (in particular, aquaponics) by such prominent scientists as: M. Bohme, A.J. Cooper, T. Goes, S.H. Lips, E.H. Salzer, T. Syrowatka, V.A. Chesnokov, E.N. Badyrina, I.G. Murasha, S.F. Vashchenko, N.I. Chekunova, D.D. Krylova, I.G. Murash, L.A. Bondarenko, Yu.M. Boremov, S.F. Vashchenko, M.V. Avdeev, P.M. Trushin, E.A. Aliev, N.A. Smirnov, I.G. Ivanov, V.V. Klimov, E.M. Basarygina, R.I. Panova, E.A. Ameen, Yu.A. Dyukarev, B.V. Latenko.

Aquaponics is a new high-tech agricultural technology that combines both the cultivation of plant products and the production of fish products.

The development of this technology for growing vegetables can significantly reduce the cost of obtaining fresh vegetables in open ground in all seasons, which will positively affect the health of the population.

Although the term "aquaponics" appeared not so long ago, the obvious advantages of co-cultivation of vegetation and freshwater animals were noticed by the ancients and



used for hundreds of decades: a valuable food product - an aquatic inhabitant, not only fertilizes the water by its vital activity, but also helps to fight pests and weeds. For example, for more than two millennia there has been a practice of growing fish in rice fields in Southeast Asia, this is the so-called rice-fish farm - a combined farm in which a paddy field flooded with water is simultaneously used to grow rice and fish. The complex method of land use has been used since ancient times in China, Japan, India, Indonesia, Vietnam, the island of Taiwan, as well as in the countries of South America.

Modern aquaponics is rightly considered a variety of hydroponics, the history of which begins with the experiments of the Dutchman I.V. Gelmont in the first decade of the 17th century, who proved that plants can be grown without soil, properly preparing water. Numerous observations have shown that the water used to grow plants using the hydroponic method is self-purifying, that is, the substances dissolved in it are absorbed by the root system.

Under the conditions of an aquaponic installation, additional water purification takes place due to the direct absorption and assimilation of nitrogen ions by plant roots. For aquaponic cultivation, the same plant species are used as for hydroponic cultivation: vegetables, herbs, strawberries, etc. These installations are environmentally sound. For example, they are especially beneficial when water and soil are scarce, which are essential for traditional agriculture.

Water is a valuable commodity in developing countries; and in aquaponics, most of the water used is returned to the system, resulting in much less water being consumed than traditional agriculture.

Undoubtedly, in conditions of water scarcity and land degradation, this way of growing plants is the future of agriculture. Unfortunately, such an ancient way of farming has found wide application only in a few countries in Europe and in the United States.

Therefore, in the development of agriculture in Uzbekistan, especially taking into account its climatic conditions, it is necessary to provide a scientific justification for the introduction of innovative technology - aquaponics in production.

Methods

In the experiments, the optimal concentrations of macro- and microelements in the nutrient solution were determined during the vegetation of plants. To clarify the composition and ratio of nutrients in the solution, the removal of the main nutrients by plants - N, P, K, Ca, Mg and other microelements were studied.





Results and Discussion

Basil cultivation averaged 2.0 kg/m² per crop. Some mortality was observed after each harvest, and the final survival rate was 84.7%. Harvesting by pruning weakened the plants, and their roots became infected with *Pythia*. Until the first harvest, the roots seemed healthy. There were no signs of nutrient deficiencies during the initial harvests. However, by the fourth crop, nutrient deficiencies were evident, especially in the second hydroponic tank of each set, indicating that some nutrients became limiting as the water traveled a distance of 61m through each set of two hydroponic tanks. Deficiency manifested itself in the form of chlorosis (yellowing) of the leaves. Initially there was a large reservoir of nutrients and no deficiencies appeared at the start of the trial. However, nutrient depletion occurred during the cultivation of four consecutive batches of basil. During this period, the ratio between the daily intake of feed and the area of crop production was 81.4 g/day/m². Basil cultivation has exceeded the nutritional capacity of the system. Therefore, the farming system was changed to staged cultivation for moderate nutrient absorption.

In a phased production trial, the plants were cut once and allowed to grow back for a final second crop. Cultivation was twice as high in the second crop (2.4 kg/m²) than in the first crop (1.2 kg/m²). The average weight of the plant was 167.1 gr. in the first harvest compared to 327.1 gr. in the second harvest. Basil showed slow growth after transplanting while it was rooting. Shearing stimulated branching and re-growth was faster. After eight harvests, there were no signs of nutritional deficiencies. The ratio between daily feed intake and growing area was 99.6 g/day/m², which is 22% higher than in the periodic test.

Growing basil outdoors resulted in significantly lower yields (0.6kg/m²) and average weight (104.4g) compared to aquaponics, but a survival rate of 100%. As with gradual growing, the plants grew slowly after transplanting and achieved an average yield and plant weight of only 0.3 kg/m² and 49.8 g. at the first harvest. The yield and weight of the plant decreased to 1.0 kg/m² and 159.1 g. for the second harvest.

A comparison of all three farming systems showed that growing basil in the aquaponic system was comparable, and was about three times more productive than field growing (Table 1). The annual predicted yield of the growing methods was 25.0, 23.4 and 7.8 kg/m². The annual predicted yield of the system was 5341 kg for aqua panic growing and 5008 kg for hydroponic growing.





Table 1. Comparison of Basil Yield, Average Plant Weight, Survival with Three Growing Methods (2021)

Growing method	Annual yield (kg/m ²)	Annual output (kg/m ²)	Average plant weight (g)	Survival rate (%)
Aquaponics	25,0	5,341	286,5	84,7
Hydroponics	23,4	5,008	244,7	-
Open ground	7,8	1,669	104,4	100

Water quality is the test of a basilica. TAN and nitrite-N concentrations remained within safe limits for fish farming (Table 2). Nutrient concentrations were lower than levels typically found in hydroponic systems, but they were generally acceptable in aquaponic systems as nutrients were produced daily, excreted directly by fish, or formed from the mineralization of organic matter. The slow removal of solids from the clarifiers and filter tanks provides sufficient time for substantial mineralization. In addition to removing fine solids, the microorganisms in the filter tank also remove dissolved organic matter, preventing it from inducing microbial overgrowth on plant roots.

Table 2. Means Values and Ranges of Water Quality Variables During Basil Production Tests (mg/L)

Variables	Hydroponics	Aquaponics
pH	7,4 (7,0-7,6)	7,1 (6,9-7,3)
total-ammonia-N	2,2 (1,6-2,9)	1,7 (1,1-2,4)
Nitrite-N	0,7 (0,4-1,1)	0,9 (0,5-1,1)
Nitrate-N	42,2 (26,7-54,7)	42,9 (30,9-51,8)
Total Dissolved Solids	532 (490-560)	550 (490-560)
Alc. (mg/L as CaCO ₃)	113,2 (65,6-206,7)	88,6 (65,6-115,6)

In this aquaponic system, the water takes on a tea color due to the accumulation of refractory organic compounds (eg tannic acid), but suspended solids levels are generally low (<10 mg/l) and the water remains clear. These characteristics have been demonstrated in all previous lettuce trials. With basil, the water became cloudy and DO levels in grow tanks dropped to a range of 4.0 to 5.0 mg/L. In previous trials of lettuce, DO concentrations have ranged from 5.0 to 6.0 mg/L in grow tanks.

pH was maintained at an average value of 7.1 to 7.4 (table 2). This value is considered high for a hydroponic system, but in an aquaponic system, the pH must be maintained above 7.0 to promote nitrification. Fish excrete large amounts of ammonia, which must be oxidized to nitrate to prevent toxicity. Nitrification produces acid and the pH



drops daily. To raise the pH from the start of the first test to the end of the second test, including the intertest period, 22.5 kg $\text{Ca}(\text{OH})_2$ was added in 23 doses and 21.5 kg KOH was added in 22 doses. Based on these data, the system will require 40.65 kg of $\text{Ca}(\text{OH})_2$ and 38.85 kg of KOH annually. In addition to pH regulation, base supplements Ca and K which are not formed in sufficient amounts from fish food for good plant growth in aquaponic systems. During the same period, 18.17 kg of iron chelate (13%) was added to the system in eight doses. The annual projected iron requirement for the system is 32.83 kg. All other essential nutrients came from fish waste.

Daily make-up water averaged 2.61 m³ or 2.4% of the system volume. The loss of water was attributed to sediment removal, screen filter washing, splashing, evaporation and transpiration.

Conclusions

Batch and staged cultivation of basil gave comparable yields, but growing all plants in the same phase led to nutrient depletion in the culture water and nutrient deficiency disorders in basil.

In staged production, the high nutrient requirements of plants in the final stages of growth were balanced by the lower nutrient requirements of plants in the early stages of growth, thereby curbing nutrient uptake and avoiding nutrient depletion.

Additional research may determine the optimal feeding ratio for staged basil cultivation and the advisability of intermittent basil cultivation at a higher feeding ratio. Based on this experiment, it is recommended to use staged growing technology in aquaponic systems, especially for crops such as lettuce and basil.

Aquaponic System - This is the ideal system for areas with limited resources such as water or flat land. It also performs well in temperate climates in environmentally controlled greenhouses. Future studies will determine the production capacity of a wide range of vegetables, herbs and flowers, improve system performance, evaluate less expensive building materials and methods, and determine the economics of various crops.

References

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