



## A STUDY OF THE ASPARAG PLANT AND ITS BIOLOGICAL-ECONOMIC AND CULTIVATION CHARACTERISTICS

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### SUMMARY

There are 300 species of asparagus (*Asparagus L.*) in the world, and 9 species are widespread in the wild flora of Azerbaijan. Among these species, medicinal asparagus (*Asparagus officinalis L.*) and asparagus (*A. Vertisillatus L.*) are still harvested from wild flora as vegetables and medicinal plants. As a cultivated plant, there are only collections and small experimental plantations exist.

This valuable plant, which is cultivated in large areas in European and American countries, has not yet reached larger areas and not recognized as industrial crops in Azerbaijan. The main reason for this is that the population has little knowledge about asparagus (doesn't know its importance and possibilities of use), late harvest (after 3-4 years), low productivity, and it is difficult to cultivate and expensive.

The article covers the issues like the importance of medicinal asparagus (*Asparagus officinalis*) in increasing the variety of vegetables, its potential uses as a valuable vegetable plant, its importance as a profitable export product, as well as, as an important medicinal and beautiful ornamental plant, the year-by-year increase in asparagus production and its cultivated areas in different areas of the world. The article provides the results of carried out scientific researches in this field.

In the conducted scientific research, in order to study the cultivation technology of the multi-stem Q2 cultivar sample obtained as a result of multiple mass improvement selections of the medicinal asparagus variety *Argenteylskaya rannyaya* of American origin in accordance with local conditions, research works were carried out in the directions of intensification of seedling cultivation and research of planting schemes of asparagus (Q-2).

During the research, it was determined that with the application of intensive technology, seedlings can be prepared in 70-80 days instead 180-185 days, by sowing the seeds under tunnel-type small-sized polyethylene curtain covers on 1<sup>st</sup> of February and transplanting the seedlings to their permanent place on 25-30<sup>th</sup> of April, resulting in shortening the period of growing by 1 year.

Among the planting schemes of the Q-2 variety sample (90+50): the 2x35cm planting scheme has a number of advantages, such as the two-row tape method, which allows to reduce the cost of the crop and to accelerate the ripening of the crop by 1-1.5 months by easily placing the plants in curtain covers and to get more income.

**Keywords:** asparagus, cultivation methods, seedling method, propagation method, planting schemes, intensive technology

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### Introduction

A significant part of human nutrition is fruit and vegetable products. Their composition is rich in nutritious, tasty and aromatic substances, which are of great importance for proper nutrition. During feeding, they improve digestion by increasing the secretion of gastric juice and help to fully absorb food, as well as to protect the acid-alkaline balance in the body. Scientific studies have shown that human plant products contain more than 60 substances important to the body, especially water carbons, proteins, fats, vitamins,

mineral substances, acids, enzymes, aromatic substances, specific healing substances, etc. These substances are not stored in the human body; they are used for everyday physiological processes. Therefore, vegetables should be consumed by people in the amount of 300-400 g (in some sources 500 g) every day throughout the year, so that in modern conditions, in order to meet the needs of the population for high-quality vegetable products, it is necessary not only to produce a certain amount, but also to expand the variety of cultivated plants. Because each type of vegetable

plant taken alone contains only a few types of beneficial substances.

About 240 types of vegetable plants in the world, and 30-140 types are used in separate countries. In Azerbaijan, 40 types of cultivated vegetable plants and a number of wild vegetable plants are used. Therefore, there is a need to increase the varieties of cultivated vegetables. In most cases, the total vegetable harvest is provided by a few productive species (tomatoes, cabbage, cucumbers, onions, carrots, beets, watermelons, etc.), all other species are considered less common and less produced (1, 2, 3).

Vegetables are an integral part of human nutrition. This is due to the richness of its composition with various substances (hydrocarbons, proteins, fats, vitamins, mineral salts, organic acids, etc.). Thus, potatoes contain 13-20% of starch, 12% of inulin in potatoes, 8-12% of vegetables such as watermelon, beets, carrots, beets, and 2-7% of sugar in most other types of vegetables (3, 16).

While vegetable products are rich in carbohydrates, they are low in proteins and fats. These oils are not edible fatty oils, but mainly in the form of aromatic essential oils, and their amount in the vegetable is very small (0.2-0.3%). These oils in vegetables are not edible oil, but are composed of fragrant, volatile essential oils (menthol, euganol, anethole, linneloleol, etc.), and although they are important, they are not a source of calories (17).

Blue beans, green peas, green beans (4-6%), mushrooms (1.9-4%), asparagus (up to 3.5-4%) are considered as high-protein vegetables. Spinach contains up to 2.5% protein, potatoes up to 2%, cabbage, savoy cabbage and Brussels sprouts up to 2.5-4.6% protein. Other vegetables contain less protein (18, 19, 20).

In our republic, the main blue bean is cultivated as a protein vegetable plant. Its crop ripens the earliest in June and is quickly harvested. Common beans can be sown again in the summer and harvested in the fall. Asparagus, which has a rich chemical composition, is a perennial, cold-resistant plant, so its harvest begins 2 months before beans and lasts until June. However, long-term maintenance of the common bean plant during two cultivations, high seeding rate per hectare (70-150 kg), low productivity per hectare, and low multiplication factor (8-10) significantly reduce the economic efficiency of beans. Although climbing bean varieties produce slightly more, they require 20-30 thousand stakes per hectare. Thus, year-round mung bean production is a difficult challenge. However, if we have grown asparagus during the absence of this plant product (until June) by making maximum use of

the beans, then in one vegetation, we can provide the population with protein vegetables by harvesting first asparagus and then 2 times beans. However, this plant, which is of special importance in world vegetable farming and is cultivated in large areas, is still collected and used from wild flora. As a cultivated plant, there are only collections and small experimental plantations.

Asparagus genus (*Asparagus* L.) belonging to the Asparagaceae family (*Asparagaceae* Juss.) has 300 species, 10 species are found in the Caucasus, and 9 species are found in Azerbaijan. Some of these species are used as food (*A. officinalis*, *A. verticillatus* L., etc.), ornamental plants (*A. asparagoides*, *A. medeloides*, *A. plumosus*, *A. sandens*, *A. setaceus*, *A. sprengeri*) and medicine (mainly *A. officinalis*) (6, 7, 8, 15).

Compared to other vegetables, asparagus has a low energy value of 23-26 kcal/100 g or 80-84 c/100 g, but it has a rich chemical composition. The main value of the plant is due to the fact that it has a number of compounds (especially carbohydrates and proteins) that have healing properties and can be easily absorbed by the body. Asparagine, which is an irreplaceable amino acid included in the composition of animal and plant proteins, regulates water-salt exchange in the human body, was obtained from asparagus for the first time [9].

The amount of asparagine in young chickpeas is 0.04%, and it is synthesized in larger amounts when chickpeas grow in dark conditions. The chemical composition of asparagus depends on the growing conditions, the amount of dry matter can vary between 6.3-10.8%, sugar - 1.1-4.6%, protein - 2.0-3.3% [10]. It was determined that the biochemical composition of asparagus varies significantly, not depending on the age of the plants, but depending on the characteristics of the variety, the harvesting method and time of the shoots. Culpepper C.W. and according to H. H. Moon [11], the highest sugar content (4.1%) is collected at the base of the pod and the lowest (1.74%) at the tip of the pod.

Asparagus is a valuable vegetable plant, canned products from its fresh, sweated stalks, various vegetables, mushrooms, fish, chicken, sausages, etc. salads and dishes are prepared together with In European countries, it is used fresh, frozen, canned and dried for the purposes mentioned above.

In Azerbaijan, asparagus is boiled in water and fried in oil (with onions). Eggs are added to the

asparagus roast to make it more nutritious. A small amount of asparagus is eaten as a snack by quickly cooking it in hot ashes, in the oven, on an ordinary hot iron, or by boiling it in water.

Asparagus is also a promising dietary and medicinal plant that can actively influence metabolic processes in the body, prevent or restore their disorders.

So, salads and soups made from it are recommended for liver, kidney, gout, diabetes, edema diseases and as a means of increasing appetite. Due to the high content of asparagine, asparagus stalks have a positive effect on the work of the heart, lower blood pressure and improve the functioning of the kidneys.

At present, asparagus is successfully used in the treatment of many diseases worldwide in the field of phytotherapy. Thus, the root, rhizome, fresh pods, stem, needle-like or stalk-shaped cladodes and seeds of the plant are used in the treatment of various diseases - liver and kidney diseases (diuretic), bladder pain, blood pressure, tuberculosis, heart pain, wind, diabetes, infertility, etc.

It is known that fatty products in a person's diet and an unhealthy lifestyle as a whole increase the risk of developing diabetes. But in a large concentration, asparagus has a positive effect on the production of insulin by the pancreas (asparagus helps to absorb sugar in muscles and other tissues by 81% better).

The use of asparagus helps to remove chlorides, phosphates, urea from the body and break down oxalic acid crystals in the kidneys and muscles, relieves fatigue. [11].

In Europe, *A. officinalis* (diuretic, kidney stimulant, cardiac sedative); *A. racemosus* in India (general tonic, diuretic, galactagogue, spasmolytic, antidiarrheal, antidysenteric, aphrodisiac); *A. adscendens* in Pakistan (anti-diarrhoeal, general debility, galactagogue, demulcent, tonic, antidysenteric); Roots of *A. cochinchinensis* species (nutritive, antipyretic, antitussive, diuretic) are used medicinally in China (6,12).

Employees of the Botanical Institute of the Azerbaijan MEA and the Central Botanical Garden obtained carotenoids from the asparagus plant using different methods. As a result of the research work, many substances that are more beneficial for the human body, including carotenoid (85 Mg %) were found in asparagus. This is a large number and is much higher than the amount of carotenoids obtained from many plants (8).

Medicinal asparagus is used not only as a vegetable and medicinal plant, but also as an ornamental plant, especially in the preparation of flower bouquets, due to its delicate branches, beautiful red berries that do not fall off the branches for a long time.

One of the main reasons for the non-spreading of asparagus crops in our republic is that the plant is not well known by people, and there is limited information about its use and cultivation.

From an economic point of view, asparagus is useful not only as the earliest ripening vegetable, but also as a plant suitable for cultivation in many regions of our republic. Asparagus can play a big role in solving the problem of providing high-quality vegetables to the population of Azerbaijan, enriching the variety in the market and extending the harvest period of vegetables.

Asparagus plant, which has a simple cultivation technology, is an economically very profitable plant because it is sold at a high price in the markets in early spring, even if it yields little. Another advantage of this plant is that it can be grown very successfully in infertile, poor loam or alkaline sandy soils.

When the plant is propagated by seeds, its harvest begins in the 3-4th year, and an asparagus plantation can produce in one place for 12-15 years (Relf and McDaniel, 2015).

The possibilities of selling fresh asparagus in Western European countries are almost unlimited. It is in great demand here in fresh, frozen and canned form. Therefore, the export of asparagus is more profitable than other vegetable crops. If the guaranteed sale of asparagus in the foreign market is possible, conditions may be created for the production of this product in many countries, including Azerbaijan. Because, despite the application of modern technologies, manual labor is used more in growing asparagus (13).

In 2019, 9,327,414 tons of asparagus were produced worldwide. China (8 303 392 t), Peru (366 758 t), Mexico (272 202 t), Germany (130 560 t), Spain (58 610 t), Italy (49 910 t), USA (34 180 t), Japan (27 426 t), Iran (25 696 t), France (19 990 t), Thailand (18 184) are among the countries producing asparagus. t), the Netherlands (18,150t), Poland (12,700t), Colombia (11,855t) and Chile (11,767t). In the following years, due to the pandemic, crop production decreased slightly (4).

According to the information provided (source: FruitNews.ru), the cultivated area of asparagus in the world is 215 thousand hectares, but this is still not enough to meet the population's demand for

asparagus. According to forecasts, 270,000 to 280,000 hectares of land will be needed to meet this demand. China is the world's largest producer of asparagus with 93,000 ha, followed by Mexico (29,000 ha) and Peru (22,000 ha) (5).

The year-by-year increase in asparagus production and cultivated areas in the world is mainly related to the growing demand for healthy food products - ecologically clean products, and this factor is expected to have a significant impact on the market in the future.

Thus, even though asparagus is a valuable vegetable, a profitable export product, an important medicine and a beautiful ornamental plant, which is given special importance in world vegetable growing, it is still collected and used from wild flora in Azerbaijan and is not included in the list of more than 40 more or less cultivated vegetable plants cultivated in the republic. Therefore, including this plant in the range of vegetables, providing the population with protein vegetable products in early spring, and also researching ways to increase the efficiency of asparagus production are always urgent issues.

We, for many years, cultivated the Argenteilskaya rannaya variety of American origin in the vegetable experiment-collection fields of ADAU, and tried to study the green asparagus cultivation technology of the new, multi-stem Q2 variety sample obtained from this variety as a result of multiple mass improvement selections, suitable for local conditions.

The method of laboratory-field experiment was used in the development of cultivation technology.

During 2021-2023, small plantations of medicinal asparagus were organized in the field of teaching and practice of the Faculty of Agronomy of the Azerbaijan State Agrarian University, and at the same time research work was carried out in 2 directions to increase the efficiency of asparagus production:

- intensification of seedling cultivation;
- study of asparagus planting schemes

In the research work, the medicinal asparagus variety Arjanteilskaya rannaya of American

origin and the multi-stem Q2 variety sample obtained from this variety as a result of multiple mass improvement selections were used.

In the development of cultivation technology, the method of laboratory-field experiment was used, the area of the experimental patch was taken 28 m<sup>2</sup> and repeated 4 times.

To intensify seedling cultivation, medicinal asparagus is cultivated in 2 variants:

Option I – control seeds were sown in the open field in 1.II and seedlings were transplanted to their permanent place in 1-10.X;

Option II – seeds were sown under tunnel-type small-sized polyethylene curtain covers in 1.II, and seedlings were transferred to their permanent place in 25.IV.

Seedling spots are made with a width of 90-100 cm according to general rules, and 4-5 small furrows are opened in that spot. The seeds were sown by hand in the furrow to a depth of 2-3.5 cm and watered. This process was carried out in 1.II and since that day it has been covered with 2 layers of polyethylene film. Covering arcs were made from 4-6 mm wire and pinned to the edge of the hole every 0.7 meters. The height of the tunnel cover was 30-40 cm.

Planting schemes of the prospective Q2 asparagus cultivar were studied in the following variants (cm):

Option I – 70x35 - control;

Option II – (90+50) : 2x35;

Option III – 70x30;

Option IV – 60x40.

40816, 40816, 47619 and 41666 plants are planted per hectare according to the variants.

### Research results and analysis

When studying the intensification of seedling cultivation, experience has shown that in fact, intensification is achieved by effectively using the growing season, bringing the seedling to a ready state for planting in 80-90 days and planting in spring instead of autumn. Because 15-300 C heat is generated in Ganja city under the polyethylene cover during winter, mass sprouts were obtained until March and reached the required size during March-April (table 1).

**Table 1.** Development of asparagus seedlings (Arjanteilskaya rannaya variety) in open spots and polyethylene cover.

Options	Mass germination	Planting date	Seedling cultivation period, days	Seedlings reach 10 cm	25.IV-də		
					Şitilin köklərinin sayı	Gövdənin sayı, ədəd	Gövdənin uzunluğu, sm
1 – control – spray I. II (open spot)	25.III	1.X	185	15.IV	2	1	14,5
2 – sow – 1.II, (under polyethylene cover)	15.II	25.IV	70	23.III	4	2	26,4

As can be seen from the table, mass germination in the control variant occurs at 20.III, and seedlings at 15.IV. - reaches only 10 cm and consists of one trunk. 25. In the IV month, since the plants still have 1 stem, 2 roots and 14.5 cm long, they cannot be planted in the field instead of seedlings. Because the plants are very small and delicate, the roots are broken and lost when transplanted.

The second option has completely different conditions. Under cover, the temperature reaches 23-28°C on sunny February days (daytime), and

the average daily temperature reaches 12-15°C. Therefore, mass germination occurs on 15.II, and until 25.IV, the plants reached an average length of 26.4 cm and had 4 large roots and 2 stems. Such a plant can be freely planted in its permanent place in 20-30 IV, and in a new weed-free wide area, baby plants grow rapidly and are ready to winter freely until 1.X, i.e., until the time of planting in the control option (2-3 large shoots close at the root). This situation is reflected in table 2.

**Table 2.** Development level reached by asparagus in the 1st vegetation in different cultivation technology (1.X.2021).

Option	Roots		Stem		Location of the plant in planting
	number, piece	length, cm	number, piece	length, cm	
I. Control – spray – 1.II, (open spot)	5	20	3	29,0	Ready for planting (seedling)
II. Sprinkling – 1.II (under polyethylene coating)	12	36	5	43,8	Ready for winter in a permanent place

Unlike other plants, asparagus is a late grower at first. Therefore, the preparation of planting material is very difficult, especially in the fight against weeds. Therefore, it is necessary to try to plant as large plants as possible in the permanent place.

Another significance of this study is that the asparagus plant is dioecious and the flowers are unisexual and if the plantation is made from monogamous plants, the productivity increases significantly. Given this, the planting material of asparagus is ready in two years for easy selection of large-flowered male plants.

As can be seen from Table No. 2, 1.X, i.e., usually until the time when asparagus is planted a lot, in the control version, the baby asparagus plants remained in a tight position in the seedling, without changing their location, and only reached the state of seedlings suitable for planting. Those plants were weeded 6 times and watered 10 times during the growing season. Seedlings planted in 1.X show slight growth until winter, but weeding is required at least 1-2 times. These plants grow slowly even in the second year.

In the second option, where intensification is applied, the seedlings reached 1.5 times larger sizes than the seedlings in the control option up to 1.X, formed large shoots on dense roots, prepared for winter, and grew even more until winter. However, plants in the control variant reach this condition after another 1 year and its yielding is delayed. In the 2nd option, plants can produce in

the 3rd vegetation. This means more intensification of planting.

If we look at the maintenance work in this option, the destruction of weeds can be done twice by cultivation and twice by hand. Watering is repeated 6 times. Although these services are carried out in the second option on a larger area and cost more, but the harvest is 1 year earlier, the additional product purchased covers these costs and there is a surplus. Thus, the role of intensification in asparagus cultivation is very large. The more the plant can be grown in the first vegetation, the more successful the work will be.

Studying planting patterns also means studying the food space of plants. In each specific planting scheme, there is a specific food area of the plant and the necessary (suitable) number of plants per hectare.

The size and shape of the optimal food plot are strongly influenced by the fertility of the soil and the climate-soil conditions of the region, the biological and varietal characteristics of the plant, the shape of the plants, the purpose of their cultivation, the mechanization of plant care and harvesting, etc. (3).

Due to the application of mechanization, the size and configuration of the food field changes. The tractor must be able to move between the rows, cultivation must be carried out, fertilizer must be applied. Therefore, the row spacing should be at least 50-70 cm and more. When applying the

140x40 cm scheme, the movement of harvesting platforms between the rows is also considered.

Many other factors affect the food sector. The fact that the cultivars planted in this row have a large habitus and are longer and long-lived should also be taken into account because asparagus can live and produce in the same place for 12-15 years (7). From this point of view, since the above-ground part of the asparagus plant is 90-130 cm and higher, it is given a large food area. In the technology of etiolated asparagus cultivation adopted in Russia, the row spacing is 100-115 cm, the plant spacing in the row is 35-40 cm, and in Hungary, at most 80 cm x 40 cm and sometimes 140 x 40 cm food area is given (20). However, researchers believe that asparagus is 70x35 cm, 60x40 cm, 70x30 cm, 70x50 cm, etc. can also be planted with schemes. In these cases, the life of the plant is significantly reduced. However, the number of plants per hectare increases and the plant can give a high yield even in that shortened life. It is more a matter of economic utility than anything else. In recent times, sowing and sowing in the tape method are more widely used in vegetable growing. Asparagus can also be planted

in different food areas in this way. For this purpose, we studied the planting schemes of asparagus, taking into account the biological characteristics of the multi-stem Q2 sample selected from the Argenteil variety, mechanization of agro technical measures in accordance with local conditions. For this, the seeds were sown under a polyethylene cover on 1.I in 2021, since the air temperature increased from 10-15.IV, the cover was removed from the seedlings, and the plants were cared for in the nursery until winter, and kept in that place for the winter. Those seedlings were transferred to a new plantation on 20.II.2022 according to the schemes given above. Plants grew and developed faster in the second vegetation year than in the first.

The cultivar Q-2 was grown in a high agro-environment and was abundantly irrigated throughout the growing season. This created conditions for the formation of numerous stems in each nest in the second vegetation, for the plant to reach large sizes, to bloom and produce ripe fruit (seeds) (table 3).

**Table 3.** The effect of planting schemes and high agrofion cultivation on the development of Q-2 asparagus variety sample (2nd vegetation; 11.10.2022)

Option (planting scheme, cm)	Planting date	Number of plants per repeat (14m <sup>2</sup> ), piece	On average for 1 plant		Bloom +, -	Fruit +, -
			Number of stems, piece	Height of stems, cm		
70x35-control	20.II	57	10-18	45-95	10-12%	10-12%
(90+50):2x35	20.II	57	4-20	35-95	18-20%	18-20%
70x30	20.II	67	8-16	47-99	7-8%	7-8%
60x40	20.II	58	8-18	63-112	5-6%	5-6%

So, according to repetitions, the number of stems in one nest in the 70x35cm scheme changed between 10-20 cm, the height of the stem is 45-95 cm, (90+50): 4-20 and 35-95cm in the 2x35cm scheme, 8-16 and 47-99cm in the 70x30cm scheme, and 8-18 and 63-112 in the 60x40cm scheme.

As can be seen from the table (table 3) in vegetation period III, different results were recorded in the number of stems and height of stems in one nest in different planting schemes and at the same planting time (20.II). Thus, in the 3rd vegetation year, the plants took their perennial form by reaching full development, compared to

the 2nd vegetation year, the number of stems they gave decreased significantly, but the size of the stems, especially the average height, increased. The results of phenological observations and biometric measurements (table 4) showed that in the third year of life, plants in all variants developed approximately equally and yielded. Differences in productivity are also noticeable.

In our experience, in almost all options, the average weight of 1 commodity pod was 30.3 g (33 pods 1 kg), the height of stems varied between 101-119 cm, the longest stem height (119 cm) was observed in the 70x30 cm planting scheme.

**Table 4.** Effect of planting schemes on the growth and yield of asparagus (Q2 variety sample) (first harvest year, 2023)

Option (planting scheme, cm)	Average number of stems in every plant, piece	Average height of stems, cm	Crows collected from 1 repetition		Average productivity	
			Number, piece	Weight, kg	t/ha	In % by control
70x35-control	4	98	223	6,77	4,79	100
(90+50):2x35	5	105	278	8,42	6,00	124,2
70x30	4	116	217	6,57	4,68	97,7
60x40	6	103	321	9,74	6,94	144,9

As can be seen from table 4, productivity (90+50): 2x35 cm scheme was 24.2% higher than 70x35 cm scheme, and 60x40 cm scheme was 44.9% higher.

If we take into account the future development of plants in separate options, we should note that the (90+50):2x35cm scheme is more promising. Because in this option, easy cultivation can be carried out between the tapes, manure can be given with platforms, and the product can be transported, which allows to reduce the cost of the product. On the other hand, in this scheme, it is possible to speed up the ripening of the product by 1-1.5 months and sell it at a higher price by placing the tape (2 rows) under a small tunnel-type polyethylene cover. Although the 60x40 cm scheme is favorable in the first crop years, in the following years the plants will be crowded and the productivity will decrease.

### Result:

1. In the conditions of the Ganja-Dashkasan region, it is possible to successfully grow medicinal asparagus and buy quality green asparagus products.
2. During the research, it was determined that with the application of intensive technology, seedlings can be prepared in 70-80 days instead 180-185 days, by sowing the seeds under tunnel-type small-sized polyethylene curtain covers on 1<sup>st</sup> of February and transplanting the seedlings to their permanent place on 25-30<sup>th</sup> of April, resulting in shortening the period of growing by 1 year.
3. (90+50): 2x35cm planting scheme has a number of advantages, like the two-row tape method, it allows to reduce the cost of the crop and to accelerate the ripening of the crop by 1-1.5 months and get more income by easily placing the plants in the curtain covers.

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