Relationship of silk butterfly lifespan longitude with economic value traits in silk cocoon breeding

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Abstract. Agriculture plays a key role in the economy of Uzbekistan. Its importance is not limited to the goals of providing food to the population. This is reflected in the cultural heritage and traditions of the people of Uzbekistan in rural areas, in each region of Uzbekistan with its own characteristics and diversity. Today, agriculture in Uzbekistan in general, including cocooning, provides jobs and income to a significant part of the population and remains the driving force of the growth of the economy of Uzbekistan. At the same time, as the economy of Uzbekistan is gradually diversifying, this means that the agrarian sector and the cocooning sector must also be radically reformed, which encourages them to look for new opportunities for competitiveness and sustainable development in the domestic and foreign markets. This requires a new approach to the development of the industry. This article discusses the importance of the role of cocooning in the agricultural sector in the national economy, the strategy for the development of Uzbekistan's agriculture for 2020-2030, selection and breeding in the development of cocooning, and the role of seed production. In addition, in 2018-2020, the results of the study of the correlation between the life span of butterflies and the valuable traits of their offspring at the Research Institute of Sericulture were cited. The use of the results in science and production practice, as well as the expected results, that is, increasing the quantity of cocoons produced, improving the quality and increasing the competitiveness, are highlighted by the authors.
Keywords. Selection, breeding, seed production, silkworm, cocoon shell, life span.

1 Introduction

Today, there are more than 1,000 breeds of mulberry silkworm in the world, belonging to the *Bombycidae* family, originating from China and Japan [1]. Monovoltine groups with a diploid set of Chromosome equal to 56 are the most productive breeds, and these breeds and systems serve as initial selection materials for the creation of new fertile and moc canoat breeds and hybrids of mulberry silkworm for different regions. At the same time, the creation of new systems, breeds and hybrids with high viability and cocoon productivity of mulberry

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silkworms, which are resistant to various ctrecc conditions and meet the high requirements of canoe sericulture, remains one of the important tasks [2].

In the world, comprehensive research is being carried out to create breeds and systems of mulberry silkworms with high cocoon productivity, vitality and reproductive power, and to give birth several times a year, and to establish their commercial use in silkworm breeding enterprises. In the researches of this direction, it is possible to grow 40-45 kg of live cocoons from 1 box (14.5 g) or 80-85 kg of live cocoons per 1 box of seeds (29 g) in one worm feeding cycle in the PRC [3]. The adaptability of previously created breeds and hybrids to different climatic conditions and the gradual change in the technological capabilities of silk fiber, the modern methods of selection of mulberry silkworm genotypes require the creation of new selection systems and the creation of commercial hybrids whose productivity and technological capabilities meet the requirements of the world market [4].

Rapid development of all sectors of the national economy of Uzbekistan based on the demands of the world market is being made a priority. In particular, special attention is being paid to cocooning, and measures are being taken to increase its volume and, especially, to drastically improve its quality indicators [5]. Silk-making is one of the oldest and most ancient crafts of the Uzbek people, and it is an important economic and social sector. It provides 5-6% of the total income of the population of Uzbekistan and has a place in the permanent and seasonal employment of more than 1.5 million of our citizens. At the same time, Uzbekistan occupies one of the leading places in the world in the cultivation of cocoons and silk fibers, and the demand for natural silk products is always high in the domestic and foreign markets. Therefore, such a situation requires continuous development of the silk industry [6].

For this, there must be a solid foundation in the field, and if we consider that the labor resources and silkworm feed base in Uzbekistan are sufficient, the third main missing thing is the creation and breeding of new promising, competitive local breeds of mulberry silkworm, as well as industrial hybrid seeds with high potential [7]. This, in turn, requires a deeper application of the innovations created by scientists in the field and the discovery of new methods of selection. In this case, it is important to study the correlation between the characteristics of female butterflies leaving the next generation with the reproductive and productivity indicators of their offspring and to direct it in the right direction. Because in the recent past, local breeds created by Uzbek scientists were multiplied at silk breeding stations, and silkworm hybrid seed factories produced not only the level of needs of Uzbek farms, but even more competitive seeds, and some of them were exported to foreign countries [8].

Along with Uzbekistan, which is a traditional cocoon breeder in the world, our country today has a sufficient number of competitively bred and hybrid mulberry silkworm seeds, as well as personnel potential. It is only necessary to put them into operation and take measures to introduce new developments in selection into production. In particular, in this decision, rapid development of the feed base of cocoon breeding in Uzbekistan, continuous improvement of silkworm care and cocoon cultivation processes, wide introduction of effective methods of production of cocoons, raw silk, silk kalava and their deep processing, establishment of production of ready-made silk products, development of the industry [9]. The goal of comprehensive development of the cocoon industry based on the establishment of a single and integrated organizational and technological system that ensures the increase of export potential and the level of employment and income of the population in rural areas is a priority task. Breeds and hybrids of high productivity, silkiness and technological properties of silkworms are of great importance in growing a high-quality and abundant cocoon harvest. If breeds and industrial hybrids suitable for each region are created and introduced, the ground will be laid for the cultivation of abundant and high-quality cocoons [10].

The territory of Uzbekistan is conditionally geographically divided into north-western, central, southern and eastern regions [7]. Naturally, the early or late arrival of spring in these regions, the awakening of the buds on the mulberry tree branches and the development of leaves, as well as the selection of breeds and hybrids suitable for each region, depending on the soil and climatic conditions, require a unique agrotechnical approach to them. Considering that the silkworm is a poikilotherm and a monophagous insect, the importance of the issue becomes even more evident.

The role of new scientifically based methods of selection and breeding work in creating new, high-yielding and high-viability breeds is very important [3]. In recent years, there is a gradual increase in the volume of cocoon cultivation in Uzbekistan, which in turn requires the improvement of the quality and technological indicators of the cultivated cocoons and their competitiveness [6]. It should be noted that the leading economic value of the mulberry silkworm is realized under the influence of polygenes. Therefore, at each stage of breed breeding, it is necessary to select the strongest genotypes for the breed during the selection process and increase the parameters of the breeding material from generation to generation. Otherwise, it is observed that the signs of productivity and vitality decrease in the breed population [7]. In silkworm selection and breeding, the viability of offspring, cocoon productivity has been the focus of breeders' attention, and in order to create any new selection systems, it would be appropriate to first of all research the correlative relationship, variability and heredity characteristics of signs and characteristics, and draw up a selection plan based on these parameters [10]. Among the selection characters, many productivity, viability, reproductive characters have been studied in depth. However, the influence of the life span of silkworm butterflies on the reproductive and productivity performance of their offspring has not been studied much. The scientific study of the variability of this important and selectively interesting trait and its correlation with leading economic value traits is one of the current scientific directions of mulberry silkworm breeding.

In the mulberry silkworm breeder, selection camaraderie is largely positive, because economically valuable characters are positively correlated with other selection characters, and as a result of selection, the indicator of the second character increases, as well as the relationship is in a negative or negative direction, and it is known in advance that the indicator of the second character decreases [2]. In this regard, the authors thoroughly studied the phenotypic correlation of various selection traits of agricultural animals in their scientific works and gave their conclusions by illuminating the analysis in a comparative manner. In particular, certain results were obtained on determining the correlative relationship of the main characteristics of the mulberry silkworm and using them in the breeding process [5].

The correlation between reproductive indicators and genetic characteristics of butterflies is of great importance for the practice of selection and breeding, as it has an effect on the percentage of physiological hatching in egg deposits [8]. When the correlation coefficients between the viability of worms were calculated, it was (r=0.316) [8]. They proved that the lower the amount of physiological waste in the seeds dropped by the butterflies, the higher the viability of the worms that came to life from the seeds in the batches, and that it is possible to obtain abundant and high-quality cocoons with good technological indicators from such silkworms.

2 Materials and methods

After the tissue incubation process, the worms that came alive were picked up with the help of syomniks. According to agrotechnical standards, it is appropriate to feed worms with mulberry leaves at 26-27 ºC for 1-3-year-olds and 24-25 ºC for 4-5-year-olds with 1000-1200 kg of feed per box.

Accordingly, if the mulberry silkworm is cared for based on the above agrotechnical standards, productive cocoons will be grown. the cocoons in the experiment were picked and cleaned from the loc, and healthy, deaf, black cocoons were identified among them. Then the cocoons were sorted, and the fertile cocoons were selected and stored according to the standard. After that, the butterflies that came out of the cocoons according to the batch were cross-breeded on the same day, and the process of papilionation was carried out. In order to determine the life span of female butterflies, the process of laying eggs was monitored and the information was recorded. The butterflies in the pots were checked at the same time every day to see if each butterfly was alive or dead. This process was carried out until the butterfly died, and the results were recorded in the experimental record book.

In this case, the life span of the butterflies of the Line 5 m and Line 67 selection systems was calculated from the moment the butterfly emerged from the cocoon to the time of natural death.

According to the life span of female and male butterflies of selective systems, the eggs of the generation obtained were divided into 3 groups depending on the period of the butterfly's life: Group I - butterflies with a longer life span; Group II - butterflies with an average lifespan; and, Group III - short-lived butterflies.

3 Results and discussion

During the research on the life span of butterflies by groups, the eggs laid by the groups of the Line 5m, Line 67 selection systems were combined, and the influence of the life span of butterflies on reproductive, biological, productivity, and technological indicators was confirmed in Table 1 below.

Table 1. Lifespan grouping of female butterflies of the Line 5 m and Line 67 systems.

Groups	**Line 5**		**Line 67**	
	Life expectancy interval, day	Average life expectancy interval, day $\overline{X}_{\pm S\bar{x}}$	Life expectancy interval, day	Average life expectancy interval, day $\overline{X}_{\pm S\bar{x}}$
2018				
I	9-11	9.7±0.67	9-11	10.0±0.58
II	7-8	7.2±0.15	7-8	7.5±0.22
III	4-6	5.2±0.37	1-3	4.1±0.67
(P_d)		**0.999**		**0.999**
2019				
I	9-13	12.06±0.45	5-6	5.5±0.50
II	7-8	7.0±0.33	3-4	3.3±0.33
III	3-6	4.3±0.87	0-2	1.3±0.46
(P_d)		**0.999**		**0.998**
2020				
I	9-10	9.2±0.17	9-11	9.7±0.29
II	7-8	7.4±0.16	7-8	7.4±0.18
III	1-6	3.4±1.03	1-6	4.5±0.56
(P_d)		**0.996**		**0.999**

According to the analysis of the given data, the life expectancy of female butterflies in the three-year data presented for the three groups was 9-11, 9-13 and 9-10 days, respectively, in the Line 5 m system group I, among which the highest result was recorded in the 2019 season. In the II - group of the Line 5 m system, the life span of butterflies was proportionally

7-8 days in all three years of experiments, in the III - group of the same system, it was 4-6 by year; 3-6; and shows the result of 1-6 days, indicating that there is a possibility to select them in the selection work depending on the life span of butterflies within the system, and in group II of the three-year experiments, it is also possible to observe a strong uniform duration.

In particular, if we look at the experimental Line 67 system of butterfly life spans by year and group, we can see different results. Group I butterflies of this system showed a life expectancy of 9-11 days in 2018, 5-6 days in 2019 and 9-11 days in 2020, while the Line 5 m system showed the highest result in 2019 (9-13 days) I - group butterflies of the Line 67 system showed the lowest result (5-6 days) among the first groups.

A similar picture can be observed in the life span of group II (3-4 days) and III (0-2 days) butterflies in the 2019 experiments of the Line 67 system. such a big difference can be explained as the specific characteristics of the weather in the spring of each year, and the genotypes of the individuals in the experiment, and these characteristics can be used in different directions according to the purpose of selection and breeding.

It can also be seen that the longest lived 11-12 days and the least 1.3-3.3 days in selective breeds and systems, respectively, these numbers are 9-11 and 1-3 days in the first year in the Line 67 system, and 9-11 in the third year and was 1-6 days. Also, Line 66 system had an average life expectancy of 11.6 days in 2019, while the highest and lowest average was 1.3 days in 2019 in Group III of Line 67 system. But indicators for each breed and system group showed almost similar results over the years. This means that the life span of butterflies depends on the genotype of the breed and system, as well as the conditions of their storage.

In genetics and selection experiments, there are a number of genetic parameters of a selective trait, which can be used to select genetic material without determining the level of their manifestation in the population. One such indicator is the phenotypic correlation (*rp*) of these traits. Since the main goal of our research work is to select mulberry silkworm selection systems based on the life span of butterflies, we tried to determine the efficiency of this new selection mark and the degree of correlative connection with other selection marks. In particular, the most important parameters are the correlation coefficient between butterfly body size surface area, cocoon weight, cocoon shell weight, silkiness, number of eggs in a nest, weight of egg laying, physiological rate and survival of eggs, and life expectancy of worms.

In order to calculate this coefficient, the indicators of the life span of butterflies obtained annually and the indicators of the above-mentioned characters were processed in Microsoft Office Excel computer and phenotypic correlation coefficients were calculated.

Table 2 shows the phenotypic correlation coefficients determined in 4 breeding systems and 2 breed populations during 2018-2020. Before analyzing the indicators of Table 2, it should be noted that the phenotypic correlation coefficient ranges from -0.999 to 0.999, and a negative indicator indicates the presence of an inverse relationship between the studied characters. A coefficient of 0-0.333 indicates a weak correlation, 0.333-0.600 a moderate correlation, and 0.600-0.999 indicates a close correlation between indicators and characteristics [1]. In our work, if a close positive correlation is found between the life span of butterflies and the leading selection traits, then it will be possible to select for the life span of butterflies in the improvement of selection systems.

Analyzing the correlation coefficients for the years 2018-2020, we can see a positive correlation between the life span of butterflies and silkiness of cocoons, *rp* = -0.232. Therefore, in order to positively change the relationship between the life span of butterflies and the silkiness of their offspring, it is necessary to carry out long-term, multiple, targeted selection works in the selection and breeding work. Also, indicators of *rp* = -0.407, *rp* = -0.129 were found in the mean of the

physiological brackishness in the eggs, and the percentage of female life expectancy of butterflies, respectively. From these negative correlation coefficients, it can be concluded that the longer the butterflies live, the less silkiness of the cocoons they wrap, the lower the percentage of physiologically broken seeds, and the lower the degree of maturation.

Table 2. Correlation between life span and leading selection traits in butterflies.

Correlated factors	2018	2019	2020	Average
Butterfly life span x Butterfly body size surface, cm^2	0.771	0.612	0.829	0.737±0.0374
Butterfly life expectancy x Cocoon weight, g	0.354	0.707	0.446	0.502±0.1059
Butterfly life span x Cocoon shell weight, mg	0.669	0.747	0.549	0.655±0.0577
Butterfly life span x Silk production, %	0.014	-0.601	-0.108	-0.232±0.1882
Butterfly life span x Number of eggs	0.598	0.831	0.923	0.784±0.0968
Butterfly life span x Egg weight, mg	0.587	0.854	0.811	0.751±0.0829
Butterfly life span x Physiologic defect of egg, %	-0.143	-0.969	-0.109	-0.407±0.8889
Life expectancy of butterfly x Life expectancy of worms, %	0.666	0.056	0.780	0.501±0.2250
Life expectancy of butterfly x Percentage of maturity, %	-0.230	-0.056	-0.290	-0.129±0.0833
Life expectancy of butterfly x Egg revival, %	0.954	0.878	0.388	0.740±0.1776

Among the data presented in Table 2, in addition to silkiness, two other main indicators, that is, the percentage of physiologically unfit eggs in seedbeds and the incidence of silkworms, have a negative result, but in fact, this is a good positive indicator in practice. Because it has already been proven by our scientists that the worms that have come to life from egg deposits with a low percentage of physiologically broken eggs have high vitality, grow evenly and produce high-quality cocoons, and the lower the percentage of disease, the higher their productivity due to the higher vitality of the worms. So, at this point, it can be concluded that paying attention to the life span of butterflies during the selection process will have its positive effect in practice.

In that, $rp = 0.737$ between body size surface, cocoon weight, cocoon shell weight and life span of butterflies; $rp = 0.502$; $rp = 0.655$ coefficients were determined. These indicators indicate that the longer a butterfly lives, the heavier the cocoon, the larger the butterfly's body size, the larger the surface area, and the heavier the cocoon shell.

The correlation between butterfly mass and cocoon mass ($rp = 0.790$), correlation between cocoon shell mass ($rp = 0.540$), phenotypic correlation coefficient between butterfly body length and cocoon weight ($rp = 0.590$) and butterfly body length and cocoon shell mass the correlation between ($rp = 0.470$) indicates that our work is on the right track.

The relationship between the pollen of breeding material and the life span of butterflies is also of great importance for breeding research. Therefore, we calculated the phenotypic correlation coefficients between the life span of butterflies and the number of eggs in the nest, egg weight. It is known that there is a very close positive relationship between the life span of butterflies and the number and weight of eggs in the nest. These correlation coefficients range from $rp = 0.751 - 0.784$, which is a very high result, and naturally, the longer the butterflies live, the more and heavier the seeds they lay.

Now, the correlative relationship between egg viability and larval viability and butterfly life span, important for breeding work, will be addressed. Egg survival and larval viability are the most important in breeding work. Because it is necessary that the offspring with any quality and productivity should be strong, viable, and their head should be protected to the maximum extent. Otherwise, such breeds and hybrids are not well accepted for production. Therefore, in our research work, we paid special attention to the relationship between the life span of butterflies and the survival of eggs, and the viability of worms. Correlation coefficients presented in Table 2 show that there is a close positive relationship between the life span of butterflies and the viability of worms, the viability of eggs (rp = 0.501; rp = 0.740). In particular, it has been shown that there is a very close correlation between the longevity of butterflies and the viability of eggs.

At this point, the phenotypic correlation coefficients of these interconnected characters will be looked at in 2018, 2019, 2020. Only in 2019, the correlation coefficient determined between the life span of butterflies and the viability of worms was equal to rp = 0.056, which showed that there is almost no correlation. It is scientifically interesting how such a suddenly changed result was obtained.

As mentioned above, cocooning is one of the main and ancient sectors of the agricultural sector of Uzbekistan and has its place in providing valuable raw materials to industrial enterprises specializing in cocoon processing. At the same time, the development of every field on a scientific basis is the need of the hour. Because only by applying the latest scientific developments to production, as well as using advanced technologies, it will be possible to increase the quantity of the produced product, improve its quality indicators and competitiveness, ensure the interest of those serving in the field, increase the export potential, reduce the cost and ensure the attractiveness of the industry.

4 Conclusions

Over the past century, strengthening the feed base of cocoon breeding in Uzbekistan, expanding it to regionalized productive mulberries, creating new promising breeds of silkworms and creating effective hybrid lines from them, initial breeding of seeds, preparation of hybrid worm eggs, cocoon cultivation and its processing are on a scientific basis. although it is being organized, the new era and the frequently changing demand in the world market require new scientific developments to be discovered and introduced into production.

Although many scientific developments have been carried out in silkworm selection and breeding, the rapidly developing market economy is posing new challenges to the industry. Among them are the creation of breeds and hybrids with high productivity and technological characteristics suitable for the rapidly changing climatic conditions, and at the same time, a short larval period, resistance to diseases, and high fertility and productivity indicators.

Our scientific observations during 2018-2020 at the Research Institute of Sericulture have shown the life expectancy of silkworm butterflies and their generation with the main economic valuable signs, including butterfly body size, surface area, cocoon weight, cocoon shell weight, silkiness, number and weight of eggs in a clutch, physiological brackish content in eggs, the degree of phenotypic correlation with worm viability, disease percentage, and egg survival percentage was studied.

As a result, it can be observed that all of the indicators listed above, except the silkiness of the cocoons, have a positive correlation with the life span of butterflies. So, there are all grounds to conclude that these features of long-lived butterflies can be effectively used in science and production in silkworm selection and breeding.

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