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Source Material for Breeding of Cow Pea (*Vigna unguiculata* L.) in Azerbaijan

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Abstract: ***Throughout the time, the defining standard of the social-economic development of the society was standards of living of its population, the main index of which is consumption of live-defining products, including fruits and vegetables. The role of beans in meeting population's need for proteins in a cheap and efficient way is incomparable. Proteins, thanks to rich amino acids, vitamins and minerals that they contain make beans a quality food. In order to fulfill population's demand of vigna provided solely by domestic production it is necessary to create new and fruitful varieties. Scientific researches and studies of potential capacities of introduced as well as already known sorts can be helpful in archiving this goal. Overall, collection, study and reproduction of vigna, known as an alternative healthy and efficient supplier of daily amount of proteins necessary for human body, require creation of new varieties. A comprehensive study of potential productivity of bean samples allows their use in the selection such as primary material, sources and donors of household-valuable features.***

Keywords: beans, vigna, alternative source of food, selection, protein, raw material

1. Introduction

To the genus Vigna Savi belong 57 [6; 14] to 200 species [5]. Many species are introduced into the culture and are of economic importance in the diet of the predominantly tropical and subtropical countries. The main crops of Vigna are concentrated on the African continent, in South and South-East Asia. This culture is also cultivated in the USA, Mexico, Brazil, Colombia, China, Japan and Mediterranean countries [10].

Some researchers believed that the birthplace of the cultural species of Vigna is in Arabia and Central Asia. According to Wight (1907), cow peas originate from the Caspian steppes. Payer points out the incorrectness of this view and gives a brief overview of the distribution of Vigna species to the following African countries: Egypt, Nubia, Kordofan, Abyssinia, Zanzibar, Gold Coast, Nigeria, etc.

N.R. Ivanov (1937), on the basis of a differential agronomic study of the world collection of Vigna VIR, in 800 samples, considers the mountainous region of large lakes Eastern Africa, Kenya, Uganda and South as the birthplace of the Vigna culture,and South Abyssinia, as area of the emergence of cultural forms of Vignasinensis and Vignacatjang. For *ssp.sesquipedalis* N.R. Ivanov gives another centre of origin: Southern China and the Philippines, the geographical and climatic conditions of which allowed the emergence of these new mutational ways [9].

Academician N.I. Vavilov (1935) quotes three sources of the origin of cultural cow pea: the Chinese source is secondary for *var.sesquipedalis*, the Indian source is for *Vigna sinensis Endli*., and the Abyssinian source for *Vigna sinensis Endli.* [13].

The most interesting are the vegetable species of Vigna are Asparagus Vigna (*Vigna unguiculata subsp. Sesquipedalis* (L.)), mung bean (*V.radiata* (L.), urad bean (*V.mungo* (L.) and moth (*V.aconitifolia* Jacq.)

Asparagus Vigna is known in culture for 1000 years. The main ways of its use is on a green "scapula" which, like beans of vegetable beans, canned, frozen, used as salads, etc.

The main areas for cultivation of cowpea are in the USA. In Mexico, it has the greatest distribution in the warm zone of Chiapas and near Guatemala, in Panama, in Cuba and on the Atlantic coast of Colombia. In the USSR: in Transcaucasia-Azerbaijan, Georgia, Abkhazia; in Central Asia: Turkmenistan, Uzbekistan - is used mainly as a food product [2].

Of the 22 types of leguminous crops cultivated in the Republic of Azerbaijan, 4 types of vegetables are used on the food purposes: sewed bean (*Pisum sativum L.*), common beans (*Phaseolus vulgaris L.*), horse beans (*Vicia faba L.*) and Vigna (*Vigna unguiculata L.*) [1].

Among beans, Vigna is distinguished by high heat, drought, acid and salt tolerance, relatively high yield of seeds and above-ground biomass. Vigna is cultivated in regions with high temperature conditions and insufficient moisture, where the bean crops are heavily depressed. Recently, improving the technology of growing and introducing new breeding achievements has solved the problem of the irrational use of soil and climatic conditions in the region by agricultural plants [9].

A rare form of cow pea is found in Azerbaijan – *proles azerbaidjanica*. The bush is erect, spreading, tall, height 70-80 cm. The lateral branches are long, from 60 to 100 cm, pointing upwards, their number from 6 to 10 pieces. Leaflets are rhomboid, of average size (8-10 cm). Colour is green and leaves are medium. Beans are short and the length varies from 11 to 17 cm. The colour of mature beans is yellow, and the colour of not mature bean - with anthocyanin. The walls of the beans are thin and the beans are cracking. Beans are located on medium-length peduncles (25-30 cm), the number of beans on the peduncle is 1-3 pieces. The number of seeds in a bean is 10-15 pieces. Seeds are small, 0.6-0.8

cm long. Coloration of seeds is yellowish-pink, cylindrical. The length of the growing season is 90-110 days [10].

Currently, the culture of Vigna is cultivated on 11862341.0 hectares, annually in the world about 5689562.0 tons of grain is being retrieved (FAOSTAT) [4].

The purpose of this work is the study of the gene pool from the collection of VIR and the national gene pool of Vigna, which can serve as a source material for domestic selection.

2. Methods and Material

The studies were conducted in 2007-2018 at the Institute of Genetic Resources (IGR) of the National Academy of Sciences (NAS) of Azerbaijan. The IGR is located on the Absheron peninsula (80 m above sea level), in a dry subtropical climate with very sunny and dry summers, warm and sunny falls, and mild almost snowles winters. The average temperature is 13.5-14.5^{0}C. Frost in winter is rare. In summer, the temperature climbs up to 38-40^{0}C, and since 2010 this can reach to 40-45^{0}C. The driest months are July and August. Most of the rainfalls occur in winter-spring period. Average yearly rainfall is mediocre and constitutes 120-150 mm, relative humidity is 70,6%. Summer is almost always dry. The soil is sandy and very poor. Caspian Sea and semi-arid plains surrounding the peninsula has big impact to the climate.

The following methods were used during the research: state method of testing plant varieties (1989), Methodology for the definition of a key set of characterization and evaluation descriptors for cow pea (*Vigna Savi*). (2011) [8; 13].

Sowing of collection samples was carried out in duplicate with an area of food of one plant 10 x 60 sm at the optimum time, in the fall at the end of April. A standard sample was sown after every 10 samples, with the Method of systematic placement of experimental plots. In the process of growing, the ranks made phenological observations, determined the time of onset of phenological phases. The onset of the phase was noted when there were signs in 10% of the plants, and complete - in the presence of signs in 75% of the plants. The dates of the onset of the main phases and interphase periods were noted: seedlings, flowering, fruiting, and ripening of beans. In connection with the above, in Azerbaijan, studies were conducted on the study of agrobiological features of beans in the conditions of the Absheron Peninsula.

Has been conducted structural analysis of plants for valuable breeding characteristics that determine seed productivity and adaptability to mechanized cultivation. Evaluation of all samples was carried out when compared with the standard. The height of the plant from the soil to its highest point (cm), the height of attachment of the lower bean (cm), the number of beans per plant, the mass of seeds from one plant, and the mass of 1000 seeds (g) have been measured.

33 samples were used as research material: 9 of them were local forms and 24 were samples obtained from VIR.

3. Results and Discussion

The goal of the research was to study the variability of the morphometric and biochemical characteristics of introduced sample varieties of Vigna and to create of a source material for the new varieties selection.

For selection it is important to know the amplitude of the variability of the growing season for certain varieties and forms. It is crucial to study vegetation period not only in total, but also according to separate phases of growth and development.

Growing period largely determines the suitability of a variety for cultivation in a particular area. Many economic and biological characteristics and properties of the species are connected with the duration of the growing season (resistance to drought, diseases and pests, quality of the product and, ultimately, crop yield) [7].

According to our observations, depending on meteorological conditions, the duration of the sowing –harvest period has a high volatility (9-29 days). The duration of this period depends on the species' characteristics of the Vigna. The duration of the growing period of the samples of Vigna is 58-90 days.

The average height of plants at the standard was 105 cm, for collection samples - from 61 to 138 cm. (VC=23,43%). The height of attachment of the lower beans at the standard was 22 cm, for collection samples – from 18 to 46 cm (VC=6,15%).

The number of beans per plant was 28 for standard, for collection samples from 9 to 33 beans (X_{av} = 22.12 pcs; VC = 42,96%). %). The largest number of beans per plant was formed by the following variety samples K-262 (23 pcs.), AzeVİG-2 (27 pcs.), AzeVİG-3 (28 pcs.), AzeVİG-1 (33 pcs.); low number of beans was observed in variety samples K-429 (9 pcs.), K-269 (10 pcs.).

The number of seeds per plant is136 for standard and 68 to 228 for collection samples (VC =5.67%) of seeds. The seed weight per plant is 22 g for a standard, 8 to 110 g for collection samples (VC = 25.43%). The mass of 1000 seeds for the standard was 163 g, for collection samples from 32 to 287 grams (VC =37.78%). The mass of seeds from 1 m2 for standard azeVIG-3 was 231.0 g. This indicator for collection samples varied from 90.0 g to502.0 g (VC=30,06%).

By the mass of grain from 1 m2, samples exceeding the standard were allocated: K-271 (270.0 g), azeVİG-2 (448.0 g), K-262 (488.0 g), AG-340 (502.0 g).

From the experience of breeding it is known that one of the main conditions is the study by the breeder the correlation between the elements of fertility. The choice of one indicator directly or indirectly affects changes in the other. In this case, the correlation of elements is measured by its volume and characteristics of the impact, and the degree of correlation from the relativity of variability and dependence on the year of study. Correlation coefficients are the most convenient indicator for studying the interdependence of

quantitative traits. The results of the study of correlations are of interest when creating adaptive genotypes and obtaining the required performance characteristics. In the literature there is little data on the relationship of quantitative traits in beans [3].

The indicators obtained during our studies suggest that all the structural elements of all the samples included in the selection are interdependent, and the increase in one of them does not lead to an increase in overall fertility.

The results of the correlation analysis revealed a correlation of genotypes of cow pea fertility indicators:

- A direct high positive relationship is noted between the number of beans per plant and the number of seeds per plant (r = 0.95 **), between the number of beans per plant and the mass of seeds per plant (r = 0.93 **); between the mass of seeds on the plant and the mass of 1000 seeds (r = 0.92 **);
- The average positive relationship is marked between the number of seeds per plant and the number of seeds per bean (r = 0.58 *);
- A direct positive relationship is noted between the mass of seeds per plant and the number of seeds per beans (r = 0.46 *); between the number of seeds per bean and yield (r = 0.46 *)

Studies have shown that to meet the need for seeds of beans, it is necessary to create new varieties, models of which combine, along with morphological features (compact bush, high attachment of the lower bean) and a set of economically useful traits. In order to more accurately compare the samples of productivity and suitability for mechanized harvesting of the samples of beans, they were divided into groups using cluster analysis [12].

To analyze the results of the study of the main economically valuable traits in the studied samples of the rank, the method of cluster analysis was used. To construct the dendrograms, the Euclidean distance and the method of unweighted pairwise grouping with averaging (UPGMA - unweighted pair group method using arithmetic averages) were used. According to the most important economically valuable attributes (plant height, height of attachment of the lower bean, number of beans and seeds per plant, seed weight per plant and 1000 seed weight, biological productivity), a statistical analysis was performed using the SPSS software package with further grouping.

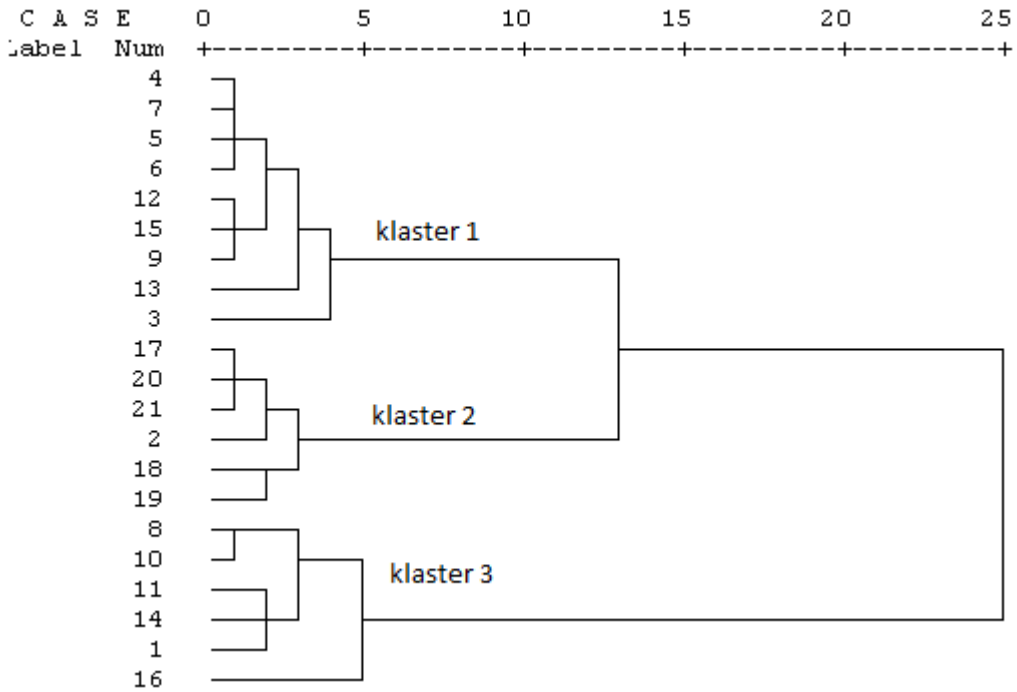

Figure 1: Dendrogram of clustering of cow pea samples on the elements of productivity and suitability for mechanical collection.: Notes Cluster 1-4) K-262, 7) K-265, 5) K-264, 6) K-263, 12) K-271, 15) K-769, 9) K-268, 13) K-273, 3) K-261; Cluster 2-17) K-1138, 20) K-3480, 21) K-5390, 2) K-259, 18) K-1190, 19) K-1292; Cluster 3-8) K-267, 10) K-269, 11) AzeVİG-2, 14) AG-340, 1) K-257,16) AzeVİG-3.

In Figure 1 it can be seen that all the studied genotypes according to the aggregate morphological characters were classified into 3 main clusters. The resulting dendrogram made it possible to group genotypes depending on the level of seed productivity.

Cluster I is characterized as medium-high and high-yielding samples. Samples K-261, K-262, K-264, K-273, K-268, K-271 are characterized as medium-growing and high-yielding.

Cluster II includes 6 samples. Cluster II combined high attachment of the lower bean. These samples are considered to be suitable for mechanical collection. The shape of the bush is compressed, determinative growth type. Samples K-1292, K-3480, K-5390 is characterized as a suitability for mechanical collection.

Cluster III also includes 6 samples. These samples are tall, large-seed and high-yielding. Samples K-269, AG-340,

AzeVİG-2, are characterized as tall, close-seeded and high-yielding.

As a result of the study of varietal samples of cowpea, promising samples were identified, which can be successfully used as starting material for the selection of cowpea. When creating new varieties of cowpea as yields as starting material, more attention should be paid to plants belonging to the first and third clusters. The plants of these samples have a complex of positive economically valuable traits, the selection of which is most desirable for the selection of cowpea for high productivity.

When creating new varieties of cowpea as a suitability for mechanized harvesting as a starting material, more attention should be paid to plants belonging to the first and second clusters. The plants of these samples have a set of positive economically valuable traits, the selection of which is most desirable for the selection of cowpea for high productivity and suitability for mechanized harvesting.

As a result of studies, the most high-yielding and high-quality samples K-257, K-271, azeVİG-2, K-262 were found in the studied cowpea samples (figure 2).

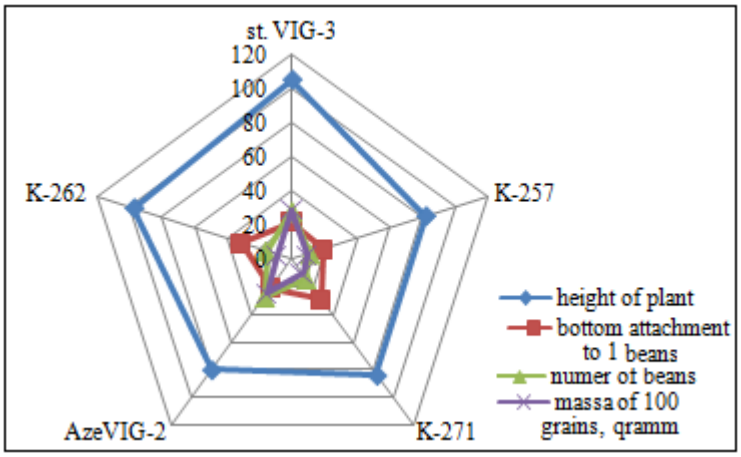

Figure 2: Characteristics of the samples selected as a source of high fertility among cow pea

Studies have shown that to meet the demand for cowpea seeds, it is necessary to create new varieties, models of which combine, along with morphological features (compact bush, high attachment of the lower bean) and a complex of economically useful traits. According to the results of research, a diverse source material was obtained, as well as recombinants differing in early ripeness, stable seed yield with good commercial qualities.

The range of variation makes it possible to set the limits for the manifestation of cowpea in the conditions studied, and the found correlation relationships between them show the grounds for selection.

We consider the creation of highly productive varieties in Azerbaijan with short and shortened interstices of the stem as one of the priority areas of selection. It is known that varieties with such characteristics provide a more ripening crop.

As a result of the research, a new variety of Vigny Aila was created, which we obtained by repeated individual selection from the VIR collection. Sort Ayla early ripeness, the period from full germination to the start of technical ripeness 60-80 days. Stem straight, leaves on long petioles, trifoliate, with ovate stipules, leaves widely ovate. Brushes are long, directed upwards, 2-5 flowers. The flag is rounded, at the base with bent ears, inside is white with purple. Beans cylindrical 14.5-15.0 cm long., Mature yellow. Each bean has 12-14 seeds. Change kidney-shaped, brown, with white cotyledons. The mass of 1000 seeds is 110-118 g. The height of the plant is 70-80 cm, the attachment of the lower beans above the soil surface is 35-40 cm. The variety is high-yielding, resistant to diseases and growing conditions. The protein content in the seeds is 25.1%. The average yield of the variety is 3.8-4.5 tons / ha.

The state register of the Republic of Azerbaijan (2018) included the “Ayla” variety with determinant stem growth, it is for combine harvesting, since all the beans on the plant are concentrated in the upper part, which allows mowing it without significant crop losses. He has a friendly maturation. Increasing the productivity of determinantal forms can be achieved by using specimens with fasciated stems in breeding programs (Figure 3; 4).

Figure 3: Grade Ayla forming beans

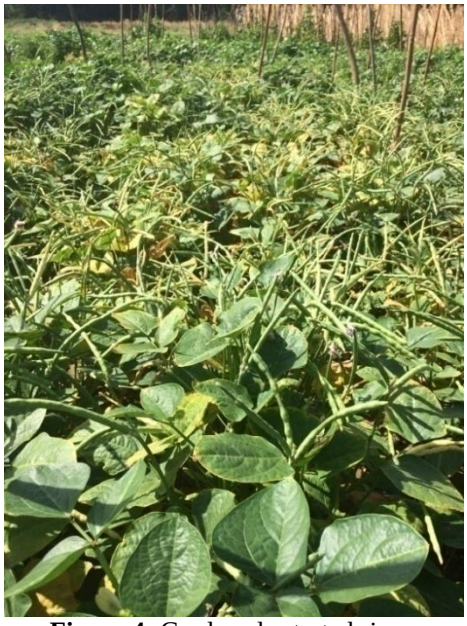

Figure 4: Grade ayla started ripen

4. Conclusions

The results of the correlation analysis revealed a correlation between the genotypes of cowpea fertility indicators:

- A direct high positive relationship is noted between the number of beans per plant and the number of seeds per plant (r = 0.95 **), between the number of beans per plant and the mass of seeds per plant (r = 0.93 **); between the mass of seeds on the plant and the mass of 1000 seeds (r = 0.92 **);
- The average positive relationship is marked between the number of seeds per plant and the number of seeds per bean (r = 0.58 *);
- A direct positive relationship is noted between the mass of seeds per plant and the number of seeds per beans (r = 0.46 *); between the number of seeds per bean and yield (r = 0.46 *).

During the implementation of the breeding program using the obtained results, we developed a new early ripening, drought-resistant, heat-resistant, disease-resistant and high-yielding variety Ayla by repeated individual selection from the VIR collection.

Long-term studies have shown that to meet the needs of the population, it is necessary to create new varieties, the models of which combine, along with morphobiological specificities and a set of economically valuable features. Based on the research results, a diverse source material was obtained, characterized by early maturity, stable yield, and good commercial qualities. Taking into account the developed and scientifically substantiated optimal parameters for the main quantitative characteristics, a model of the variety for groups with early and medium ripeness was proposed. The drought, stress factors, diseases and pest tolerant, productive and fast-growing “Ayla” variety, which has been retrieved from k-263 (VIR) sample through individual selection, is being successfully tested by the ANAS Institute of Genetic Resources in the State Commission on the Variety Testing and Protection of the Selection Achievements.

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