Some features of primary seed production of large-grained rice genotypes on the example of variety Anait

R R Dzhamirze, N V Ostapenko, S V Garkusha and N N Chinchenko

Federal State Budgetary Scientific Institution «Federal Scientific Rice Centre», 3 Belozerny, Krasnodar, 350921, Russia

E-mail: dzhamirze01022010@yandex.ru

Abstract. The article presents the results of studying the characteristics of rice grain of variety Anait. It was previously noted that in this variety in the primary seed production nurseries there is a different quality of grain on the panicle and in the plant community. This can be explained by the different quality of technological indicators of grain and milled rice. The variety of grain quality of Anait is due to the interaction of its three forms: matrix (maternal), environmental and genetic. In the primary seed production nursery (P-1) of rice variety Anait, 25 families were analyzed. A biometric analysis of plants was made and important technological indicators of the quality of grain and milled rice were determined. Variability in the grain thickness was established, expressed by the variability of the mass of 1000 grains not only between families, but also within the family, on a panicle. Rice variety Anait is unique in that it has a very large grain, but the weight of 1000 grains can vary from 33.0 to 44.4 g. The weight of 1000 grains in it depends on the thickness of the grains. Family varieties were grouped into three classes according to the grain thickness: class I - with a thickness of 2.0-2.2 mm; II class - 1.9-2.0 mm and III class - families with high mobility of the trait, i.e. showing inconsistency in thickness over 2016-2018. The variability of the main technological quality traits of grain and milled rice by classes amounted to: I class - filminess - 0.3-5.7%, grain thickness - 0.7-2.0%, weight of 1000 grains - 2.1-3.8% ; II class - 0.9-8.4%, 0.3-3.2% and 0.5-3.6%, respectively; III class - 8.2-9.3%, 5.5-7.3% and 6.2-10.4%, respectively. Specific correlation relationships in each class are established, which determine their peculiarity in the subsequent seed production.

1. Introduction
In a scientifically based technological system for cultivating agricultural plants, breeding and seed production occupy a leading place as the most powerful, environmentally friendly levers in increasing the yield and quality of crop products [1, 2].

Stable grain production largely depends on the level of organization of seed production - a system of measures to preserve varietal qualities, grow seeds of high sowing conditions, multiply them in the required quantities, store and control their quality [3].

The accumulation of heterogeneity traits in the process of reproduction destabilizes the variety as a homogeneous system. It is difficult to definitely establish the timing of the physical aging of a variety, i.e. deterioration of its quality compared to the source material. Varietal, sowing and yielding qualities of seeds of crops, including rice, do not depend on reproduction, but are determined by the level of seed production [4].
By different quality, we understand the difference in seeds according to morphological (mass, shape, size, degree of filling), chemical, physiological, genetic traits, ability to germinate and provide a certain productivity of plants in the progeny [5; 6; 7].

In seed production practice, there are three categories of different quality: environmental, matrix, and genetic.

The most attention of seed producers is attracted by the matrix quality of seeds, due to the nature of fruit formation in plants and their varietal characteristics.

Grain formation is a complex physiological process. It is associated with the characteristics of fertilization, the relationship of the ovary with the vegetative parts of the plant, with environmental conditions, etc. The embryo arises as a result of the fusion of gametes, of different genetic and physiological levels. Grain growth and increase in its volume depend on the variety and growing conditions, in particular on the temperature prevailing during the development of grain [5].

Lower temperatures and precipitation slow down the process of filling and ripening of grain. The period from heading to full ripeness in the south is shorter than in the northern regions. Early flowering varieties are broad and thick, and late flowering varieties are long. Commodity and technological features of the grain mass are largely determined by the different quality of grain in various places of the spikelets, ears, panicles. Grains from the same inflorescence differ in size, density, chemical composition, physical properties, technological qualities, seed dignity, etc. [7].

The rice grain ripens unevenly within not only the plant, but also on the same panicle. The difference in the maturation of spikelets on a panicle is 5-7 days, and within the plant 15-20 days. This is the reason for the underripening of grains and causes maternal (matrix) diversity [8].

In addition to the heterogeneity due to the unequal conditions for the development of seeds in different inflorescences and inflorescence sites, they distinguish the genetic heterogeneity caused by the difference in the composition and properties of individual pollen grains, ovules, and embryo sacs. The genetic different quality is associated with the process of fertilization of flowering plants. Pollen that does not participate in fertilization causes a phenomenon called the multiple fertilization effect.

Substances found in pollen grains are used in the process of embryo and nutrient tissue formation. Under natural conditions, pollination options are not the same, so the multiple effect of fertilization will be different. This is one of the important sources of seed quality.

Ecological diversity is the result of seed formation under slightly different environmental conditions and with different supply of nutrients to the embryo. Ecological diversity is environmental factors that influence the formation of seeds: uneven daylight hours, temperature, rainfall, topography, altitude. This leads to a different chemical composition of the seeds, their morphological and physiological characteristics. When seeds ripen, amino acids turn into proteins under the influence of the corresponding enzymes. But if precipitation falls during this period, then starch is intensely formed in the seeds. Consequently, seeds located on the same plant, but ripening at the same time, turn out to be in different environmental conditions and turn out to be of different quality. The quality of seeds is affected by pests (corn bug), the level of agricultural technology. In conditions of a high crop culture, the yield of seeds of any crops is higher and their quality is better. Changes in seeds caused by environmental influences are not inherited, but they can be of great importance for the yield of this variety. Geographic experiments show that with the intensification of agriculture, the issues of zonal seed production become even more important. The above forms of different quality are interconnected with each other. [9].

In the primary seed production nurseries of new varieties, the appearance of atypical plants is often observed and, if they are not removed, the variety becomes clogged. Three possible causes of the appearance of phenotypes unusual for the variety are considered: cross-pollination, mutagenesis, and heterogeneity.

Rice is a self-pollinator, but its cross-pollination is possible from 1% to 7% [3; 10]. With an average weight of 1000 grains of 29 g and a yield of 70 kg / ha (or 0.7 kg / m²), approximately 24,000 grains per 1 m² can be obtained. At 7% cross-pollination, the number of hybrid grains per 1 m² reaches 1680 pcs.
(taken the maximum value of the estimated pollination). But even if cross-pollination is equal to 1%, the number of hybrid grains is still large - 240 pcs/m² [11, 12; 13: 14].

It should be considered that if the P-1 nursery is located on a fallow field inside the crops of the main variety, then pollination occurs with its own variety, and such hybrid grains do not differ from their parental forms, and there will be most of them. But if several varieties are sown on a field, or there are weed-field red-grain forms on the field and cross pollination occurs, then offspring will grow from such a hybrid seed, which will necessarily differ from the main variety, which will subsequently lead to the loss of its economically valuable traits.

It is known that the flowering of the rice panicle begins from the upper branches to the lower, and with a shift in the flowering period, the weight of the spikelet decreases. Usually, empty and shriveled are last spikelets on the twigs [3; 10; 15].

Breeding programs have almost always been focused not only on high rice yields, but also on grain quality, since the main product of its processing is milled rice.

The technology for the production of seeds of modern varieties, when carrying out varietal change, especially in primary links, is not well understood. And if close attention is paid to morphological characteristics in the process of seed production of varieties, then the technological traits of grain and milled rice have not been studied enough.

**The purpose of the research** is to study the different quality of Anait rice grains in the process of reproduction and to establish the possibility of its use to increase productivity and improve the technological characteristics of milled rice and develop source material for further breeding work.

2. Materials and methods of research

The material in the work was 25 families of large-grained, early-ripening rice variety Anait. The studies were carried out for three years: 2016-2018. Families were sown in primary seed production nurseries according to the methods of “Federal Scientific Rice Centre” with plots of 0.5 m² (P-1) and 6.5 m² (P-2) by seeders: central seeding Wintersteinger “Rowseed” and cassette version Wintersteinger “Plotseed” [16]. The sowing rate of 7 million germinating grains per 1 hectare at the experimental plot of FSBSI "Federal Scientific Rice Centre" (Belozery, Krasnodar).

The work was carried out at Federal Scientific Rice Centre during 2016-2018 in accordance with GOST 15.101.80 - “Procedure for conducting research work” and methods developed at the institute [17].

The technological characteristics of grain and milled rice were determined in accordance with GOST 55289-2012, GOST 10843-76, GOST 10987-76 and “Guidelines for assessing the quality of rice grain” [18]. The mass of 1000 grains was determined by the method of conversion from the mass of grain on a panicle and the number of filled spikelets. The linear dimensions (length and width) of each grain were determined using a Vin Sit image scanner and a GOST 577-684 micrometer (thickness).

All data obtained are statistically processed, and the coefficient of variation (CV, %) and the degree of correlation (r) of the studied traits by classes are revealed [19, 20, 21].

3. Results and discussion

In 2016, in the rice variety Anait in the primary seed production nursery (P-1), a family-wide analysis revealed a different quality according to the linear dimensions of the husked grain, which resulted in a large variability by weight of 1000 grains. Rice variety Anait is distinguished by large grain, but the range of values by weight of 1000 grains can reach 33.9-44.4 g [12; 13: 14]. In 2017, 600 Anait plots were sown in the primary seed production nursery (P-1). Of these, 25 typical morphological families were selected for study. First, three plants were analyzed in each family. In the field, their height was measured and productive bushiness were determined. In the laboratory, biometric and technological analyzes were carried out according to other traits. To do this, grain from each plant was divided approximately in half: one part was examined, the other was sown in 2018 in a field of P-1 type, where five plants were analyzed in each family.
In addition, the plants remaining in 25 plots were threshed (each family separately), numbered and partly sown in 2018 according to the P-2 type (nursery for testing the second year progeny), and the other part against a provocative background to determine blast resistance. The analysis showed that all families of the variety were moderately resistant to the disease.

The results of the statistical analysis show that, according to such traits as the density and length of the main panicle, the length, width and index of the family’s grain, there are no significant differences in experiment. The above traits relate to the main varietal characteristics.

As it is known, the most constant traits are the shape of the caryopsis and its length to width ratio (1 / b), which are used as the main indicators for identifying the *Oryza sativa* species for subspecies and branches [10, 15, 17]. This confirms that when selecting families for research and when choosing plants for biometrics, there were no violations of the methodology.

The different grain quality in the experiment was associated with a significantly different thickness of the grains on one panicle (from 1.2 mm to 2.4 mm) and between families: from 1.8 mm to 2.1 mm.

The height of the rice straw plays an important role, especially for large-grain varieties. When 130-150 filled grains are formed on a panicle with a mass of 1000 grains 36-40 g, the load on the straw increases by 1.5-1.7 times. Therefore, in breeding, plants with straw height predominantly up to 105-110 cm are more promising and potentially resistant to lodging. It can be seen from the table that all Anait families belong to the medium-height group - 97.0-110.0 cm. Significant differences in plant height are observed (table 1).

| Family number | Plant height, cm | Main panicle length, cm | Main panicle density, pcs/cm | Grain sterility, % | Mass of 1000 grains, g | Filminess, % | Size of husked grain, mm | Grain index (1/b) | Broken rice in husked grain, % |
|---------------|------------------|-------------------------|-----------------------------|-----------------|----------------------|-------------|------------------------|------------------|-------------------------------|
| 1             | 102.7            | 19.3                    | 5.4                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 2             | 103.7            | 19.5                    | 5.4                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 3             | 105.7            | 19.7                    | 5.5                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 4             | 107.7            | 19.8                    | 5.6                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 5             | 109.7            | 19.9                    | 5.7                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 6             | 111.7            | 20.0                    | 5.8                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 7             | 113.7            | 20.1                    | 5.9                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 8             | 115.7            | 20.2                    | 6.0                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 9             | 117.7            | 20.3                    | 6.1                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 10            | 119.7            | 20.4                    | 6.2                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 11            | 121.7            | 20.5                    | 6.3                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 12            | 123.7            | 20.6                    | 6.4                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 13            | 125.7            | 20.7                    | 6.5                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 14            | 127.7            | 20.8                    | 6.6                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 15            | 129.7            | 20.9                    | 6.7                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 16            | 131.7            | 21.0                    | 6.8                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 17            | 133.7            | 21.1                    | 6.9                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 18            | 135.7            | 21.2                    | 7.0                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 19            | 137.7            | 21.3                    | 7.1                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 20            | 139.7            | 21.4                    | 7.2                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 21            | 141.7            | 21.5                    | 7.3                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 22            | 143.7            | 21.6                    | 7.4                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 23            | 145.7            | 21.7                    | 7.5                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 24            | 147.7            | 21.8                    | 7.6                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |
| 25            | 149.7            | 21.9                    | 7.7                         | 16.1            | 41.7                 | 88.0        | 1.7                    | 3.06             | 0.18                          |

LSD (0.05) = 5.82, 2.62, 1.69, 7.61, 2.48, 1.17, 0.08, 0.035, 6.55
The panicle length is an important, genetically determined trait that determines the potential grain content and panicle density as a whole. The value of this trait in the studied families is 19.5-22.8 cm, which is about 20% of the total height of the plant.

The density of the main panicle characterizes the number of filled grains per length unit of the generative organ. The value of the trait for an average of three years is 5.4-7.8 pcs/cm, which is not the highest indicator for rice, but optimal for a group of large-grain varieties.

The formation of large grains in rice, and especially in early ripening varieties, is more intense than in medium and late ripening. The dependence of this process on environmental factors is great (dry wind, heat, etc.), since even insignificant fluctuations in humidity and temperature lead to significant fluctuations in the value of this trait. Grain sterility, having wide modification variability, plays an important role in the productivity of the rice plant and the yield as a whole. As it is known, grain sterility depends on a large number of factors, related traits and their complex relationship. Therefore, the selection of promising genotypes is advisable to carry out with less grain sterility to prevent the likely risks of yield loss in the future. The studied Anait families have a wide range of trait values (from 7.0% to 33.2%), but families No. 5, 8 and 9 are distinguished with low values (7.8-9.1%). Families No. 2, 6, 10, 12, 15, 19-24 are noted with a high rate of grain sterility - from 16.0 to 33.2%.

The mass of 1000 grains is a slightly varying technological trait of the grain that characterizes the variety [17; 22; 23]. This indicator is related to the amount of dry matter in the grain and its size. A slight variation of this trait indicates sufficient uniformity of the variety. The weight of 1000 grains in the experiment for three years varied within 35.2-42.8 g. For years, respectively, the value of the trait ranged from 38.1 to 46.5 g; from 33.9 to 44.4 g and from 34.2 to 43.7 g.

Filminess is a trait that depends on many factors, including agricultural farming techniques, filling conditions, type of grain, grain size, maturity or ripeness of the rice grain. Rice filminess is a relative value that characterizes the ratio of the mass of flowering and spikelet scales to the total mass of grain, expressed as a percentage, or the percentage of flower and spikelet scales in the rice grain. Filminess in different forms and varieties of rice ranges from 10 to 35% [22; 23]. In the breeding process of developing varieties when crossing, donors with a filminess of 16% are considered optimal [3]. The filminess of Anait families were on average 17.7-21.9%.

Since the Anait thickness index of husked grain has a high variability, it was decided to systematize the data to conditionally divide all plants by the grain thickness into two classes, taking into account the fact that 75-85% of the grains fall into the interval of often encountered thickness [12, 14].

The first (I) class included ten families out of 25 removed for analysis (No. 1, 3, 5, 6, 7, 11, 14, 21, 22 and 23) with the thickest grains - 2.0-2.2 mm. To the second (II) class - twelve families (No. 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 24 and 25) with an average grain thickness of 1.9-2.0 mm (table 2)

**Table 2.** Characteristic and variability of some plant traits in Anait families, grouped according to the grain thickness into conditional classes, 2016-2018.

| Family number | Height, cm | Filminess | Broken rice content | Thickness | Grain index | Mass of 1000 grains |
|---------------|------------|-----------|---------------------|-----------|-------------|--------------------|
|               | cm         | (%)       | %                   | mm        | %           | g                  | CV, %               |
| I class       |            |           |                     |           |             |                    |                    |
| 1             | 98.0       | 2.7       | 18.0                | 3.1       | 14.6        | 36.9               | 2.03                | 1.3                 | 2.33                | 1.5                 | 39.7                | 3.8                 |
| 3             | 106.7      | 1.4       | 19.1                | 0.3       | 14.3        | 46.1               | 2.02                | 0.3                 | 2.28                | 0.7                 | 40.9                | 2.1                 |
| 5             | 107.7      | 1.4       | 18.3                | 0.8       | 20.3        | 18.6               | 2.05                | 2.0                 | 2.27                | 0.9                 | 41.8                | 3.0                 |
| 6             | 104.3      | 5.5       | 17.6                | 3.0       | 16.3        | 25.3               | 2.10                | 0.7                 | 2.28                | 0.0                 | 42.8                | 3.7                 |
| 7             | 99.3       | 4.1       | 17.9                | 3.9       | 18.1        | 15.0               | 2.07                | 1.5                 | 2.28                | 0.7                 | 41.6                | 2.6                 |
| 11            | 99.7       | 0.6       | 18.5                | 3.3       | 11.4        | 41.4               | 2.05                | 1.1                 | 2.32                | 0.5                 | 41.7                | 2.4                 |
| 14            | 102.7      | 2.2       | 18.5                | 0.8       | 12.3        | 44.9               | 2.01                | 1.0                 | 2.31                | 0.9                 | 39.8                | 2.4                 |
| 21            | 95.0       | 1.1       | 17.7                | 0.3       | 10.4        | 44.2               | 2.06                | 1.2                 | 2.27                | 1.3                 | 41.7                | 2.9                 |
| 22            | 102.7      | 2.2       | 17.7                | 6.7       | 11.4        | 28.7               | 2.10                | 1.0                 | 2.28                | 0.8                 | 42.0                | 2.3                 |
| 23            | 103.3      | 7.3       | 18.5                | 0.5       | 10.6        | 67.2               | 2.03                | 1.0                 | 2.30                | 0.7                 | 40.6                | 3.0                 |
Three families (2, 4, and 8) with a predominant distribution of the grain thickness of 1.7–1.9 mm occupied an intermediate position and were assigned to the third class (III). When conducting measurements, they noted the distribution of grains by thickness without obvious advantages in any direction. The percentage ratio of 10 to 20% in six gradations.

Determination of the coefficient of variation (CV,%) of the studied traits in the represented Anait families for three years allows us to achieve the research goal and competently build further seed production with early-ripening, large-grain rice variety Anait.

From table 2 it can be seen that most of the analyzed traits by classes show slight variability (from 0 to 10%) [19, 21]. It was noted that families assigned to the first class with the largest grain thickness (2.01-2.10 mm) and a mass of 1000 grains - 39.7-42.8 g, have a filminess of 17.6-19.1%. Families assigned to the second class, with a grain thickness of 1.83-1.88 mm and a mass of 1000 grains of 35.2-36.8 g, have a relatively high filminess of 19.9-22.0%.

As can be seen from table 2, the most mobile trait for all families over three years is the content of broken rice in husked grain. We attribute this to the fact that the variety Anait has a large grain with a powdery spot shifted to the ventral side, which makes it more vulnerable to formation, harvesting and processing than small and medium grain without a powdery spot. This is confirmed by the high variability (CV) of the trait by class: Class I - 15.0-67.2%; II class - 12.6-62.2%; class III - 20.5-23.6% and only in family. 4 this indicator is low - 5.3%.

According to the grain thickness, the coefficient of variation for three years in the classes amounted to: Class I - 0.7-2.0%; II class - 0.3-3.2%; class III - 12.5-14.3%. It can be seen that families assigned to the third class have an average degree of variability (10% <CV <20%) for this trait, which affects the stability of the mass of 1000 grains.

First-class families formed a maximum mass of 1000 grains - 39.7-42.8 g and have slight variability during the study period (CV = 2.1-3.8%). Families of the second class with a trait value of 35.2-37.9 g also have slight variability (CV = 0.5-4.5%). Separately, it should be noted that families of the third class with an average weight of 1000 grains - 36.6-39.1% already have an average degree of variation of a trait over three years - 13.2-15.6%, which indicates a close relationship between this trait and unstable thickness of the grain, which is traceable throughout the entire period of research.

| LSD_{05} | 6.33 | 0.81 | 8.26 | 0.041 | 0.037 | 2.10 |
|----------|------|------|------|-------|-------|------|
| II class |      |      |      |       |       |      |
| 9        | 103.7| 2.8  | 20.7 | 4.5   | 6.8   | 36.1 |
| 10       | 101.7| 3.0  | 20.5 | 5.7   | 8.7   | 20.5 |
| 12       | 99.0 | 2.0  | 20.6 | 4.2   | 12.2  | 25.9 |
| 13       | 105.7| 3.8  | 20.3 | 2.3   | 9.0   | 62.2 |
| 15       | 105.3| 0.5  | 20.8 | 6.9   | 12.6  | 12.6 |
| 16       | 100.3| 3.5  | 20.5 | 1.2   | 10.4  | 44.2 |
| 17       | 104.0| 5.0  | 21.2 | 4.8   | 10.0  | 23.5 |
| 18       | 110.0| 3.6  | 20.2 | 3.2   | 12.0  | 12.6 |
| 19       | 102.3| 5.0  | 22.0 | 0.9   | 14.9  | 42.4 |
| 20       | 99.7 | 1.5  | 19.9 | 3.1   | 5.3   | 35.9 |
| 24       | 101.7| 2.8  | 20.4 | 8.4   | 8.1   | 33.4 |
| 25       | 97.0 | 2.7  | 20.9 | 2.7   | 10.8  | 44.3 |
| LSD_{05} | 5.41 | 1.48 | 6.35 | 0.051 | 0.036 | 1.64 |

| LSD_{05} | 6.33 | 0.81 | 8.26 | 0.041 | 0.037 | 2.10 |
|----------|------|------|------|-------|-------|------|
| III class|      |      |      |       |       |      |
| 2        | 102.7| 4.1  | 20.0 | 9.3   | 14.3  | 20.5 |
| 4        | 104.0| 3.5  | 19.6 | 8.3   | 13.4  | 5.3  |
| 8        | 101.3| 2.5  | 20.7 | 8.2   | 10.4  | 23.6 |
| LSD_{05} | 8.8  | 1.20 | 2.97 | 0.060 | 0.040 | 2.78 |
To obtain a more visual picture of the relationship of technological traits of grain and milled rice, a correlation analysis was carried out for the selected classes. The data obtained allow us to see the specifics of the relationship of characters by class, due to the different activities of groups or individual genes with the same set of chromosomes (table 3).

**Table 3.** Correlation of some traits of plants in Anait families, grouped according to the grain thickness in conditional classes, 2016-2018.

| №  | Trait                          | Mean value | 1      | 2      | 3      | 4      | 5      |
|----|-------------------------------|------------|--------|--------|--------|--------|--------|
| 1  | Plant height, cm              | 101.9      |        |        |        |        |        |
| 2  | Filminess, %                  | 18.2       | 0.47   |        |        |        |        |
| 3  | Broken rice content, %        | 13.8       | 0.41   | -0.01  |        |        |        |
| 4  | Grain thickness, mm           | 2.05       | -0.18  | -0.78  | 0.14   |        |        |
| 5  | Grain index (l/b)             | 2.29       | -0.29  | 0.25   | -0.28  | -0.51  |        |
| 6  | Mass of 1000 grains, g.       | 41.3       | 0.14   | -0.48  | 0.19   | 0.87   | -0.66  |

I class

| №  | Trait                          | Mean value | 1      | 2      | 3      | 4      | 5      |
|----|-------------------------------|------------|--------|--------|--------|--------|--------|
| 1  | Plant height, cm              | 102.5      |        | -0.10  |        |        |        |
| 2  | Filminess, %                  | 20.7       |        |        |        |        |        |
| 3  | Broken rice content, %        | 10.1       | 0.16   | 0.66   |        |        |        |
| 4  | Grain thickness, mm           | 1.86       | 0.12   | -0.23  | 0.04   |        |        |
| 5  | Grain index (l/b)             | 2.29       | 0.26   | -0.06  | -0.07  | 0.19   |        |
| 6  | Mass of 1000 grains, g.       | 36.2       | -0.02  | 0.55   | 0.62   | 0.10   | -0.13  |

II class

| №  | Trait                          | Mean value | 1      | 2      | 3      | 4      | 5      |
|----|-------------------------------|------------|--------|--------|--------|--------|--------|
| 1  | Plant height, cm              | 102.7      |        |        |        |        |        |
| 2  | Filminess, %                  | 20.1       |        | -0.99  |        |        |        |
| 3  | Broken rice content, %        | 12.7       | 0.75   | -0.83  |        |        |        |
| 4  | Grain thickness, mm           | 1.92       | 0.79   | -0.87  | 0.99   |        |        |
| 5  | Grain index (l/b)             | 2.28       | 0.99   | -0.99  | 0.73   | 0.78   |        |
| 6  | Mass of 1000 grains, g.       | 38.0       | 0.65   | -0.75  | 0.99   | 0.98   | 0.64   |

III class

Note: 1 – Plant height, cm; 2 – Filminess, %; 3 – Broken rice content, %; 4 – Grain thickness, mm; 5 – Grain index (l/b);

In first-class families, filminess is closely negatively related with a grain thickness (r = -0.78), and negatively related to a mass of 1000 grains (r = -0.48). In this case, the grain thickness is strongly positively related to the mass of 1000 grains (r = 0.87) and medium negatively with the grain index (r = -0.51). The mass of 1000 grains is largely negatively dependent on the grain index (r = -0.66). Broken rice content, as the main visual indicator of quality, in these families did not express dependence on the studied traits.

In second-class families, the mass of 1000 grains is significantly positively associated with filminess (r = 0.55) and broken rice content (r = 0.62). The broken rice content, in turn, depends on the filminess (r = 0.66). At the same time, the grain thickness has practically no effect on the studied characteristics.

When analyzing two classes of Anait families, we observe a completely different relationship between the studied traits, which gives us reason to talk about their different genotypes.

We do not analyze the families of the third class due to the small sample and the strong variability of the indicators.

Comparative characteristics of the variety Anait when transferred to SVT (2009-2011) and harvested in 2016-2018 indicates the variation of almost all the traits. In 2016-2018 an increase in the length of the main panicle, grain sterility, panicle density, and filminess was noted. A decrease was observed in
the linear sizes of the grain (length, width, thickness) and weight of 1000 grains. The grain index was practically unchanged (table 4).

Table 4. The range of variation of the studied characteristics in families of Anait, P-1, harvested in 2009-2011 and 2016-2018 (minimum-maximum).

| Trait under study                        | 2009-2011       | 2016-2018       |
|-----------------------------------------|-----------------|-----------------|
|                                         | Class by the thickness of husked grain |                  |
|                                         | I               | II              | III             |
| Plant height, cm                        | 106-109         | 95-116          | 97-117          | 101-115 |
| Main panicle length, cm                 | 17.7-21.0       | 19.5-22.3       | 18.5-23.0       | 19.3-23.0 |
| Grain sterility, %                      | 7.6-11.0        | 9.1-21.7        | 8.9-33.2        | 7.8-22.2 |
| Main panicle density, pcs./cm           | 3.6-5.8         | 5.4-7.5         | 5.4-8.2         | 6.3-7.5 |
| Fruitlessness, %                        | 16.7-18.0       | 16.6-19.0       | 19.0-22.0       | 19.0-21.0 |
| Vitreousity, %                          | 75-78           | 56-91           | 55-94           | 61-95   |
| Broken rice content in husked grain, %  | 24.0-29.5       | 2.9-37.6        | 1.1-20.5        | 3.5-14.3 |
| Length of husked grain, mm              | 7.3-7.6         | 7.0-7.7         | 6.9-7.6         | 7.0-7.5 |
| Width of husked grain, mm               | 3.2-3.3         | 3.0-3.3         | 2.95-3.2        | 3.05-3.2 |
| Thickness of husked grain, mm           | 2.3             | 2.0-2.2         | 1.8-2.0         | 1.88-2.0 |
| Grain index (l/b)                       | 2.2-2.4         | 2.3-2.4         | 2.3-2.4         | 2.3-2.35 |
| Mass of 1000 grains, g                  | 42.2-43.3       | 35.3-42.5       | 33.0-39.5       | 33.0-39.1 |
| Total milled rice, %                    | 65-70           | 63.0-70.4       | 61.0-69.0       | 62.0-69.0 |
| Head rice content, %                    | 50-56           | 40.2-78.0       | 40.0-90.3       | 34.0-92.0 |

An analysis of table 4 shows that families conditionally assigned to the first class are most consistent with the characteristics of the original variety (2009-2011). They have a range of variation in mass of 1000 grains of 35.3-42.5 g. The thickness of the grains on average has a size of 2.0-2.2 mm There is almost complete agreement on the classes of grain thickness during the years of study. These families will form the basis of the primary seed production of the variety. And some differences between families in technological quality traits make it possible to choose the best families before combining seeds. For example: families No. 7, 11, 21, 22, and 23, when analyzing grain and milled rice, are distinguished by relatively high indicators (e 2). The same can be said about the head rice content: for the first class it is low (40-78%), but families with an indicator of up to 90% can be distinguished. The total milled rice by variety is not high (63-70%). But this is also typical of early-ripening large-grain varieties with a powdery structure. The grain (the head rice content depends on it), which largely depends on the climatic conditions of cultivation [22, 23].

Families that are conventionally assigned to the second class have a mass of 1000 grains significantly lower than the main characteristics of the variety (33-39 g). The thickness of the grain is on average 1.8-2.0 mm. Such families are also subject to removal from the population, because do not correspond for a number of parameters to the initial characteristics of the variety. But when propagated, they can be the basis for developing a new rice variety, large-grain, with a mass of 1000 grains of 35-39 g, while it is possible to take into account the technological indicators of the quality of grain and milled rice by family. For example: families 9, 10, 20, and 24 are distinguished by the total milled rice and the head rice content, have a low broken rice content in husked grain (table 2). So these families that can be the basis for obtaining the original seeds of a new rice variety.

Anait families, conventionally assigned to the mixed class, have a variability of mass of 1000 grains per plant 33-39 g. The grain thickness is on average from 1.9 to 2.0 mm. These families are carriers of different quality according to the linear sizes of the grain. Because the phenomenon of variability in the grain thickness was repeated during reseeding in 2017-2018 we can talk about the heterogeneity of families on this basis. And during the initial seed production, families with a low mass of 1000 grains should be rejected from the population. If desired, they can be re-selected and get a new source material, evaluating the biometric and technological parameters separately for plants.
As can be seen from the data presented, the range of thickness variation by class for individual measurements is approximately the same: 1.2-2.4 mm. But the average thickness of the grains, which was calculated as a result of dividing the sum of the thickness of all grains on the panicle by their number, has differences in classes. And these differences as a result determined the mass of 1000 grains.

It is believed that the different quality of grain is a manifestation of modification (non-hereditary) variability [3]. However, in our experience, the following trend is observed: families with a large grain (class I) have a large amount of broken rice in husked grain (up to 10-20%), if the weight of the grain is reduced, then grain crushing during processing will decrease (up to 5-12%)

This means that in the primary seed production system, with careful study of the families in P-1 and P-2, this type of variety can be maintained unchanged. And rejected but appreciated families can be used as source material.

4. Conclusion
In the large-grain variety Anait, there is a different quality in the grain thickness for families from 1.8 to 2.1 mm.

The weight of 1000 grains of the first class of Anait families is directly dependent on their thickness (r = 0.87) and is 39.8-42.5 g. These families are the basis for the selection of original plants for primary seed production.

For this variety, the thickness of the grain and the weight of 1000 grains are important indicators for the rejection of families in primary seed production

Since the large-grain variety Anait has shown different quality in terms of the technological characteristics of grain and milled rice, we recommend that appropriate assessments should be made for this type of variety in the primary seed production system.

Anait families, distinguished in the second and third classes, can be used as source material for breeding work.

In the process of primary seed production of a large-grain variety, a number of indicators can be improved, and the variety can be grown for a long time without significant changes in characteristics.

References
[1] Dzhamirze R R, Ostapenko N V, Garkusha S V and Chinchenko N N 2019 Evaluation of rice varieties of Kuban breeding in the conditions of environmental variety testing on the territory of the Republic of Adygea The Fifth Technological Order: Prospects for the Development and Modernization of the Russian Agro-Industrial Sector (TFTS 2019). Advances in Social Science, Education and Humanities Research 393 pp 279-83
[2] The collective of authors 2000 The main morphological and approbation characters of varieties and hybrids of grain, legume, cereal and oilseed crops (Krasnodar: Soviet Kuban) p 3
[3] Aleshin E P 1993 Rice (Moscow)
[4] Ulyanov D V 2003 Improving the methods of rice seed production using different standards, methods of sowing and doses of mineral fertilizers (Krasnodar)
[5] The influence of external conditions on the formation of seeds, their quality. Grain Biology, 2014: [electronic resource]:http://agro-archive.ru/biologiya-zernovyh-kultur/1433-vliyanie-vneshnih-usloviy-na-formirovanie-semyan-ih-kachestva.html (Accession date 28.06.2016 r.)
[6] Kizilova E G 1974 Variety of seeds and its agronomic value (Kiev: Urozhay)
[7] Causes of seeds and fruits of different quality./ http://agro-archive.ru/biologiya-zernovyh-kultur/1433-vliyanie-vneshnih-usloviy-na-formirovanie-semyan-ih-kachestva.html
[8] Aprod A I 1960 Influence of harvesting terms on the paddy rice quality VNIIZ 2 M pp 20-2
[9] Makrushkin N M 1985 Ecological basis of industrial seed production of grain crops (M: Agropromizdat) pp 50-8
[10] Natalin N B 1973 Rice growing (M: Kolos)
[11] Rubets V S, Shirokolova A V and Pylnev V V 2015 The effect of spontaneous hybridization on the varietal purity of triticale crops (× TriticosecaleWittm.) Proceedings of the TSHA 5 37-53
[12] Ostapenko N V, Dzhamirze R R, Lotochnikova T N and Chinchenko N N 2016 Features of primary seed production of rice variety Anait Rice growing 3-4 21-7
[13] Dzhamirze R R, Ostapenko N V, Garkusha S V and Chinchenko N N 2019 Problems of primary seed production of some rice varieties AGRITECH-II-2019, IOP Conf. Series: Earth and Environmental Science 421 082028 doi:10.1088/1755-1315/421/8/082028

[14] Ostapenko N V, Dzhamirze R R, Lotochnikova T N and Chinchenko N N 2016 Different quality of grains in a panicle of rice variety Anait. Scientific support for the production of agricultural crops in modern conditions Materials of the international scientific-practical conference (Krasnodar: ARRI) pp 158-63

[15] Gushchin G G 1938 Rice (M.: Selkhozgiz) 831 p

[16] Kovalev V S and Ostapenko N V 1987 Improving the methods and techniques for laying competitive varietal testing of rice (Krasnodar: Abstracts of the conference reports of young scientists and specialists) pp 10-2

[17] Zelensky G L 1985 Intra-varietal variability and methods of primary seed production of intensive type rice varieties (Krasnodar)

[18] Romanov V B et al. 1983 Guidelines for assessing the rice grain quality (Krasnodar: ARRI) 22 p

[19] Dospekhov B A 1979 Methodic of field experiment (M: Kolos) 416 p

[20] Dzyuba V A 2007 Multifactorial experiments and methods of biometric analysis of experimental data (Krasnodar: Methodological recommendations) 76 p

[21] Sheudzhen A Kh and Bondareva T N 2015 Methods of agrochemical research and statistical evaluation of their results: study guide 2nd ed. revised and enlarged (Maykop: Polygraph-Yug) 664 p

[22] Nalivko G V 1980 Theoretical and experimental studies of the formation of rice quality (Odessa)

[23] Lotochnikova T N 2006 Variability of technological and biochemical grain quality traits of new rice varieties of Russian breeding (Krasnodar)