Justification of prospective pistachio (pistacia vera l.) varieties and forms while creating plantations in Uzbekistan

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Abstract. This article presents the results of research on the study of the qualitative properties of the fruits of selected promising pistachio forms. When creating pistachio plantations, it is recommended to use varieties with different periods of flowering and fruit ripening. This arrangement reduces the likelihood of damage to the pistachio flowers by spring frosts, increases the chances of pollination and ensures that the harvest is carried out in stages. For the creation of plantations in forestry, promising forms 518-G, 521-G, 527-SH, 528-G, 52-RG, 21-SH and 59-G are recommended as the most productive, large-fruited and resistant to adverse environmental factors, and also pests.

1. Introduction

Today pistachio is an important nut crop in many countries of the world [1, 2]. More than 100 varieties and forms of pistachio are used in the world. These varieties and forms are large-fruited, high-yielding, and are considered effective for the simultaneous flowering of male and female plants. In this direction, the selection of pistachios and the creation of new plantations are widely developed in Iran, Turkey, Syria, North Africa and the Mediterranean countries [3, 4]. There are 10 varieties in Italy, in Spain there are 46 female and 29 male forms, in the Kerman province of Iran there are more than 70 local varieties, in Greece there are 14 varieties, in the collection of the Research Institute of Pistachio Growing in Rafsanjan there are 45 varieties and forms, in the collection of the Research Institute of Pistachio Growing in Turkey there are 16 varieties, in the collection the University of Aleppo Syria 10 female and 10 male forms, in the Institute of Desert Studies of Palestine about 5 varieties and forms [5, 6]. In the world, one of the urgent problems is the expansion of the range of pistachios with highly productive varieties and forms, in order to provide the population with its high-quality products. These pistachio collections are important in the creation of new pistachio plantations and renewal of old plantations [7, 8].

In the Republic of Uzbekistan in the field of forestry, major reforms are being carried out in the field of walnut farming. In recent years, more than 3000 hectares of pistachio trees have been created. Particular attention is paid to the cultivation of pistachios, increasing its yield and introducing new varieties into production [4, 7]. To create highly productive pistachio plantations and increase export potential, it will be necessary to conduct research on a comprehensive assessment of the yield and quality of fruits of local forms and the study of these indicators depending on external factors, which is...
very relevant. To date, high-yielding pistachio varieties "Uzbekistan", "Mustakillik", "Bobotog", "Shirin" have been created and introduced into forestry production.

2. Materials and Methods

The object of the research is pistachio collection-uterine plantations at the "Gallaaral" forest experimental station of the Jizzakh province, pistachio forest cultures on the territory of the "Saraykurgan" forestry enterprise of the Samarkand province and natural pistachios at the "Babatag forestry".

The study of phenological, morphological and bioecological indicators in vegetatively propagated forms of pistachio present by observation, taxation and laboratory methods was carried out in industrial plantations grown in rainfed conditions on poor (Saraykurgan) and medium-provided (Nurata) humidity in experimental areas. Research on the selection assessment of pistachio forms was carried out according to the methodology "Comprehensive assessment of the economic and biological characteristics of valuable varieties of pistachio real", developed by GM Chernovaya [3]. Statistical processing of the obtained research results was carried out according to the method of B.A. Dospekhov [1].

3. Results and Discussion

The territories of the Saraykurgan forestry enterprise and the Galyaaral experimental site, where the research was carried out, can be considered favorable for the cultivation of real pistachio. The average annual air temperature is +14.2 and +13.01°C, respectively, the absolute minimum is –30°C and –25°C, the annual precipitation is 313 mm and 360 mm, the average relative humidity is 55.3% and 53.5%. But rare cold snaps, which are sometimes observed in the first and second decades of April, can coincide with the flowering phase and destroy the crop.

It should be noted that valuable forms of present pistachio, regardless of natural and climatic conditions, have different phenophases. This unchanging characteristic is inherent in every variety and form. For example, if in some forms the flowering phase coincides with the first decade of April, then in others it coincides with the first decade of May. In accordance with this, the ripeness of the crop is divided into early (third decade of July), medium (until mid-August) and late (third decade of August).

The phenophase of the present pistachio proceeds differently in different climatic regions. In turn, the selected forms of phenophases proceeded with different periods. For pistachios, the present flowering phase is important, since the safety of this year's harvest depends on the mismatch between the flowering phase and the period of late spring frosts. If the flowering phase on the 518-G maternal tree in Babatag falls on April 12–17, then in the grafted, in the collection on the Gallaaral site, it falls on April 22–28. And on the territory of the Saraykurgan forestry it takes place on April 19-25. If the duration of the formation of the crop (from flowering to full ripening of the fruit) in the form of 518-G in Babatag was 118 days, then in Gallaaral - 115 days, and in Saraykurgan - 113 days.

Table 1. Groups of true pistachio forms in the Saraykurgan forestry enterprise by the timing of the entry into the flowering phase

| #  | Phases            | Forms            | Timing            |
|----|-------------------|------------------|-------------------|
| 1  | Early blooming    | –                | 1–10 April        |
| 2  | Blooming in the middle | 4-SH, 33-SH, 59-G | 10–15 April       |
| 3  | Late blooming     | 518-G, 527-SH, 528-G, 21-SH, 25-SH | 15–20 April       |
| 4  | Very late flowering | 521-G, 22-SH, 52-RG | After 20th of April |
Each phenological phase of pistachio in Gallaaral and Saraykurgan began 6–14 days later than in Babatag. Despite this, it was noted that the duration of the crop formation in comparison with Babatag was reduced by 3-7 days (518-G and 527-SH). The main reason for this is the relatively high soil moisture.

The beginning of the growing season of the present pistachio forms selected in Saraykurgan takes place in the 2-3rd decade of March. The flowering phase in the studied forms lasted from April 14 to May 2. Late flowering times reduce the risk of spring frost. The data obtained show that the flowering phases in forms 21-SH, 22-SH and 52-RG, both on the mother trees and on vegetatively propagated trees, remained unchanged - flowering in both cases occurred at a later date (Table 1).

It is known that as soon as the flowering phase ends, the fruit formation phase begins. The formation of the present pistachio fruit occurs in two stages: the first stage is the development of the endocarp of the fruit (fruit shell), which lasts from the 3rd decade of April to the 3rd decade of June, and the second stage - the formation of the nucleus of the fruit can continue from the end of July to the end of August.

One of the main indicators that determine the quality of real pistachio fruits is large-fruited. In the experiments carried out, it can be observed that on vegetatively propagated trees, valuable characteristics of mother trees are not preserved or they are partially changed.

![Figure 1. Change in the size of pistachio fruits in the Gallaaral experimental plot comparison with the Saraykurgan forestry enterprise](image-url)

The grafted trees in the Gallaaral experimental plot showed an increase in the size of the fruits in comparison with the fruits of the Saraykurgan trees. At the same time, a noticeable change was observed in the length and thickness of the fruit. Fruits of forms 527-SH and 528-D increased in length...
by 4.61% and 2.34%, respectively. And in terms of thickness, the best indicator was for forms 518-G and 521-G - 4.62%. Fruits of form 518-G, decreased in width by 0.18%, and in thickness by 3.95% (Figure 1).

The main difference in the biometric parameters of fruits of mother trees of promising forms, selected in Saraykurgan and grafted trees, was observed in the thickness of the fruits (0.22-8.97%). If the changes in the length of the fetus were in the range of 0.25-1.81%, then the width of the fruit alters in the range of 0.39-6.47%. The significant difference in the thickness of the fruit is explained by the fact that the opening of the fruit is of different sizes. Typically, the endocarp of a pistachio fruit opens up to a size of 0–5 mm (Figure 2). Thus, the opening of the fruit is the reason for the change in thickness to varying degrees [2].

![Figure 2. Changes in the size of fruits in grafted pistachio trees, comparison with mother trees in the Saraykurgan forestry enterprise](image)

The degree of one-dimensionality of the true pistachio fruit, selected on the territory of Babatag, in Saraykurgan and Gallaaral, was in the range of 67.8–86.7%. The breeding assessment for this indicator was carried out on a 3-point scale. The number of one-dimensional fruits in all forms of pistachio growing in Saraykurgan was over 80% and was estimated by 3 points. The lowest indices of unidimensionality of fruits were observed in forms 518-G and 521-G on the territory of Gallaaral, while the number of unidimensional fruits by forms was 67.8% and 73.3%, respectively, and was assessed by two points. Although the biometric indicators of fetuses were higher in Gallaaral, in Saraykurgan the number of one-dimensional fruits predominated.

Exactly the same work on the assessment of fruits was carried out on the forms selected in Saraykurgan. Form 33-Sh (88.9%) has the highest rate of unidimensionality of fruits for maternal trees, and the lowest rates are for forms 22-W and 59-D, in which unidimensionality was 76.7% and 78.9%, respectively, with an estimate of 2 points. On grafted trees, a decrease in the number of one-dimensional fruits can be observed. The highest rate of unidimensionality of fetuses was noted in forms 25-W and 33-Sh, which, respectively, amounted to 84.4% and 82.2% and was assessed by 3 points. In the rest of the forms, the unidimensionality of the fruits was below 80% and they were assessed by two points. Forms 52-RG and 4-W (67.8% and 70%) have the lowest one-dimensionality index.
According to the level of one-dimensionality of fruits (over 60%), all studied forms meet the requirements for varieties and forms of pistachio recommended for the creation of industrial plantations.

High level of fruit opening (over 80%) of the studied forms of real pistachio, which meet the requirements for the best varieties of pistachio was noted for form 528-G - 97%, and the lowest rate for form 521-G - 86.3–89% (Figure 3).

![Figure 3](image)

**Figure 3.** Qualitative indicators of the fruits of pistachio forms in different areas

The fruits of the present pistachio are of different sizes, respectively, and have different weights. The higher the weight of the fruit, the larger it is and this increases the price of the product. According to general principles, large fruits reduce the number of fruits in 1 kg (800-900 pieces/kg), while small ones - on the contrary, increase (1000-1300 pieces/kg). Although large-fruited trees have the same yield as small-fruited trees, growing large-fruited is more efficient economically.

Pistachio forms, propagated by grafting, do not fully preserve the quality indicators of the fruits of the mother tree. As the reasons for this, one can indicate the biological and ecological characteristics of the rootstock, microclimatic and soil conditions of the area. According to the results of research in the forms of pistachio propagated by grafting in the Saraykurgan forestry enterprise and the Galyaaral experimental station, a noticeable positive variability was revealed (Figure 4).

When selecting and evaluating the present pistachio forms, special attention was paid to the size of the fruit. The results of studies of biometric indicators of the fruits of the studied forms showed that forms with very large fruits (volume over 4 cm$^3$) are not found. The forms 521-G and 527-Sh taken from Babatag were identified as large-fruited. Their volume was 3.74 and 3.21 cm$^3$, respectively, and was evaluated by two points. Large-fruited forms were not found among the forms taken from Saraykurgan. Fruits of forms 52-RG and 59-G are categorized as medium size by volume. The volume of fruits of other forms was not estimated due to the fact that they were less than 2 cm$^3$, and were assigned to the small-fruited group.
Figure 4. Variability of quality indicators of fruits in grafted pistachio trees in Saraykurgan (in comparison with the mother tree)

In terms of the yield of the present pistachio forms, the highest rate was observed in Gallaaral. Form 518-G yielded 3.2 kg/tree annually and this figure was 204.3% higher than in Saraykurgan. Exactly the same high rate was observed in the form 527-SH: if the average yield per tree in Saraykurgan was 1.36 kg, then in Galyaaral this figure was 2.33 kg (159.1%). In both territories, the lowest yield was observed for form 528-G: in Saraykurgan - 1.40 kg/tree, and in Galyaaral - 1.37 kg/tree. The trees were 20 years old.

Factors that determine the future harvest of the present pistachio. During the study period, the highest rate in terms of the number of shoots that formed generative buds this year for the next year's harvest was noted in forms 527-SH and 4-SH (over 80%) and was rated 5 points. And the lowest rate was observed in forms 518-G and 33-W (less than 70%) and they were rated 3 points. Form 4-Sh on the territory of Saraykurgan had the highest rate in terms of the number of generative buds (80.7%), which was rated 5 points. The lowest indicator was observed in form 33-W (below 70%) with a score of 3 points. Other forms, according to the number of formed generative buds, were in the range of 70–79% and were assessed by 4 points.

The biochemical composition of the fruits of the true pistachio forms in the territories was studied separately. According to the results of the study, the amount of fat in the fruits of the pistachio forms selected in the territory of Babataq was 0.7–5.4% higher in Saraykurgan than in Gallaaral. The main reason for this is the relatively high air temperature and low annual precipitation in Saraykurgan. On the contrary, the amount of sugar in the fruits of the forms growing in Gallaaral was higher. The highest level of fat was observed in fruits of forms 527-III (62.1%). A high level of sugar was noted in form 521-G (6.7%). In order for the real pistachio fruits to have a peculiar taste, the amount of sugar in them must be above 4%, and the amount of fat in the range of 58–60%.

During the growing season, from flowering to the formation of real pistachio fruits, various factors affect the yield reduction. In particular, during the flowering period, the flowers are not completely pollinated and are damaged by various pests, and during the period of fruit formation - by a hot and dry wind, and during fruit ripening - by diseases and pests. In addition, it was revealed that due to the lack of nutrients and moisture on the trees of the present pistachio, there is a premature loss of fruits.
The yield safety of the studied forms of real pistachio was 10.4% on average, i.e. almost 90% of the harvest is lost as a result of the effects of various adverse factors.

According to the results of a comprehensive assessment of the studied forms in Saraykurgan, only the form 521-G from Babatag was rated 5 points. This form also scored higher on the territory of Gallaaral than other forms. The rest of the pistachio forms growing in both experimental territories were evaluated by 4 points. Form 52-RG from Saraykurgan, gaining 143 points, showed the highest rate and was rated 5 points. Forms 21-SH and 59-G were evaluated with 4 points. These forms of pistachio meet the requirements for varieties recommended for plantations. It should be noted that the forms 4-W and 25-W in the mother tree were rated 4 points, and in grafted trees - 3 points. This means that grafting pistachios partially changes their biological and ecological characteristics.

Pistachios created by sowing seeds to a permanent place, after grafting, begin to bear fruit for 4 years. The created pistachio trees begin to generate income in 8–10 years, after entering the full fruiting season. In this regard, the creation of pistachio plantations is a long-term process, but in a short time all costs are covered. The main costs of establishing plantations are the costs of sowing and maintenance. It includes the following types of work: soil cultivation, harvesting seeds and sowing, setting up fences, feeding young plants during the growing season, grafting and other care work. Under rainfed conditions, an acceptable sowing scheme for creating pistachio plantations is considered to be 8x6 m. With this scheme, 192 trees are placed on one hectare. Therefore, if arranged one pollinator tree to 7 female specimens, then there will be 168 fruit trees in total. After 15 years, the pistachio tree begins to bear fruit intensively and each tree yields up to 4.5–6 kg in natural conditions. When using agrotechnical measures, it can be got an average of 10-12 kg yield for each tree.

4. Conclusions
It was revealed that a high amount of annual precipitation has a positive effect on the volume and quality of the pistachio harvest in the Gallaaral experimental plot. When creating pistachio plantations, it is recommended to use varieties with different periods of flowering and fruit ripening. This arrangement reduces the likelihood of damage to the pistachio flowers by spring frosts, increases the chances of pollination and ensures that the harvest is carried out in stages. For the creation of plantations in forestry, promising forms 518-G, 521-G, 527-SH, 528-G, 52-RG, 21-SH and 59-G are recommended as the most productive, large-fruiting and resistant to adverse environmental factors, and also pests.

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