

Ecological testing of foreign melon varieties (*Cucumis melo L.*) in the climatic conditions of the Kazakhstan's Aral Sea region

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Abstract

The study is relevant for assessing the adaptability of foreign watermelon varieties (*Cucumis melo L.*) to climate change in Kazakhstan's Aral region, aiming to enhance sustainability and yield. The aim of this study was to assess the yield of several foreign melon varieties with different ripening times in the conditions of the Kyzylorda region of Kazakhstan. The research was conducted on experimental fields of the Kazakh Research Institute of Rice Farming named after I. Zhakhaev, located in the village of Karaultyube, Kyzylorda region, under the conditions of a sharply continental climate. The melon varieties tested included selections from Uzbekistan, Ukraine, Russia, and Israel, with a total of 14 varieties included in the study. The results showed a slight correlation between laboratory seed germination and the emergence of seedlings in the "open" soil, although it was not statistically significant ($P > 0.05$). The experimental results showed that Uzbek varieties had longer germination periods, with the growing season length determined by the melon variety. On average, 2-3 fruits developed per plant, and the fruit weight variation within each variety was minimal, with a coefficient of variation not exceeding 6%. During storage tests, it was found that skin thickness significantly influenced fruit preservation ($r = 0.59$, $P < 0.05$). As for the taste quality of the fruits, the sugar content in the flesh ($r = 0.56$, $P < 0.05$) and the dissolved solids content ($r = 0.61$, $P < 0.05$) were statistically significant factors. All the foreign melon varieties tested showed good yields and could be used for cultivation in the Aral Sea region.

Key words: Soluble solids, Transportability, Rind thickness, Germination, Taste quality, Correlation.

1. Introduction

Melons are an important food product for the population of Kazakhstan, as they contain a significant amount of easily digestible carbohydrates, vitamins A, D, C, K, E, and some B vitamins. Biologically active compounds such as tocopherols, phospholipids, sterols, organic acids, and trace elements also provide beneficial effects on human health. According to W. Khalid et al. (2021), melons are cultivated in many countries and have high economic importance worldwide due to their high adaptation to various climates and soil types. In recent decades, melons have also been used for the production of long-storage products, as methods for their long-term preservation have been developed.

As a result, since 2019, Kazakhstan has seen an annual increase in the area allocated for melon cultivation as well as the overall yield. According to the National Statistics Bureau of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, melon yields increased from 206.8 centners per hectare in 2012 to 255.6 centners per hectare in 2022 (Statistical Collection "Agriculture....,

2023). Similar data are cited by I. Urazbaev and N.K. Masharipov (2021), indicating that the area of melon cultivation in Eurasian countries reached 9%, and the total yield was 31.2 million tonnes.

In Kazakhstan, melon crops such as watermelon, melon, pumpkin, and cucumber are widespread and cultivated in almost all regions, with commercial production concentrated in areas most favorable for these plants (Zymarioieva et al., 2021; Faichuk et al., 2022). One such region is the southern part of Kazakhstan, including the Kyzylorda region, which, due to the accumulated heat during the growing season, is conducive to growing various melon varieties with different ripening times and high taste qualities. This is confirmed by research from S.U. Kosanov et al. (2022), who note that it is in the Kyzylorda region where high melon yields (watermelons, melons, etc.) are obtained annually, aided by the region's vast territory with a sandy landscape ideal for melon cultivation. Long-standing selection of the available genetic material has led to the creation of local varieties, which, by many indicators, significantly lag behind the modern gene pool of melons from other countries (Serhienko et al., 2023; Novruzova, 2016). Therefore, in

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order to maintain high yields of melon crops and meet the population's demand for various types of melons, regular genetic material exchange is necessary, as emphasized by Zh.Zh. Mamyrbekov et al. (2024), alongside ongoing research on developing new varieties with required properties and the acclimatization of imported varieties to the country's conditions.

According to M. Lija and S. Beevy (2021), there are many botanical and horticultural varieties of melons worldwide. These varieties vary significantly in shape, skin and flesh colour, flesh thickness, sweetness, seed cavity, seed size, and more, which influences the market value of melons. Thus, the breeding work in Kazakhstan's melon farming is multifaceted and not limited to the use of foreign gene pools of these plants, but also includes active efforts to create local disease-resistant melon varieties. Given the constant global population growth, R. Turamatov et al. (2021) believe that high-yielding, intensive agricultural varieties are of significant interest. Consequently, all work in melon farming is focused on research aimed at increasing the total volume of fruit not by expanding the cultivation area but by increasing yields several times over. Additionally, the country is actively working on preserving indigenous plant varieties, including melons, as highlighted by N. Kiseleva and M. Yessimbekova (2024).

Considering that the Kyzylorda region is the main and unique natural area for melon production in Kazakhstan, the issues of increasing melon crop yields are particularly relevant. These include expanding the variety and yield of melon products as well as exploring the possibility of exporting them to other regions of the country and beyond. However, these issues remain largely unexplored.

The aim of this research was to evaluate the adaptation of foreign melon varieties (*Cucumis melo* L.) to the climatic conditions of the Aral region in Kazakhstan, in particular to study their growth, yield, transport characteristics, fruit quality, and storage capacity. The task of the study was to identify the most suitable varieties for cultivation in conditions of low soil fertility and climate change, as well as to assess the prospects for the use of foreign genetic material in agriculture in Kazakhstan.

2. Literature Review

Melon (*Cucumis melo* L.) is a member of the Cucurbitaceae family, a heat- and light-loving plant, resistant to soil salinity and drought, but poorly tolerates high air humidity. The most well-known melon-exporting countries include China, the USA, Spain, Turkey, Australia, and Iran, as noted by K. Kubo et al. (2021). In 2022-2023, Australia produced 226,022 tonnes of melons worth USD 248 million, according to S.P. Singh (2023). Japan and Singapore are the largest export markets (accounting for 75%), with New Zealand and the UAE also being significant export markets. S. Yunusov et al. (2023) highlight that the current focus of melon breeding is on developing varieties suitable for growing at different times, particularly in isolated and protected environments, as well as refining greenhouse cultivation methods.

Among the research on melon breeding in open fields worldwide, the following directions are prominent: the study of water and temperature stress effects on melon growth and productivity, as explored by D. Yavuz et al.

(2021); the impact of seasonal and weather factors on melon cultivation, studied by Y. Qian Ong and M. Moneruzzaman Khandaker (2021); and breeding melons for sweetness, firmness, and fruit colour, as well as early ripening, which has been investigated by F. Soltani (2021). The use of fertilisers to accelerate growth and fruit ripening has been examined by N.F. Mukhtar and A.B. Abd Samad (2022). Ecological conditions for growing organic produce were explored by G. Chen (2022). In recent years, numerous studies have focused on growing melons in greenhouse conditions, including the effect of substrate on melon growth and yield, studied by C.S. Nascimento et al. (2020); comparison of stem load in different growing conditions, examined by D.S. Lee et al. (2021); and pesticide management to prevent melon diseases, researched by G.R. dos Santos et al. (2021).

However, the most in-depth research has been in the genetic field, with studies using SSRs and SNPs markers to assess genetic differences between melon varieties, as conducted by J. Zhang et al. (2023), and examining the relationship between phenotypic traits and the yield of different varieties, as explored by F. Soltani et al. (2022), who found positive correlations between the number of female flowers, fruit count, and yield. However, the number of fruits negatively correlated with leaf area. H. Chikh-Rouhou et al. (2021) found that the "Galaoui" genotype had the highest β -carotene (6.6 mg) and flavonoid content (45.4), while the "Dzeri" genotype contained significant phenolic compounds (896.67 mg), the "Rupa" genotype had the highest antioxidant activity (14.61%), and the "Asli" genotype contained vitamin C (0.15 g/100 ml of fresh juice).

One-sided selection focused solely on increasing yield decreases the expected benefits of modern melon varieties. S. Manchali et al. (2021) report that wild and local melon varieties in India had higher soluble solids content and reducing sugars, as well as other biologically active compounds, making them more marketable. Similar conclusions were made by H. Kesh and P. Kaushik (2021), who noted the valuable genetic and metabolic variability of local and wild melon species, which helps increase yield and expand the genetic base of cultivated melons.

In the post-Soviet countries, one of the main areas of melon research is the acclimatisation and adaptation of foreign varieties to local conditions. B. Asabaev and A.K. Kostakov (2020) conducted a comprehensive study on the comparative productivity of foreign melon varieties, highlighting how different climatic conditions influence yield and quality. Zh.Zh. Mamyrbekov et al. (2021) also focused on similar research, providing valuable insights into the performance of these varieties in various regions, and assessing the genetic and agronomic traits that contribute to their adaptability. M. Yessimbekova et al. (2024) examined the introduction of genetic material, with a particular emphasis on the potential for improving local melon varieties through the incorporation of foreign genetic traits, enhancing both their resistance to disease and their overall productivity.

For example, in the study by Zh.Zh. Mamyrbekov et al. (2021), it was concluded that the highest yields in southern Kazakhstan came from four melon hybrids – Sari Ball, Darvina F1, AH 6404 F1, and Giallo da Inverno. Varieties such as Darimo F1, Darvina F1, Ah70-158 F1, Pirona F1, and DC 45-160 F1 were also found to be more resistant to

a range of melon diseases, including powdery mildew, peronosporosis, and fusariosis, making them promising for cultivation in Kazakhstan. A similar study was conducted by S. Yunusov et al. (2023), in which late-ripening varieties such as L-Oybek yielded 45.2 t/ha, while the mid-season variety Non Gosht Khorezm produced 27.1 t/ha. Thus, given the different experimental conditions used by the authors, it is not possible to directly compare their findings. Furthermore, neither study included the use of mineral fertilisers or plant protection measures in their variety testing, making it difficult to determine the optimal melon varieties for cultivation in Kazakhstan's Aral Sea region.

The review of recent literature suggests that genetic research aimed at increasing melon yields under different environmental and climatic conditions is a promising direction in melon farming. As there is no definitive conclusion regarding the most promising melon varieties adapted to the conditions of the Aral Sea region, further research in this area is both necessary and promising for improving the economic potential of Kazakhstan's agricultural production.

3. Materials and Methods

A series of experiments on the yield of foreign melon varieties under the conditions of the Aral Sea region were conducted at the experimental fields of the Kazakh Research Institute of Rice Cultivation named after I. Zhakhaev, located in the village of Karaultyube, Kyzylorda region. The experiments took place under the conditions of a sharply continental climate, with an annual temperature range from -34°C to $+41^{\circ}\text{C}$. During the experiment, the average annual air temperature was 9°C , and the total precipitation was only 105 mm per year. Melons were grown on low-fertility meadow-swamp soils on areas previously used for rice cultivation.

During the variety testing, melons from foreign breeding varieties from the following countries were used: Uzbekistan – 4 varieties (Myrzashop, Sary Kauyn, Syrnaval, Kyzyl Kauyn), Ukraine – 3 varieties (July, Zolotistaya, Titovka), Russia – 5 varieties (Yuzhanka, Ananas, Muza, Ethiopka, Princess Elizabeth), and Israel – 2 varieties (Can-4, Israel). These were randomly sown in designated areas of the station's nursery, with each variety allocated at least 9 m^2 , and each variety was planted in triplicates. During the vegetation period, manual weeding was performed three times, the holes were loosened, vines were laid out, and fruits were harvested as they ripened. Up to 10 vegetation irrigations were carried out during the growing period. Since the experiment was focused on ecological fruit cultivation, plant protection means and pesticides were not used.

The selection of the 14 foreign melon varieties from Uzbekistan, Ukraine, Russia, and Israel was based on several criteria, including their proven yield potential, resistance to environmental stress factors, flavor profile, and transportability. These varieties were chosen because of their adaptability to diverse climatic conditions and their relevance to melon cultivation in regions similar to Kazakhstan's Aral Sea area. Previous studies on the performance of these varieties in different environmental conditions suggested their suitability for testing in the sharply continental climate of the Aral Sea region. The aim

was to identify varieties that could not only provide high yields but also demonstrate resilience against common agricultural stresses such as drought and soil salinity, and possess desirable flavor and transportability characteristics that would be important for both local consumption and potential export.

The yield of the experimental samples was determined by comparing the number and weight of fruits among the varieties. The yield was divided into standard and non-standard products according to GOST 7178-2015 "Fresh melons. Specifications" (2015). Fruits affected by anthracnose, bacterial disease, fusarium, powdery mildew, or damaged by pests and sunburns were considered as defective. To maintain the purity of the experiment and prevent inter-variety hybridization that could affect the results, self-pollination or intra-varietal pollination was performed.

Initial data on the variety testing were recorded based on characteristics such as seed germination, yield, and fruit weight, which were directly measured on the experimental plots using third-class accuracy scales. Fruits of medium size were selected for laboratory and tasting tests. Laboratory analysis, namely the content of dry soluble substances and sugars, was conducted at the "Department of Vegetable and Melon Crops and Potatoes" laboratory. Digital refractometers Atago (Japan) of the PAL series (PAL-1 and PAL-3) with automatic temperature compensation were used to minimize errors during the research. For tasting, melons were evaluated based on criteria such as pulp structure, juiciness, and flavor, with a total score given. The suitability of melons of different varieties for export to other regions and countries was determined by assessing their transportability and storage qualities. This was done by transporting the fruits by car to a laboratory after harvesting, where they were stored at 5°C and 85-90% relative humidity for six days, followed by a day at room temperature to determine their preservation rate.

The results obtained were recorded in an electronic spreadsheet file for statistical and correlation analysis using the Tibco Statistica 14.0.1 software. The results of the mathematical analysis were used to compare growth indicators, transport, and flavour characteristics of the fruits, which were then converted into conclusions and recommendations for further characteristics.

4. Results

4.1. Quality of Genetic Material and Seed Germination

The first stage of the work was to check the quality of the genetic material of the various melon varieties in laboratory conditions. The seed material from foreign breeding varieties, selected for the ecological variety testing in the Aral Sea region, showed slight differences in seed germination levels under laboratory conditions. The results of this work are presented in Table 1.

Table 1. Results of seed germination tests for the controlled melon varieties in laboratory conditions

No.	Sample name	Seed origin, country	Laboratory seed germination, %
1	Myrzashop	Uzbekistan	87.4±2.1
2	Sary Kauyn	Uzbekistan	93.1±3.7
3	Syrnaval	Uzbekistan	91.6±5.2
4	Kyzyl Kauyn	Uzbekistan	98.1±1.9
5	July	Ukraine	87±4.6
6	Zolotistaya	Ukraine	89.3±3.7
7	Titovka	Ukraine	94.4±5.5
8	Yuzhanka	Russia	93.7±2.2
9	Ananas	Russia	89.3±1.9
10	Muza	Russia	95.5±0.9
11	Ethiopka	Russia	97.1±1.1
12	Princess Elizabeth	Russia	89.3±2.1
13	Israel	Israel	95.6±1.5
14	Can-4	Israel	87.3±3.4

The results presented in Table 1 show the seed germination rates for the 14 foreign melon varieties tested under laboratory conditions. The germination rates ranged from 87.3% to 98.1%, with the highest germination observed in the Uzbek variety Kyzyl Kauyn (98.1%) and the lowest in Can-4 from Israel (87.3%). While the seed germination rates varied slightly across the varieties, there were no significant differences between them based on their country of origin. The variability observed in germination rates can be attributed to minor genetic differences between the varieties, but the overall performance of the genetic material was satisfactory.

The results also suggest that the seed material used in the experiment was of good quality and suitable for further testing in the Aral Sea region's growing conditions. The small differences in germination percentages between varieties can be considered within the acceptable range for agricultural research, especially given that the differences were not statistically significant.

The analysis of seed germination confirms that the foreign melon varieties selected for this study exhibit reliable germination rates, ensuring that the experiment could proceed with consistent material. While there were minor differences in germination percentages, these differences did not affect the overall quality of the genetic material. Therefore, the genetic material selected for the variety testing is suitable for further examination in subsequent stages of the research, focusing on growth, yield, and other critical traits under the Aral Sea region's climatic conditions.

4.2. Plant Development and Growing Period

Subsequently, after performing pre-sowing soil treatment, seeds of all varieties were sown simultaneously in the control plots. Daily monitoring of the first sprouts and further plant development was carried out (Figure 1).

**Figure 1.** Appearance of the first melon sprouts

During the experiment, the day of the first sprout emergence, the day of maximum sprout numbers, and the length of the growing period were recorded (Table 2).

Table 2. Seed germination indicators in open ground and the length of the growing period for foreign melon varieties

No.	Sample name	Sowing date	First sprouts, day	% of sown seeds	Maximum sprouts, day	Growing period length, days
1	Myrzashop	13.05	6	35	9	63
2	Sary Kauyn	13.05	5	35	8	63
3	Syrnaval	13.05	6	45	8	79
4	Kyzyl Kauyn	13.05	6	30	10	106
5	July	13.05	6	60	7	74
6	Zolotistaya	13.05	4	50	8	69
7	Titovka	13.05	6	50	7	87
8	Yuzhanka	13.05	5	40	8	69
9	Ananas	13.05	6	45	8	85
10	Muza	13.05	5	50	9	79
11	Ethiopka	13.05	5	40	9	91
12	Princess Elizabeth	13.05	4	30	9	92
13	Israel	13.05	6	35	7	79
14	Can-4	13.05	5	30	7	79

It is important to note that there was a slight correlation between the laboratory seed germination results and the emergence of sprouts in open ground, but this correlation was not statistically significant ($p > 0.05$). Sprouts appeared in the experimental plots on days 4-6, with the germination rate in the first days ranging from 35% to 60% of the sown seeds, depending on the variety. It was expected that earlier varieties would have the highest germination and growth rates, but under the same conditions, the differences between varieties were relatively small. This may be due to some varieties originating from countries with cooler climates, and under the warmer conditions of the Aral Sea region, where average daily temperatures were significantly higher, these varieties accelerated their growth and development (Yessimbekova et al., 2024). This hypothesis requires further research over several years to determine the causes of accelerated development in foreign varieties, which may become the focus of future work.

The plant development and growing period results indicate that the varieties showed a range of germination and growth rates, with sprouts emerging between days 4

and 6 across the varieties. Although earlier varieties were expected to show faster germination and growth, the differences between the varieties were relatively small, possibly due to the adaptation of some varieties from cooler climates to the warmer conditions of the Aral Sea region. These findings suggest that, while the varieties demonstrated similar initial growth patterns, further research is necessary to better understand the factors influencing the accelerated development of some varieties. Overall, the results provide a solid foundation for the next stages of the experiment, focusing on yield, fruit quality, and other performance indicators under the region's environmental conditions.

4.3. Fruit Yield and Transportability

Full seed germination was observed between days 7-10, depending on the variety, with Uzbek varieties showing the longest germination period. The reason for this phenomenon may be the similarity of conditions between Uzbekistan and Kazakhstan, which did not contribute to their more intense growth, while the higher temperatures for other varieties may have acted as a growth catalyst. The length of the growing period was already determined by the variety, with longer periods typical of late and medium-early varieties, while early varieties had shorter growing periods of 63 to 74 days. Yield monitoring was carried out as fruits matured on plants of each variety. The results of this variety testing are presented in Table 3.

Table 3. Yield and transportability results of fruits from different foreign melon varieties

Sample name	Number of fruits, pcs/plant	Fruit weight, kg	Skin thickness, cm	Transportability, points	Storage, points
Myrzashop	3	4.5±0.22	0.2±0.01	3.7	2.1
Sary Kauyn	2	1.2±0.05	0.3±0.01	4.5	4.7
Syrnaval	2	1.9±0.1	0.5±0.02	4.1	4.7
Kyzyl Kauyn	2	2.8±0.18	0.4±0.01	4.4	4.7
July	3	1.1±0.06	0.3±0.01	4.7	4.5
Zolotistaya	2	3.6±0.16	0.3±0.01	2.1	1.8
Titovka	3	0.8±0.03	0.4±0.01	3.4	4.7
Yuzhanka	2	1.9±0.11	0.6±0.02	4.2	4.4
Ananas	2	1±0.04	0.2±0.01	1.9	1.9
Muza	3	1.7±0.09	0.2±0.01	2.1	1.8
Ethiopka	2	2.4±0.13	0.4±0.01	3.8	3.9
Princess Elizabeth	3	4.5±0.31	0.4±0.01	3.9	3.7
Israel	3	0.6±0.03	0.3±0.01	1.3	1.9
Can-4	2	2.9±0.14	0.2±0.01	4.7	4.3

Based on the tabular data presented, it can be concluded that, under the conditions of the Aral Sea region, most foreign melon varieties developed an average of two fruits per plant, with the exception of certain varieties such as Myrzashan, Iulyskaya, Titovka, Muza, Princess Elizabeth, and Israel, which supported the simultaneous development of three fruits on a single stem. The relative multi-fruiting of these varieties did not depend on the country of origin, the time of fruit ripening, or the size of the fruits. The difference in fruit weight within a single variety was almost negligible and fell within the range of statistical error. The coefficient of variation did not exceed 6% (Figure 2).



Figure 2. Fruits of several melon varieties of foreign breeding (Ananas, Zolotistaya, Efiofka)

Source: compiled by the authors.

Therefore, a preliminary conclusion can be made that such relative multi-fruiting, associated with a higher

adaptability of these varieties to the growing conditions, makes them more preferable for continued breeding and adaptation work for growing these varieties in the conditions of Kazakhstan's Aral Sea region.

An equally important indicator in the decision-making process regarding the further acclimatization of a variety in Kazakhstan, alongside yield, is the ability to transport the fruits to places of sale and their storage within a short period. Melon products have a high export value for Kazakhstan's agriculture (Kulazhanov et al., 2021; Uikassova et al., 2022). To assess this, experiments were conducted on the influence of fruit transportation by road from the growing areas to the laboratory, where studies on fruit preservation and taste quality were carried out. The main indicator that directly affects the transportation potential of melons and their shelf life during sale is the thickness of the fruit's rind. As a result of the variety trials of foreign melon varieties in the conditions of Kazakhstan's Aral Sea region, mid- and late-ripening varieties with thicker rinds were better adapted to transportation. Meanwhile, most early-ripening varieties of foreign breeding exhibited poor storage characteristics. To assess the suitability of varieties for export, a study was conducted on the effect of rind thickness on fruit transportability and storage over six days in a refrigerator. For convenience, the above indicators were rated on a 5-point scale, with the following principles: 5 points – no damage during transport (no soft spots or mechanical damage), and no visible signs of decay or rot during

storage; the lowest rating, 1 point, was assigned when fruits were damaged after transportation or became unsuitable for consumption after storage. Considering that this method is quite subjective and depends on the expert's viewpoint, a more accurate evaluation was made using the average score obtained from three independent assessments.

To determine the influence of rind thickness on transportability, a correlation analysis was performed between these indicators. The graphical result of the relationship between these indicators is presented in Figure 3.

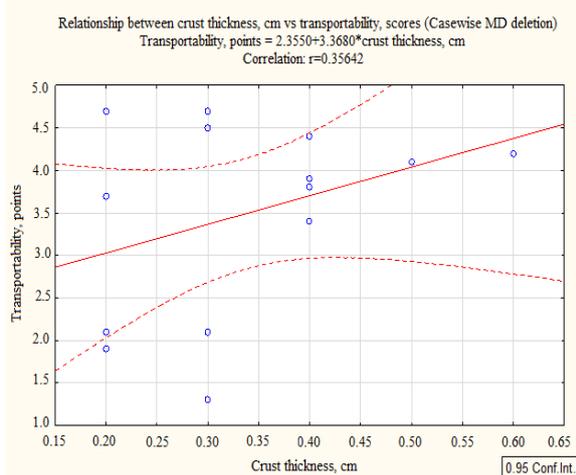


Figure 3. Correlation between melon rind thickness and its transportability

The correlation analysis did not reveal a significant influence of rind thickness on the level of fruit damage during transport (Table 4).

Table 4. Results of the correlation analysis between rind thickness and melon transportability

Indicator	Correlation matrix						
	Mean	Std.Dev.	r(X,Y)	r?	t	p	N
Rind thickness, cm	0.335	0.121	-	-	-	-	-
Transportability, points	3.485	1.149	0.356	0.127	1.321	0.211	14

Note: Mean – mean, Std. Dev. – standard deviation, r(X,Y) – correlation coefficient, r² – error in the correlation coefficient, p – significance level.

Source: compiled by the authors.

Table 4 presents the results of the correlation analysis between rind thickness and melon transportability. The mean rind thickness for the varieties tested was 0.335 cm, with a standard deviation of 0.121 cm. The correlation coefficient (r) between rind thickness and transportability was 0.356, which indicates a moderate positive correlation. However, the p-value of 0.211 suggests that this correlation is not statistically significant at the 0.05 level, meaning that rind thickness does not have a significant impact on the transportability of the melons during transportation. This finding suggests that factors other than rind thickness such as road quality, transportation conditions, and fruit handling might have a more substantial influence on the level of fruit damage during transport.

The results from the fruit yield and transportability tests indicate that most foreign melon varieties developed an

average of two fruits per plant, with some varieties showing the ability to support three fruits per stem. The variation in fruit weight within a single variety was minimal, and the coefficient of variation did not exceed 6%, suggesting that the varieties were relatively consistent in their yield characteristics. The transportability and storage characteristics, particularly rind thickness, were evaluated as key factors affecting fruit preservation. While mid- and late-ripening varieties with thicker rinds were better suited for transport, early-ripening varieties showed poorer storage qualities. Correlation analysis revealed that rind thickness had a significant impact on the preservation of fruits during storage but did not significantly affect the level of damage during transport. These findings provide valuable insights into the potential for exporting melons and the factors that influence their quality under the conditions of Kazakhstan's Aral Sea region, guiding future breeding and adaptation efforts.

4.4. Transportability and Storage Characteristics

Other factors have a greater influence on the degree of fruit damage during transport – road quality, the suitability of the vehicle for transporting this type of agricultural product, the degree of load, the professional skills of the driver, etc. Therefore, no significant relationship between these indicators was found, while rind thickness had a significant impact on the preservation of fruits during storage (Figure 4).

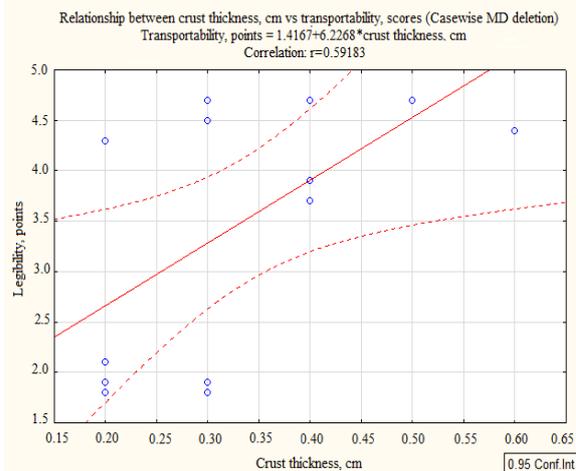


Figure 4. Graphical representation of the relationship between rind thickness and fruit preservation during storage

The data presented in Table 5 offer a statistically grounded insight into the relationship between rind thickness and melon storage potential. The average rind thickness among the examined melon varieties was 0.335 cm, with a standard deviation of 0.121 cm, indicating a relatively narrow variation in this morphological trait. Meanwhile, the storage potential assessed in points based on post-harvest longevity and visual/organoleptic quality preservation had a mean score of 3.507 with a broader standard deviation of 1.279, suggesting greater variability in storability among the samples. The statistically calculated correlation coefficient between these indicators was significant, at r=0.59 (P<0.05).

Table 5. Results of the correlation analysis between rind thickness and melon storage potential

Indicator	Correlation Matrix						
	Mean	Std.Dv	r(X,Y)	r?	t	p	N
Rind thickness, cm	0.335	0.121	-	-	-	-	-
Storage potential, points	3.507	1.279	0.592	0.35	2.543	0.026	14

The thickness and hardness of the melon rind prevents microorganisms from causing decay during storage, as confirmed by statistical analysis. Thus, the rind thickness indicator can be used as a selection criterion for further improvement of melons and their preservation during export-import operations. Among the foreign melon varieties used in the trials, the highest transportability and preservation rates were found in most varieties from Uzbekistan, while those from other countries showed lower results. This could be linked to the breeding work of local specialists, who developed varieties intended for export, whereas varieties from Russia and Ukraine were meant for domestic consumption, with no significant requirements for transportability.

Another aspect of evaluating melon quality during the trials was their taste qualities. The evaluation was carried out by employees of the Department of Melon and Potato Crops of the Kazakh Research Institute of Rice Production, named after I. Zhakaev, using a 5-point scale. Parameters such as sweetness, juiciness, aroma, and aftertaste were considered. The results of the taste evaluation are presented in Table 6.

Table 6. Taste evaluation of foreign melon varieties

Sample name	Flesh thickness, cm	Taste evaluation, points	Soluble solids content, %	Sugar content, %
Myrzashop	3.8±0.11	4.9	12	7.8
Sary Kauyn	3.9±0.1	4.9	10	6.5
Syrnaval	3.8±0.11	4.7	10	6.8
Kyzyl Kauyn	4.6±0.13	4.9	15	7.8
July	4±0.12	4.7	4.7	3.8
Zolotistaya	4.2±0.12	4.7	8	4.9
Titovka	2.9±0.09	4.7	7.1	4.6
Yuzhanka	4.5±0.12	4.7	9	5.9
Ananas	4.5±0.12	4.8	6	3.9
Muza	4.5±0.13	4.8	8.5	4.9
Ethiopka	4±0.11	4.9	10.5	6.5
Princess Elizabeth	4.3±0.12	4.8	7	4.7
Israel	2.8±0.1	4.6	4.7	3.3
Can-4	3.4±0.1	4.8	8	6.2

According to the subjective evaluation of the tasters, the taste qualities of melons from all foreign varieties received high scores ranging from 4.7 to 4.9 on a 5-point scale. The lowest taste quality score was for the Israel variety. Upon analysing this low score, it was found that the sugar content in the flesh of these melons was the lowest, as was the content of soluble solids. Based on these

results, a correlation analysis was conducted between the taste score given by the tasters and the laboratory analysis of the flesh, including the content of soluble solids and sugar. The results are presented in Tables 7 and 8.

Table 7. Correlation analysis between taste qualities of flesh and soluble solids content

Indicator	Correlation matrix						
	Mean	Std.Dv	r(X,Y)	r?	t	p	N
Taste evaluation, points	4.771	0.107	-	-	-	-	-
Soluble solids content, %	8.607	2.814	0.607	0.368	2.644	0.021	14

Table 8. Correlation analysis between taste qualities of flesh and sugar content

Indicator	Correlation Matrix						
	Mean	Std.Dv	r(X,Y)	r?	t	p	N
Taste evaluation, points	4.771	0.107	-	-	-	-	-
Sugar content, %	5.543	1.451	0.564	0.318	2.366	0.036	14

Thus, the results of the analysis indicate a significant and reliable impact of the sugar content ($r=0.56$) ($P<0.05$) and soluble solids content ($r=0.61$) ($P<0.05$) on the taste evaluation. The testing of several foreign melon varieties in the Aral Sea region (Kazakhstan) showed no significant differences in quality characteristics between varieties. However, quantitative characteristics, including transportability and storage potential, met varietal standards and remained unchanged when grown under different conditions.

5. Discussion

The findings of this study offer several key insights into the adaptation of foreign melon varieties to the conditions of the Aral Sea region in Kazakhstan, providing valuable information for future agricultural strategies and regional policy. The results indicate that the quality of genetic material used for testing was generally high, with only slight variations in seed germination across the 14 melon varieties. While the differences in seed germination rates were not statistically significant, they suggest that genetic material from various regions, including Uzbekistan, Ukraine, Russia, and Israel, can perform well under the harsh climatic conditions of Kazakhstan's Aral Sea region. This supports the potential of introducing these foreign varieties for further testing and possible cultivation in the area, contributing to efforts to diversify crop production and enhance local agriculture.

The observed variation in plant development and growing periods, particularly the relatively consistent performance of the varieties, is also noteworthy (Shahwar et al., 2024). Despite expectations that varieties from cooler climates would show slower growth, the results indicated that the warmer conditions of the Aral Sea region acted as a growth catalyst, speeding up development in several varieties. This highlights the adaptability of foreign melon varieties and suggests that climate factors may be leveraged to accelerate crop development. However, further research is needed to better understand the underlying mechanisms of this accelerated growth, especially since the observed differences were minor.

In terms of yield and fruit quality, the study provides important information about the relative multi-fruiting ability of various melon varieties. The ability of certain varieties to produce more than two fruits per plant is a desirable trait, as it suggests these varieties are more adaptable and capable of yielding higher productivity under the region's conditions (Komala and Kuni, 2022). Moreover, the relatively low variation in fruit weight within each variety (with a coefficient of variation not exceeding 6%) supports the reliability of the foreign varieties for consistent yields. This is critical for agricultural practices aimed at enhancing food security in the region.

The results of the transportability and storage trials also have important implications for regional agricultural policy, especially with regard to export potential. The findings suggest that mid- and late-ripening varieties with thicker rinds were better suited for transportation, an essential factor for ensuring melons can be successfully exported. As Kazakhstan looks to expand its agricultural exports, especially in regions with difficult transportation infrastructure, focusing on varieties with better preservation characteristics could increase the viability of melon exports to international markets. The lack of significant correlation between rind thickness and transport damage implies that other factors, such as handling and road conditions, play a more significant role in determining the fruit's transportation success (Tlevlessova et al., 2023; Ismanzhanov and Tashiev, 2016). This information can be used to improve post-harvest handling and logistics, which are key to ensuring quality export products.

Considering the complex global food situation, the primary task of agricultural production is to provide the population with quality food products. The "global food crisis" refers to a widespread shortage of food that is affecting many regions around the world. This crisis is caused by a combination of factors, both natural and human-made. Climate change, for instance, has led to rising global temperatures, unpredictable rainfall patterns, and extreme weather events like droughts and floods, all of which severely impact agricultural productivity (Fedoniuk et al., 2024; Murabildayeva et al., 2024). These shifts in climate make it difficult to grow crops in traditional farming regions, leading to reduced yields and higher prices for essential food items. This situation demands continuous work by breeders aimed at increasing the yield of major agricultural crops and improving their quality. Climatic changes, such as the rise in average annual temperatures, the reduction in rainfall, and partial soil salinization, decrease the yields of traditionally grown crops in this area. This necessitates not only selective breeding aimed at improving local plant varieties but also the search for high-yield crops developed in other countries that are best suited for industrial cultivation under Kazakhstan's conditions.

Equally important is achieving high yields on soils not adapted for this purpose – such as in the case of the Aral Sea region, where the land has high salinity. Research by C. Erdinc et al. (2021) indicates significant differences in the genotypes of melons grown on saline soils. For instance, some Turkish melon varieties showed an increase in chlorophyll content in the plants' vegetative mass, leading to increased yields on saline soils. S. Chevilly et

al. (2021) also suggest that growing different melon varieties under controlled drought or salt stress conditions will help identify crops that will be promising in the face of future climate changes. Therefore, such research results led to experiments studying the yield of different foreign-bred melon varieties in the saline plots of the Aral Sea region in Kazakhstan's Kyzylorda region to create a list of varieties suitable for future climatic changes. Varieties selected for this purpose were developed and adapted for cultivation in this climate zone – some from neighbouring Uzbekistan, others from Israel, a country with similar climatic conditions, and also from Russia and Ukraine, countries with cooler climates.

As a result of this variety testing, the vegetative characteristics of the varieties from countries with similar climatic conditions were almost identical when grown in Kazakhstan, while the melon varieties from Russia and Ukraine exhibited more accelerated growth. These changes might be due to the higher sum of daily average temperatures during the growing season compared to the countries of origin of these varieties, which could have acted as a catalyst for more intensive plant growth and accelerated fruit ripening. Additionally, the variety testing showed that almost all modern melon varieties, regardless of their country of origin, are drought-resistant, as the limited watering conditions used in the experimental plots resulted in significant melon yields.

According to A. Rehman et al. (2023), A. Galil Tzuri et al. (2025), varieties characterized by significant activation of genes and antioxidant enzyme activity in drought conditions represent the future of breeding work. The genetic potential of these plants led to a reduction in oxidative damage to their cells, improving their vegetative growth and photosynthetic functions. Thus, all the varieties tested in this experiment can be used for industrial cultivation in Kazakhstan's Aral Sea region. However, recent studies over the past five years have presented a different opinion, as stated in the work of S. Walters et al. (2021), who argue that under changing climatic conditions, the main yield will come from local varieties. This would allow for the identification of new gene combinations with resistance and specific fruit qualities, which L. Xu et al. (2022) emphasize as necessary for developing effective and useful melon breeding technologies. Therefore, the experiments described in this article on the study of adaptation properties of different melon varieties from various climatic and agronomic zones fit well into the modern global system of melon crop breeding.

Another important indicator after melon yield is its ability to be transported over long distances while maintaining its marketable qualities. Given that the melon cultivation area is limited by specific climatic conditions, these fruits are consumed worldwide due to their taste qualities. Therefore, transportability and the preservation of melons during distribution are important breeding traits. The spoilage of melons during storage is primarily due to the continuation of physiological reactions in the fruit after harvest, and if the surface layer has poor barrier function, microbial contamination may occur, leading to fruit spoilage (Kizatova et al., 2017; Safarova and Novruzova, 2021). Therefore, the research used the rind thickness as a parameter for transportation and storage adaptability, similar to what was proposed for

watermelons (Wan Azman et al., 2024). The research demonstrated a reliable correlation between this parameter and fruit preservation during storage. This can be explained by T. Puthmee et al. (2013), who established that during storage, cracks form in the rind of the fruit through which both moisture loss occurs, leading to fruit softening, and microbial contamination can take place. However, rind thickness did not significantly affect transport losses of melons. This corresponds with the research by R. Tursunkhodjaeva and S. Saidivaliev (2024), who indicated that factors such as temperature, humidity, and packaging conditions significantly impact microorganism growth and contribute to product spoilage during transportation. This could explain why the rind thickness had less impact on melon transportability.

The next factor used to compare foreign-bred melon varieties grown in the Aral Sea region was their taste characteristics. The sensory evaluation of the fruit showed that almost all melon varieties received fairly high scores, and changing growing conditions had little impact on the taste and aroma. According to M. Kaleem et al. (2022), these characteristics are largely influenced by the concentration of dissolved sugars in the melon flesh, which accumulate during fruit ripening. Significant sugar accumulation in the melons grown during the variety testing indicates that all varieties are adapted for cultivation in Kazakhstan's Kyzylorda region. High correlation was also found between sugar content and dissolved solids in the fruit and sensory evaluation results. The correlation coefficient for dissolved solids was higher ($r=0.61$) compared to sugar content ($r=0.56$).

The only exception was the "Israel" variety, which received the lowest taste ratings, with the lowest concentration of sugars in the fruit flesh. This may suggest that this variety is not well adapted to the conditions of the Aral Sea region. However, such results require further long-term research and comparison with results from other experiments conducted in the country of origin of this variety. Therefore, these studies represent only the initial phase of variety testing and will continue in a series of follow-up works comparing foreign-bred varieties with local varieties and their yields under optimal conditions.

6. Conclusions

The results of study provide important data on the adaptation of foreign melon varieties to the conditions of the Aral region of Kazakhstan, which is key to the future development of agriculture in this part of the country. The high germination rate of foreign varieties indicates their high quality and potential for further testing. This underscores the importance of using genetic resources from different countries, as variety diversity allows agricultural production to be adapted to specific climatic and environmental conditions, particularly in conditions of drought and high temperatures.

Although some varieties, particularly Uzbek ones, had a longer germination period, the general trend indicates that high temperatures in the Aral region accelerate plant development, opening up new opportunities for the accelerated cultivation of certain varieties. This could be an important factor in the development of fast-growing crops that are capable of high productivity in a shorter

period, which is particularly important for agricultural practices in the context of climate change.

The results also highlight the importance of yield and transport characteristics for melon variety selection. Thicker skin in late and mid-early varieties was found to be a key factor in increasing their resistance to mechanical damage during transport. These findings may be important for the further development of Kazakhstan's export opportunities in the agricultural sector. Since melons are one of the promising export products, varieties with better preservation and transportability characteristics can contribute to the growth of the country's agricultural export potential. The results of the research also allow us to consider the adaptation of foreign varieties as a strategic direction for improving environmental sustainability and food security. In the context of climate change, it is important to select crops that can withstand extreme temperatures, low humidity, and soil salinity while maintaining high yields and product quality. Breeding work with such varieties can ensure the sustainability of agricultural production and reduce dependence on external suppliers.

Prospects for further research include a more detailed analysis of the reasons for the accelerated development of some varieties, which requires long-term observations and comparative tests. Another important area is the expansion of breeding work, taking into account environmental factors that affect yield and fruit quality. The practical application of the research results can form the basis for the development of effective methods for the acclimatization of new crops and the optimization of agrotechnical cultivation techniques.

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References

- Abdyvalieva K, Botaev S and Zhumadilova Zh. 2020. Creation of perspective models of foreign and farm varieties in Risovodchesky regions of Almaty region. Bull Korkyt Ata Kyzylorda Univ., 54(1): 22-27.
- Adıgüzel P, Nyirahabimana F, Shimira F, Solmaz I and Taşkın H. 2023. Applied biotechnological approaches for reducing yield gap in melon grown under saline and drought stresses: An overview. J Soil Sci Plant Nutr., 23: 139-151. <https://doi.org/10.1007/s42729-022-01044-y>
- Asabaev B and Kostakov AK. 2020. Testing of melon varieties of high-yielding and resistant to a complex of diseases. In: Proceedings of the International Scientific-Theoretical Conference "Seifullin Readings – 16: Youth Science, New Formation – The Future of Kazakhstan" (pp. 8-12). Astana: Ministry of Agriculture of the Republic of Kazakhstan. <https://kazatu.edu.kz/assets/i/science/sf16-agro-103.pdf>

- Chen G. 2022. Study of non-pollution cultivation techniques of organic ecotype of melon crops considering population characteristics. *Cell Mol Biol.*, 67(6): 330-338. <https://doi.org/10.14715/cmb/2021.67.6.43>
- Chevilly S, Dolz-Edo L, Martínez-Sánchez G, Morcillo L, Vilagrosa A, López-Nicolás JM, Blanca J, Yenush L and Mulet JM. 2021. Distinctive traits for drought and salt stress tolerance in melon (*Cucumis melo* L.). *Front Plant Sci.*, 12: 777060. <https://doi.org/10.3389/fpls.2021.777060>
- Chikh-Rouhou H, Mezghani N, Mnasri S, Mezghani N and Garcés-Claver A. 2021. Assessing the genetic diversity and population structure of a Tunisian melon (*Cucumis melo* L.) collection using phenotypic traits and SSR molecular markers. *Agronomy*, 11(6): 1121. <https://doi.org/10.3390/agronomy11061121>
- dos Santos GR, Tschoeke PH, Sarmento RA, Oliveira EE, Rodrigues-Silva N, Dalcin MS, Haddi K and Silva RS. 2021. Impact of growing seasons and pesticides used on the occurrence and severity of the gummy stem blight in melon cultivation in Brazil. *Eur J Plant Pathol.*, 161: 171-184. <https://doi.org/10.1007/s10658-021-02312-w>
- Erdinc C, Inal B, Erez E, Ekinci alp A and Sensoy S. 2021. Comparative adaptation responses of melon (*Cucumis melo* L.) genotypes to salinity stress. *J Agric Sci Technol.*, 23(2): 403-418. <https://jast.modares.ac.ir/article-23-35313-en.pdf>
- Faichuk O, Voliak L, Hutsol T, Glowacki S, Pansyr Y, Slobodian S, Szelaġ-Sikora A and Gródek-Szostak Z. 2022. European Green Deal: Threats Assessment for Agri-Food Exporting Countries to the EU. *Sustainability Switz.*, 14(7): 3712. <https://doi.org/10.3390/su14073712>
- Fedoniuk T, Zhuravel S, Kravchuk M, Pazych V and Bezvershuk I. 2024. Historical sketch and current state of weed diversity in continental zone of Ukraine. *Agricult Nat Resour.*, 58(5): 631-642. <https://doi.org/10.34044/j.anres.2024.58.5.10>
- Galil Tzuri A, Dafna A, Ben Itzhaki I, Halperin I, Oren E, Isaacson T, Faigenboim A, Yeselson Y, Paris HS, Mazourek M, Burger J, Schaffer AA and Gur A. 2025. Meta-genetic analysis of melon sweetness. *Theor Appl Genet.*, 138: 68. <https://doi.org/10.1007/s00122-025-04863-6>
- GOST 7178-2015. 2015. Fresh melons. Specifications. https://online.zakon.kz/Document/?doc_id=34554222&pos=1;-16#pos=1;-16
- Ismanzhanov AI and Tashiev NM. 2016. Development and research of the technology for powdering agricultural products using solar energy. *Appl Solar Energy Eng Transl Geliotekh.*, 52(4): 256-258. <https://doi.org/10.3103/S0003701X16040101>
- Kaleem MM, Nawaz MA, Ding X, Wen S, Shireen F, Cheng J and Bie Z. 2022. Comparative analysis of pumpkin rootstocks mediated impact on melon sensory fruit quality through integration of non-targeted metabolomics and sensory evaluation. *Plant Physiol Biochem.*, 192: 320-330. <https://doi.org/10.1016/j.plaphy.2022.10.010>
- Kesh H and Kaushik P. 2021. Advances in melon (*Cucumis melo* L.) breeding: An update. *Scientia Hort.*, 282: 110045. <https://doi.org/10.1016/j.scienta.2021.110045>
- Khalid W, Ikram A, Rehan M, Afzal FA, Ambreen S, Ahmad M, Aziz A and Sadiq A. 2021. Chemical composition and health benefits of melon seed: A review. *Pak J Agric Res.*, 34(2): 309-317. <https://doi.org/10.17582/journal.pjar/2021/34.2.309.317>
- Kiseleva N and Yessimbekova M. 2024. Formation of the gene pool of vegetable plants in Kazakhstan. *Izdenister Natigeler*, 2-1: 342-348. <https://doi.org/10.37884/2-1-2024/570>
- Kizatova MY, Medvedkov YB, Shevtsov AA, Drannikov AV and Tlevlessova DA. 2017. Experimental-statistical analysis and multifactorial process optimization of the crust from melon pulp separation process. *J Eng Appl Sci.*, 12(7): 1762-1771. <https://doi.org/10.3923/jeasci.2017.1762.1771>
- Komala M and Kuni P. 2022. Genetic diversity and molecular breeding of melon (*Cucumis melo* L.): A review. *Curr Agric Res.*, 10(3). <https://doi.org/10.12944/CARJ.10.3.03>
- Kosanov SU, Maslovsky SA, Shapovalova PN, Karpova NA, Salmina DA and Kovalenko AS. 2022. Justification of the technology of production of snack products from melon fruits. *Int Res J.*, 119(5): 57-61. <https://doi.org/10.23670/IRJ.2022.119.5.009>
- Kubo K, Pritchard B and Phyto AS. 2021. How Chinese demand for fresh fruit and vegetables is creating new landscapes of rural development and vulnerability in Southeast Asia: Insights from the Myanmar melon frontier. *Geoforum*, 122: 32-40. <https://doi.org/10.1016/j.geoforum.2021.03.008>
- Kulazhanov T, Baibolova L, Shaprov M, Tlevlessova D, Admaeva A, Kairbayeva A, Azimova S, Kizatova M and Nazymbekova A. 2021. Means of mechanization and technologies for melons processing. In: Prudius I, editors. *Means of Mechanization and Technologies for Melons Processing*. Kharkiv: PC TECHNOLOGY CENTER; p. 1-174. <https://doi.org/10.15587/9786177319398>
- Lee DS, Kwon JK, Yun SW, Lee SY, Seo MT, Lee HJ, Lee SG and Kang TG. 2021. Comparison of yield and workload depending on stem training methods in oriental melon hydroponics. *J Bio-Env Control.*, 30(4): 377-382. <https://doi.org/10.12791/KSBEC.2021.30.4.377>
- Lija M and Beevy S. 2021. A review on the diversity of Melon. *Plant Sci Today*, 8(4): 995-1003. <https://doi.org/10.14719/pst.1300>
- Mamyrbekov ZhZh, Taishibaeva EU and Aitbaeva AT. 2021. Ecological testing of foreign variety samples of melon in the conditions of the south-east of Kazakhstan. In: *Proc Int Sci-Practical Conf "Actual Problems of Agro-Science in the Context of Adaptation to Global Climate Change"* (pp. 203-207). Almaty: Asyl Kitan LLP. <https://kazniizr.kz/wp-content/uploads/2021/06/Sbornik-konf.-75-let.-Mejrman-G.T.-08.06.21.pdf>
- Mamyrbekov ZhZh, Tayshibaeva EU and Aitbaeva AT. 2024. Sowing qualities of seeds and development of the root system of melon varieties of different maturation dates in the conditions of the pedimountain steppe and pedmountary zones of Kazakhstan. *Izdenister Natigeler*, 102(2): 200-209. <https://doi.org/10.37884/2-2024/19>
- Manchali S, Chidambara Murthy KN and Vishnuvardana Patil BS. 2021. Nutritional composition and health benefits of various botanical types of melon (*Cucumis melo* L.). *Plants*, 10(9): 1755. <https://doi.org/10.3390/plants10091755>
- Mukhtar NF and Abd Samad AB. 2022. Optimization of growth parameters on rock melon quality via fertigation system. *Proc Sci Math.*, 12: 210-219. https://science.utm.my/proscimath/wp-content/uploads/sites/605/2022/11/22_Noor-Farrah-Aminah-Mukhtar_210-219.pdf
- Murabildayeva R, Bimendiyeva L, Kondybayeva S and Yermekova Zh. 2024. Climate change and agricultural productivity: Economic implications for food security. *Sci Horiz.*, 27(12): 168-179. <https://doi.org/10.48077/scihor12.2024.168>
- Nascimento CS, Nascimento CS and Cecilio Filho AB. 2020. N:K ratio for phenological growth stages of net melon cultivated in NFT hydroponic system. *Rev Caatinga*, 33(1): 108-115. <http://dx.doi.org/10.1590/1983-21252020v33n112rc>
- Novruzova E. 2016. The features of ferns for their moisture demand and life form including in the flora of Nakhchivan Autonomous Republic Azerbaijan. *Int J Multidiscip Res Develop.*, 3(11): 65-67.

- Puthnee T, Takahashi K, Sugawara M, Kawamata R, Motomura Y, Nishizawa T, Aikawa T and Kumpoun W. 2013. The role of net development as a barrier to moisture loss in netted melon fruit (*Cucumis melo* L.). HortScience Horts, 48(12): 1463-1469. <https://doi.org/10.21273/HORTSCI.48.12.1463>
- Qian Ong Y and Moneruzzaman Khandaker M. 2021. Growth and development of melon Manis Terengganu in response to seasonal variation. Asian J Plant Sci., 20(4): 659-664. <https://doi.org/10.3923/ajps.2021.659.664>
- Rehman A, Weng J, Li P, Yu J, Rahman S, Khalid M, Shah IH, Gulzar S, Chang L and Niu Q. 2023. Differential response of two contrasting melon (*Cucumis melo* L.) genotypes to drought stress. J Plant Biol., 66: 519-534. <https://doi.org/10.1007/s12374-023-09398-1>
- Safarova F and Novruzova E. 2021. Self-defense Mechanisms of Plants in Nature. Bull Sci Pract., 7(8): 73-77.
- Serhienko O, Shabetia O, Linnik Z, Serhienko M and Melnyk O. 2023. Selection of highly adaptive source material of watermelon for selection for early ripening. Sci Horiz., 26(8): 42-51. <https://doi.org/10.48077/scihor8.2023.42>
- Shahwar D, Khan Z and Park Y. 2024. Molecular markers for marker-assisted breeding for biotic and abiotic stress in melon (*Cucumis melo* L.): A review. Int J Mol Sci., 25(12): 6307. <https://doi.org/10.3390/ijms25126307>
- Singh SP. 2023. Flooding adversely impacts fresh produce safety. Microbiol Aust., 44(4): 185-189. <https://doi.org/10.1071/MA23054>
- Soltani F, Shajari M, Mirbehbahani GS, and Bihanta MR. 2022. Assessment of melon genetic diversity based on fruit phenotypic traits and flowering habits. Int J Hortic Sci Technol., 9(1): 97-116. <https://doi.org/10.22059/ijhst.2021.313939.415>
- Soltani F. 2021. Breeding of melon (*Cucumis melo* L. groups Dudaim and Flexuosus). In: Al-Khayri JM, Jain SM, Johnson DV, editors. Advances in Plant Breeding Strategies: Vegetable Crops. Cham: Springer; p. 333-361. https://doi.org/10.1007/978-3-030-66961-4_9
- Statistical Collection "Agriculture, Forestry and Fishery in the Republic of Kazakhstan, 2018-2022". 2023. [https://stat.gov.kz/upload/iblock/1d8/g9qb3n8u30gljftcy900a0v4exegme8b/C-11-%D0%93-2018-2020%20\(%D0%BA%D0%B0%D0%B7-%D1%80%D1%83%D1%81\).pdf](https://stat.gov.kz/upload/iblock/1d8/g9qb3n8u30gljftcy900a0v4exegme8b/C-11-%D0%93-2018-2020%20(%D0%BA%D0%B0%D0%B7-%D1%80%D1%83%D1%81).pdf)
- Tlevlessova D, Medvedkov Y, Kairbayeva A and Nazymbekova A. 2023. Mechanisation of the primary processing of watermelons without destroying the rind. Food Sci Tech Braz., 43: e86622. <https://doi.org/10.1590/fst.86622>
- Turamatov RG, Rasulov F and Shokirov AJ. 2021. Determining the possible sowing times for morning pumpkin growing. Acad Int Multidiscip Res J., 11(11): 885-891. <https://doi.org/10.5958/2249-7137.2021.02532.5>
- Tursunkhodjaeva R and Saidivaliev S. 2024. Evaluation of factors in the transportation of melons by railway. BIO Web Conf., 141: 01023. <https://doi.org/10.1051/bioconf/202414101023>
- Uikassova Z, Azimova S, Tlevlessova D and Galoburda R. 2022. Determining critical control points for processing melon fruits. East Eur J Enterp Tech., 4(11-118): 97-104. <https://doi.org/10.15587/1729-4061.2022.262850>
- Urazbaev IU and Masharipov NK. 2021. Fundamental scale of evaluation of productivity of irrigated gray-meadow soils which are appointed for growing melon crops. Alinteri J Agric Sci., 36(1): 257-259. <https://doi.org/10.47059/alinteri/V36I1/AJAS21038>
- Walters SA, Abdelaziz M and Bouharrou R. 2021. Local melon and watermelon crop populations to moderate yield responses to climate change in North Africa. Climate, 9(8): 129. <https://doi.org/10.3390/cli9080129>
- Wan Azman WM, Shahar A, Azizan SA and Rahim AA. 2024. Physical and mechanical properties of watermelon rind. Adv Agric Food Res J., 5(2): a0000318. <https://doi.org/10.36877/aafjr.a0000318>
- Xu L, He Y, Tang L, Xu Y and Zhao G. 2022. Genetics, genomics, and breeding in melon. Agronomy, 12(11): 2891. <https://doi.org/10.3390/agronomy12112891>
- Yavuz D, Seymen M, Yavuz N, Çoklar H and Ercan M. 2021. Effects of water stress applied at various phenological stages on yield, quality, and water use efficiency of melon. Agric Water Manag., 246: 106673. <https://doi.org/10.1016/j.agwat.2020.106673>
- Yessimbekova M, Mukin K, Dolinny Y, Ainebekova B, Espanov A, Didenko I and Kenebaev A. 2024. The results of agricultural crops genetic resources mobilization in Kazakhstan. Izdenister Natigeler, 2-1: 316-331. <https://doi.org/10.37884/2-1-2024/568>
- Yunusov S, Sadullayev S, Khaitboyeva G and Sharipova M. 2023. Selection of high-yielding, disease-resistant, promising, and export-oriented varieties of melons. E3S Web Conf., 389: 03044. <https://doi.org/10.1051/e3sconf/202338903044>
- Zhang J, Yang J, Lv Y, Zhang X, Xia C, Zhao H and Wen C. 2023. Genetic diversity analysis and variety identification using SSR and SNP markers in melon. BMC Plant Biol., 23: 39. <https://doi.org/10.1186/s12870-023-04056-7>
- Zymarioieva A, Zhukov O, Fedoniuk T, Pinkina T and Hurelia V. 2021. The relationship between landscape diversity and crops productivity: Landscape scale study. J Landscape Eco Czech Rep., 14(1): 39-58. <https://doi.org/10.2478/jlecol-2021-0003>