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EVALUATION OF EGGPLANT (*Solanum melongena* L.) VARIETIES AND VARIETY-FORMS DISTRIBUTED IN AZERBAIJAN BASED ON PHENOTYPIC AND AGRONOMICALLY IMPORTANT TRAITS

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Eggplant (*Solanum melongena* L.) is a food crop widely cultivated in tropical and subtropical regions of the world and has high economic importance. Local germplasm samples include varieties and variety-forms distinguished by phenotypic diversity, and their use in breeding programs aimed at improving yield and fruit quality is of great importance. The main objective of the conducted research was to group local and introduced eggplant varieties and variety-forms cultivated in Azerbaijan according to their phenotypic traits and to evaluate them based on agronomic traits. The research was conducted in 2025 under Absheron conditions on 23 eggplant varieties and variety-forms. A randomized block design with three replications was used in field experiments. During the research, morphological traits of plants and yield-related traits were studied, including the number of days to 25–75% flowering, plant height, number of branches per plant, number of fruits, fruit length, diameter, weight, and yield per plant. Descriptive statistics, analysis of variance (ANOVA), correlation analysis, and hierarchical cluster analysis methods were used to determine the level of differences among the studied varieties and variety-forms (genotypes). It was determined that significant phenotypic diversity exists in the studied genotypes in accordance with consumer requirements. A high, significant positive correlation ($r = 0.861$, $p < 0.01$) was determined between yield per plant and the number of fruits per plant, which shows that this trait plays a main role in yield formation. Cluster analysis divided the genotypes into three main groups, which reflects the presence of significant genetic differences among the studied genotypes. The experiment shows that there are genotypes with high potential among those distributed in Azerbaijan and they can be used in carrying out work aimed at improving eggplant breeding.

Keywords: eggplant, *Solanum melongena*, phenotypic variability, landraces, yield traits, correlation analysis, cluster analysis

INTRODUCTION

Eggplant (*Solanum melongena* L.) is an important vegetable crop cultivated worldwide and belongs to the genus *Solanum* in the family Solanaceae. Currently, China is the largest producer of eggplant, with approximately 39.2 million tons produced from about 783,000 ha in 2019 (FAO., 2020). The ancestor of eggplant, *Solanum incanum* (eggplant bitter apple), is considered a pre-domesticated subtropical species native to West Asia and North Africa, and it has been widely used as a valuable source of drought resistance and phenolic variation in eggplant breeding programs (Knapp et al., 2013).

Eggplant is a common annual vegetable crop grown in tropical and subtropical regions of the world (Kaur et al., 2014). Brinjal shows considerable regional variation in fruit characteristics such as shape, size, color, and texture. As a result, numerous varieties and hybrids are cultivated in different countries. The popularity of hybrid cultivars among growers is mainly attributed to the large percentage of heterosis observed for yield (56.16%) and yield-related traits (40.56–57.64%) (Sharma et al., 2013).

In recent years, nutritional habits have changed considerably, and the consumption of fruits and vegetables has increased due to the abundance of health-promoting compounds they contain

(Yahia et al., 2018). Fruits and vegetables provide a wide range of essential nutrients, including minerals (Jiménez-Aguilar, Grusak, 2017), proteins (Raigón et al., 2008; Sedlar et al., 2021), dietary fiber (Ciudad-Mulero et al., 2019), and antioxidants (Gürbüz et al., 2018; Karasawa, Mohan, 2018; Sidhu, Zafar, 2018). In particular, the increased appreciation of fruits and vegetables has largely been attributed to the beneficial health effects associated with dietary antioxidants (Hussain et al., 2014).

In Azerbaijan, eggplant is also an important vegetable crop and is widely cultivated in various agricultural regions of the country. According to recent agricultural statistics, eggplant production in Azerbaijan reached approximately 91.7 thousand tons in 2022.

This study was conducted with the aim of investigating the phenotypic diversity of local and introduced eggplant varieties and variety-forms cultivated in Azerbaijan and evaluating their agronomically important traits. Despite the widespread consumption and economic importance of eggplant in the country, information on the phenotypic variability of germplasm materials and traits related to yield is limited. Determining the level of phenotypic variation among local and introduced forms is important for the efficient use of genetic resources in breeding programs. Therefore, the vegetation and yield indicators of eggplant genotypes cultivated in open field conditions under Absheron conditions were studied. The obtained results will assist in the identification of promising genotypes and will serve as a scientific basis with useful data for the development of future breeding strategies.

MATERIALS AND METHODS

The field experiment was conducted in 2025 under Absheron conditions. In the experiment, local and introduced varieties and variety-forms of eggplant (*Solanum melongena* L.) were used. In total, 23 eggplant varieties and variety-forms were used in the study. The phenotypic traits of the varieties and variety-forms were studied and grouping was carried out based on phenotypic traits.

The seeds were sown on March 5, 2025, the seedlings were pricked out, and after reaching the appropriate vegetative stage, they were transplanted to the open field on May 2, 2025. The experiment was conducted using a randomized complete block design (RCBD) with three replications. In the experimental field, a total of 18 plants per genotype were planted, with a row spacing of 100 cm and a plant spacing of 60 cm. During the vegetation period, standard agrotechnical practices were applied to ensure optimal growth and development of the plants. Irrigation of the plants was carried out using the drip irrigation method, and the water requirement of the plants (ETc) was met at approximately 100% level. Control of weeds, diseases, and pests, fertilization, and other agrotechnical practices were carried out in accordance with local agricultural recommendations.

Phenotypic observations were conducted during the vegetation period and at the time of harvest. Plant height, number of branches per plant, fruit dimensions (length and width), fruit weight, number of fruits per plant, marketable and total yield per plant were studied. Statistical analyses were performed to evaluate the differences among eggplant genotypes. Observations for traits were carried out on 5 randomly selected marked plants in each variant.

Statistical analysis: the results obtained for trait parameters were analyzed by one-way analysis of variance (ANOVA) using the Statgraphics Centurion XVII program (Statistical Graphics Corporation, 2014). During the analysis, local forms selected as factors were taken. The results were expressed as mean ($\pm$) standard deviation (SD). Differences between mean values were considered statistically significant at the $p \leq 0.05$ level.

RESULTS AND DISCUSSION

As a result of the evaluation of eggplant genotypes, significant phenotypic variability was determined for the studied traits. Descriptive statistics and analysis of variance (ANOVA) were applied to assess the level of variation and to determine the statistical significance of differences among genotypes.

Table 1.

Estimates of variability in eggplant landraces

Characters	Mean	Minimum	Maximum	Difference	SD	CV%
Bush height (cm)	66.07	53.00	86.00	33	8.47	12.8
Weight of single fruit	78.68	63.00	95.00	32	8.37	10.6
Number of fruits per plant	17.86	10.00	25.00	15	8.73	20.9
Day to 50 percent flowering	66.51	52.00	78.00	26	6.02	9
Number of branches per plant	6.57	4.00	9.00	5	1.63	24.8
Fruit Length (cm)	13.05	7.50	21.50	14	3.27	25
Fruit Diameter (mm)	6.73	4.00	12.00	8	1.44	21.5
Fruit yield (kg in plant)	1.40	0.75	2.09	1.34	0.31	21.9

The descriptive statistical indicators of the studied local eggplant varieties and variety-forms are presented in Table 1. Significant phenotypic variability was observed for the evaluated traits, which indicates the presence of a broad genetic base among the studied eggplant material. Particularly, high variation was recorded for fruit length, number of branches per plant, and yield indicators, which reflects significant phenotypic diversity among genotypes. Phenotypic diversity in eggplant has been widely reported, particularly in fruit-related traits such as fruit size and weight, which have been strongly influenced by domestication and breeding processes (Shahmorad Moghanloo and Hasanov, 2024).

Table 2.

Analysis of variance for fruit yield in eggplant genotypes

Source	df	Sum of Squares	Mean Square	F value	P value
Genotype	22	6.20	0.28	29.59	<0.001
Error	46	0.44	0.01		
Total	68	6.64			

= not significant, * = significant at 5%, ** = significant at 1%

The results of the analysis of variance for fruit yield among eggplant genotypes are presented in Table 2. The results showed that the effect of the genotype factor on fruit yield is highly statistically significant ($P < 0.001$). This demonstrates the presence of significant genetic variability among the studied genotypes.

Table 3.

Pearson correlation coefficients between morphological traits and fruit yield in 23 eggplant (*Solanum melongena* L.) genotypes.

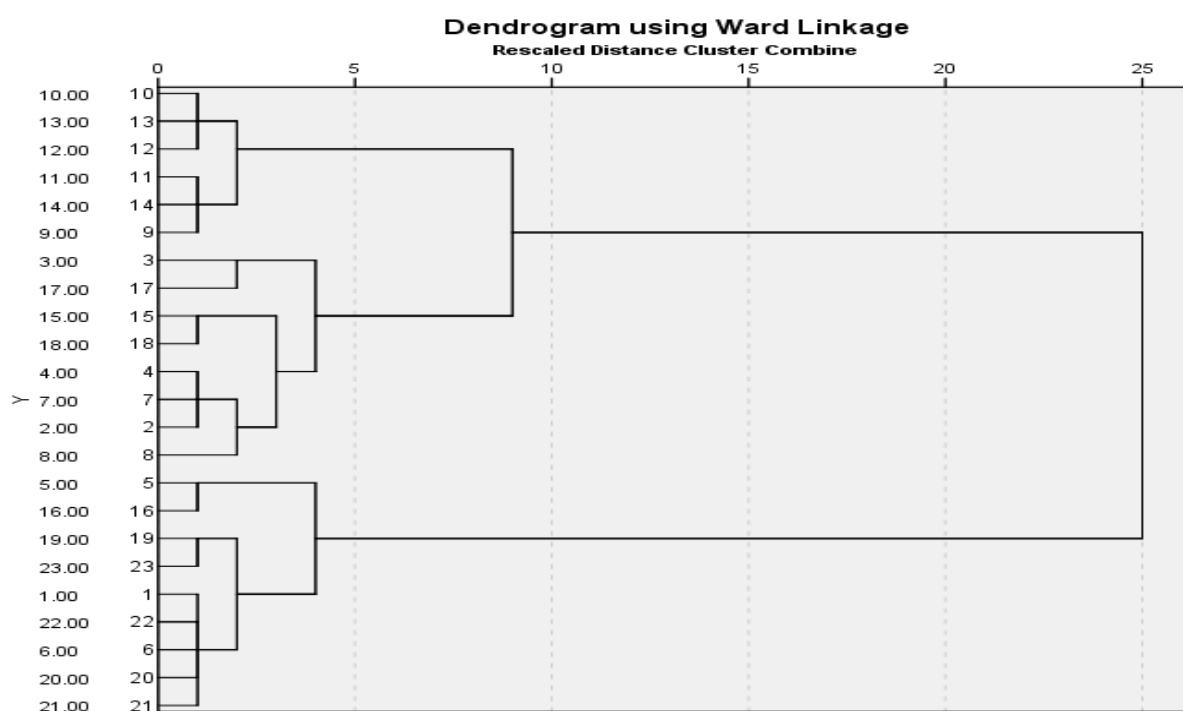
	Bush height (cm)	Weight of single fruit	Number of fruits per plant	day to 50 percent flowering	N of branches per plant	Fruit Length (cm)	Fruit Diameter (cm)	Fruit yield (kg in plant)
Bush height (cm)	1	0.17	-0.29*	0.19	0.03	0.05	0.15	-0.19
Weight of single fruit		1	-0.17	0.20	0.02	-0.03	0.27*	0.35**
Number of fruits per plant			1	-0.02	-0.14	-0.32**	0.04	0.86**
day to 50 percent flowering				1	0.05	0.01	0.08	0.08
N of branches					1	-0.23	0.09	-0.11

per plant								
Fruit Length (cm)						1	-0.35**	-0.33**
Fruit Diameter (cm)							1	0.17
Fruit yield (kg in plant)								1

NS = not significant, * = significant at 5%, ** = significant at 1%

Correlation analysis showed a strong and positive relationship between yield per plant and number of fruits per plant ($r = 0.861$, $p < 0.01$), indicating that this trait plays a key role in yield formation. In addition, single fruit weight showed a positive relationship with yield and fruit diameter ($r = 0.349$, $p < 0.01$; $r = 0.266$, $p < 0.05$), confirming that fruit size and fruit number contribute to total yield. In contrast, fruit length showed a negative correlation with fruit number and yield, indicating a possible trade-off between fruit size and yield potential. A moderate but statistically significant negative relationship was observed between plant height and fruit number ($r = -0.291$, $p < 0.05$), which may reflect a greater allocation of assimilates to vegetative growth in taller genotypes. The number of branches showed no statistically significant relationship with yield, indicating a limited effect of canopy structure on yield under the studied environmental conditions.

The strong positive correlation observed between fruit number and fruit yield in the present study is consistent with previous reports in eggplant, where fruit number was identified as a major determinant of yield (Kaushik et al., 2018; Kumar et al., 2020).



Hierarchical cluster analysis using Ward's linkage based on eight morphological and yield-related traits revealed substantial phenotypic diversity among the 26 eggplant genotypes. The dendrogram separated the genotypes into three major clusters at a rescaled distance of approximately 20, indicating clear genetic divergence among groups. Genotypes within the same cluster exhibited relatively similar phenotypic profiles, particularly for fruit-related traits such as fruit length, fruit diameter, and fruit yield per plant. In contrast, clusters were clearly

differentiated by variations in plant architecture and fruit characteristics, suggesting different yield formation strategies among genotypes. The observed clustering pattern highlights the presence of considerable variability within the studied germplasm and provides useful information for selecting genetically divergent parents in eggplant breeding programs aimed at improving yield and fruit quality.

CONCLUSION

The present study demonstrated the existence of significant phenotypic variability among local eggplant varieties and variety-forms cultivated in Azerbaijan. The number of fruits per plant and single fruit weight were identified as the main traits contributing most to yield. The significant genetic variability observed among genotypes provides promising opportunities for the selection of superior parents in eggplant breeding programs. In addition, cluster analysis revealed clear genetic differentiation among genotypes, which can be effectively utilized in the development of high-yielding and well-adapted eggplant varieties. The obtained results provide valuable scientific information for the selection and genetic improvement of eggplant, as well as for the conservation of local germplasm resources in Azerbaijan.

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<http://www.fao.org/faostat/en/#data>

AZƏRBAYCANDA YAYILMIŞ BADIMCAN (*Solanum melongena* L.) SORTLARININ VƏ SORT FORMALARININ FENOTİPİK VƏ AQRONOMİK ƏHƏMİYYƏTLİ ƏLAMƏTLƏRİNƏ QORƏ QIYMƏTLƏNDİRİLMƏSİ

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Badımcan (*Solanum melongena* L.) dünyanın tropik və subtropik bölgələrində geniş becərilən, qida bitkisi və yüksək iqtisadi əhəmiyyətə malikdir. Yerli genofond nümunələri içərisində fenotipik müxtəlifliyi ilə fərqlənən sort və sort-formalardan məhsuldarlığın və meyvə keyfiyyətinin yaxşılaşdırılmasına yönəlmiş seleksiya proqramlarında istifadə mühüm əhəmiyyət daşıyır. Aparılmış tədqiqat işinin əsas məqsədi Azərbaycanda becərilən badımcanın yerli və introduksiya sort və sort-formalarını fenotipik əlamətlərinə görə qruplaşdırmaq və təsərrüfat əlamətlərinə görə qiymətləndirmək olmuşdur. Tədqiqat işi 2025-ci ildə Abşeron şəraitində 23 badımcan sort və sort-forması üzərində aparılmışdır. Sahə təcrübələrində üç təkrarlı təsadüfi bloklar üsulundan istifadə edilmişdir. Tədqiqat zamanı bitkilərin morfoloji əlamətləri, məhsuldarlıqla əlaqəli əlamətlər, o cümlədən 25-75% çiçəklənməyə qədər olan günlərin sayı, bitkilərin hündürlüyü, bir bitkidə olan budaq sayı, meyvə sayı, meyvələrin uzunluğu, diametri, kütləsi və bir bitkinin məhsuldarlıq göstəricisi əlamətləri öyrənilmişdir. Öyrənilmiş sort və sort-formalar (genotiplər) arasında fərqliliyin səviyyəsini müəyyən etmək üçün təsviri statistika, dispersiya analizi (ANOVA), korrelyasiya analizi və iyerarxik klaster analizi metodlarından istifadə olunmuşdur. Müəyyənəndirilmişdir ki, öyrənilən genotiplərdə istehlakçıların tələblərinə uyğun əhəmiyyətli fenotipik müxtəliflik mövcuddur. Bir bitkinin məhsuldarlıq göstəricisi ilə bitkidə olan meyvə sayı arasında yüksək, etibarlı müsbət korrelyasiya ($r = 0.861$, $p < 0.01$) müəyyən edilmişdir ki, bu da həmin əlamətin məhsuldarlığın formalaşmasında əsas rol oynadığını göstərir. Klaster analizi nəticəsində genotiplər üç əsas qrupa ayrılmış və bu da tədqiq olunan genotiplər arasında əhəmiyyətli genetik fərqliliyin mövcudluğunu əks etdirmişdir. Təcrübə Azərbaycanda yayılmış genotiplərin içərisindən yüksək potensiala malik olan genotiplərin olduğunu göstərir və onlardan badımcanın seleksiyası işlərinin təkmilləşdirilməsi istiqamətində işlər aparılmasında istifadə oluna bilər.

Açar sözlər: badımcan, *Solanum melongena*, fenotipik dəyişkənlik, yerli formalar, məhsuldarlıq əlamətləri, korrelyasiya analizi, klaster analizi

**ОЦЕНКА СОРТОВ И СОРТ-ФОРМ БАКЛАЖАНА (*Solanum melongena* L.),
РАСПРОСТРАНЁННЫХ В АЗЕРБАЙДЖАНЕ, НА ОСНОВЕ ФЕНОТИПИЧЕСКИХ И
ХОЗЯЙСТВЕННО ЦЕННЫХ ПРИЗНАКОВ.**

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Баклажан (*Solanum melongena* L.) является пищевой культурой, широко выращиваемой в тропических и субтропических регионах мира и обладающий высокой экономической значимостью. Среди образцов местного генофонда сорта и сорт-формы, отличающиеся фенотипическим разнообразием, играют важную роль в селекционных программах, направленных на повышение урожайности и качества плодов. Основной целью проведённого исследования было группирование местных и интродуцированных сортов и сорт-форм баклажана, выращиваемых в Азербайджане, по фенотипическим признакам и их оценка по хозяйственно-ценным характеристикам. Исследовательская работа была проведена в 2025 году в условиях Апшерона на 23 сортах и сорт-формах баклажана. В полевых опытах использовался метод случайных блоков с тремя повторностями. В ходе исследования изучались морфологические признаки растений и признаки, связанные с урожайностью, включая количество дней до 25–75% цветения, высоту растений, число ветвей на одно растение, число плодов, длину, диаметр и массу плодов, а также показатель урожайности одного растения. Для определения уровня различий между изученными сортами и сорт-формами (генотипами) использовались методы описательной статистики, дисперсионного анализа (ANOVA), корреляционного анализа и иерархического кластерного анализа. Установлено наличие значительного фенотипического разнообразия среди изученных генотипов, соответствующего требованиям потребителей. Выявлена высокая достоверная положительная корреляция ($r = 0.861$, $p < 0.01$) между урожайностью одного растения и числом плодов, что указывает на ключевую роль данного признака в формировании урожайности. В результате кластерного анализа генотипы были разделены на три основные группы, что отражает наличие значительной генетической дифференциации между изученными материалами. Полученные результаты показывают, что среди генотипов баклажана, распространённых в Азербайджане, имеются формы с высоким потенциалом, которые могут быть использованы для совершенствования селекционной работы по улучшению баклажана.

Ключевые слова: баклажан, *Solanum melongena*, фенотипическая изменчивость, местные формы, признаки урожайности, корреляционный анализ, кластерный анализ

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