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Evaluation of the productivity potential of eggplant lines developed on the basis of interspecific hybridisation and gametic breeding

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Purpose. Improvement of the gene pool of the cultivated form of eggplant (*Solanum melongena* L.) through interspecific hybridisation with *Solanum aethiopicum* L. and gametic breeding; analysis of the interspecific lines for a set of valuable quantitative traits determining the yield structure. **Methods.** Studies for the comprehensive evaluation of eggplant lines of interspecific origin were carried out during 2021–2023 in protected soil conditions at the experimental base of the Institute of Vegetable and Melon Growing of the National Academy of Agrarian Sciences of Ukraine. Phenological observations and biometric measurements of plants of four lines were carried out. The stability of the manifestation of seven quantitative traits during the research years was determined by the methods of variation statistics [calculation of the mean square deviation (σ), coefficient of variation (V), Pearson's paired linear correlation (r_p)]. **Results.** The analysis identified eggplant lines of interspecific origin that were superior to the standard variety 'Almaz' in terms of the level and stability of quantitative traits. Thus, F_6(Pavlotas-20 / 'Almaz')I_1 and BC_1[F_5 (Pavlotas-20 / 'Almaz')]I_1 showed a statistically significant increase in fruit width (by 16.48% and 14.85%, respectively). Meanwhile, line BC_2[F_5 (Pavlotas-20 / 'Almaz')]I_1 exhibited higher productivity (by 18.11%) compared to the standard variety. The correlation analysis shows that the trait "Productivity of one plant" has a strong positive relationship with the trait "Number of fruits per plant" (r_p = 0.75) and a strong negative relationship with "Average fruit width" (r_p = –0.70) and "Duration of the period from mass germination to technical fruit maturity" (r_p = –0.72). The selected line BC_2[F_5 (Pavlotas-20 / 'Almaz')]I_1 exhibited a four-day shorter period from mass germination to technical fruit maturity compared to the standard variety. **Conclusions.** The line BC_2[F_5 (Pavlotas-20 / 'Almaz')]I_1 was isolated based on the complex of quantitative traits. It underwent an additional stage of gametophytic breeding, resulting in a high adaptive potential to growing conditions.

Keywords: *quantitative traits; genetic alignment; correlations; gametophytic progeny; breeding.*

Introduction

Eggplants are a vegetable that belongs to the nightshade family and is widely consumed throughout the world, particularly in Africa and Southeast Asia [1, 2]. They have significant nutritional and medicinal value, with the fruits being rich in protein components, minerals, and antioxidants [2]. However, the commercial cultivation of eggplants faces several stress factors in agrocenoses, including both biotic factors such as heat and drought, and abiotic factors such as disease agents like fusarium wilt, verticillium wilt etc. [3, 4]. Certain species of nightshade plants, which are closely related to the cultivated form of eggplant, possess resistance to the most prevalent fungal diseases. This makes them valuable sources for the introduction of relevant beneficial genes through interspecific hybridization with *S. melongena* [5]. One such species is *S. aethiopicum Gilo* group, which freely hybridizes with the cultivated form of eggplant and is therefore widely used in introgressive breeding [6, 7].

Solanum aethiopicum Gilo group, also known as the red eggplant, is closely related to *Solanum melongena* and is therefore valuable for both genetic improvement and as a potential rootstock. It is a carrier of genes that confer resistance to *Fusarium oxysporum* f. sp. *melongenae*, *Verticillium dahliae*, and gall nematodes [8]. As "red eggplants" are a cultivated species, they do not exhibit the undesirable characteristics typically found in the wild relatives of eggplants, such as small fruits, thorns, and high concentrations of saponins and glycoalkaloids [9]. *S. aethiopicum* is distinguished by a wide range of genetic and morphological diversity and has a diploid set of chromosomes ($2n$ = 24)

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[6, 10]. The genetic diversity serves as the foundation for broadening the range of genotypic variability in interspecies hybrid offspring. This variability can manifest in both quantitative and qualitative traits that are valuable for breeding prior to the commencement of the crossbreeding program [2]. Although the sexual interspecific hybrids between *S. melongena* and *S. aethiopicum* are highly sterile, it has been demonstrated that recombination between these two genomes is possible, and that backcrossing hybrid generations from *S. melongena* with useful introgressions from the *S. aethiopicum Gilo* group can occur [11].

It is widely acknowledged that natural selection during the haploid gametophytic phase of a plant's life cycle can play a significant role in accelerating evolution and maintaining genetic variation. Recent theoretical advancements have further highlighted the significance of gametophytic breeding for various evolutionary processes [12]. Specifically, it has been demonstrated that gametophyte breeding has an impact on the evolution and adaptation of plants [13]. Haploid gametophytes and diploid sporophytes are subject to different selection pressures due to their difference in ploidy. The gametophyte lacks heterozygosity, which prevents the expression of dominance effects. Despite their different morphology, gametophytes and sporophytes typically express similar sets of genes, ranging from 60 to 90% [13]. The advantages of pollen breeding are indisputable, as it allows for the involvement of a large number of genotypes in artificial selection and creates high selection "pressure" under strictly controlled environmental conditions. Furthermore, gametic breeding has been shown to affect the ecological stability of both vegetative and reproductive organs of the sporophyte (i.e. the adult plant), as convincingly demonstrated in tomato [14].

Between 2006 and 2018, the Institute of Vegetable and Melon Growing of the National Academy of Agrarian Sciences developed tomato and cucumber lines using single and double gametophyte breeding. The single gametophytic breeding resulted in an increased number of fruits on the first three panicles of cultivated tomato (*Lycopersicon esculentum* Mill.) lines compared to the control [15]. Treating cucumber pollen with a high positive temperature (+60 °C) enabled the creation of gametophytic offspring that exhibit both high resistance to high positive daytime temperatures and productivity [16].

Based on the above, the research program for the creation of promising lines of eggplant based on interspecific hybridization provided for an additional series of experiments to increase their adaptive potential by achieving the effect of gametophyte breeding.

The aim of this research is to comprehensively assess eggplant lines of interspecies origin based on the level of manifestation of quantitative traits that are structural components of productivity and the length of the growing season. The research also aims to determine the degree of effectiveness of gametophytic breeding for the creation of highly productive lines.

Materials and Methods

The study was conducted in the forest-steppe zone of Ukraine using the generally accepted technology for growing eggplants in protected soil conditions; "The methodology of experimental work in vegetable and melon growing" was followed [17]. An unheated glass greenhouse with an area of 1000 m^2 was used, and the experimental samples of eggplant were grown by the seedling method. Seeds were sown in March of the second decade, and seedlings were planted in protected soil in May of the third decade. The planting scheme used was 0.45 × 0.7 m, and the accounting plots covered an area of 10.08 m^2 with one repetition.

Until 2021, backcross (saturating) crossings were conducted between the interspecific Pavlotas-20 line [F_{12} (*S. melongenum* 'Fialka' / *S. aethiopicum*)] and the cultivated eggplant variety 'Almaz' (*S. melongena*). As a result, four promising lines were obtained: Pavlotas-20 (large-fruited KSN), F_6 (Pavlotas-20 / 'Almaz')I_1, BC_1[F_5 (Pavlotas-20 / 'Almaz')]I_1, and BC_2[F_5 (Pavlotas-20 / 'Almaz')]I_1. Breeding work was carried out to select the best in terms of productivity and length of the growing season. To enhance abiotic resistance, the proposed research program aimed to incorporate gametophyte breeding methods and elevated daytime temperatures into the breeding process for developing a new linear eggplant material. During the 2021–2023 research program, an experiment on gamete breeding was conducted on one of the high-yielding lines, BC_2[F_5 (Pavlotas-20 / 'Almaz')]I_1. The experiment involved incubating the line's own pollen, which had been subjected to temperature processing (+60 °C) for 2 hours, before pollination.

The following samples were studied: Pavlotas-20 (large-fruited KSN), F_6(Pavlotas-20 / 'Almaz')I_1, BC_1[F_5(Pavlotas-20 / 'Almaz')]I_1, and BC_2[F_5 (Pavlotas-20 / 'Almaz')]I_1.

The eggplant variety 'Almaz' from the breeding of the Donetsk Experimental Station of the IVM of the National Academy of Agrarian Sciences of Ukraine was used as the standard.

The linear samples were selected following the existing methodical instructions for eggplant breeding and seed production, as well as the method of field experiments in vegetable production [18]. During the analysis of the selections, the manifestation of the following quantitative characteristics was studied in the work: "Number of fruits on a plant"; "Average fruit length"; "Average fruit width"; "Fruit shape index"; "Average fruit weight"; "Productivity of a plant"; "Duration of the period from mass germination to technical fruit maturity".

Statistical calculations were performed by considering the annual improvement breeding of 8–10 plants from each selected linear sample of eggplant. The study used the following statistical indicators as criteria for investigating the genetic stability of quantitative traits: mean square deviation (σ), coefficient of variation (*V*), and amplitude of variation (A_m). The research results' primary experimental data underwent processing using variational statistical methods [19].

Results and discussion

An important indicator for determining the productivity potential of the eggplant is the number of fruits formed on the plants. Table 1 summarises the quantitative data for this indicator. The range of variation for the trait "Number of fruits on one plant" in the group of linear genotypes of interspecies origin was between 5.0 and 6.16 psc. In the standard variety 'Almaz', this indicator was found to be X_{med} = 5.71 ± 0.56 pcs. All studied lines, except for BC_2[F_5 (Pavlotas-20 / 'Almaz')]I_1, did not show a statistically significant increase in this indicator. The number of fruits in BC_2[F_5 (Pavlotas-20 / 'Almaz')]I_1 showed a tendency towards an increase (X_{med} = 6.16 ± 0.59 pcs.), while the other lines were inferior to the standard variety. The line with the smallest number of fruits was BC_1[F_5 (Pavlotas-20 / 'Almaz')]I_1 (X_{med} = 3.75 ± 0.58 pcs.) (Table 1).

Table 1

Variation of the trait "Number of fruits on a plant" in linear eggplant samples, pcs (average for 2021–2023)

Sample	$X_{med} \pm m_x$	X_{min}	X_{max}	σ	V, %
Variety 'Almaz', standard	5.71 ± 0.56	3.0	9.0	2.09	36.6
Pavlotas-20 (large-fruited KSN)	5.0 ± 0.75	2.0	11.0	2.59	51.9
F_6(Pavlotas-20 / 'Almaz')I_1	4.60 ± 0.43	3.0	7.0	1.35	29.4
BC_1[F_5 (Pavlotas-20 / 'Almaz')I_1	3.75 ± 0.58	2.0	9.0	2.01	53.5
BC_2[F_5 (Pavlotas-20 / 'Almaz')I_1	6.16 ± 0.59	3.0	14.0	2.59	42.0
X_{min}	3.75	2.0	7.0	1.35	29.4
X_{max}	6.16	3.0	14.0	2.59	53.5
$A_m = X_{max} - X_{min}$	2.41	1.0	7.0	1.24	24.1

When analysing the statistical indicators of the stability level of this trait, it is important to note its strong variability over the years of research, depending on the growing conditions. The standard variety 'Almaz' (36.6%), the Pavlotas-20 line (large-fruited KSN) (51.87%), BC_1[F_5 (Pavlotas- 20 / 'Almaz')]I_1 (53.48%) and BC_2[F_5 (Pavlotas-20 / 'Almaz')]I_1 (42.0%) crossed the limit of 33.3% in terms of the coefficient of variation (*V*). The only exception was line F_6 (Pavlotas-20 / 'Almaz') I_1 (29.4%).

The indicator "mean square deviation (*σ*)" is used in the theory of mathematical statistics to measure the dispersion of values of a random variable relative to its center of distribution. In this sample of investigated eggplant samples, the indicator varied from 1.35 to 2.59. Line F_6 (Pavlotas-20 / 'Almaz')I_1 (σ = 1.35; V = 29.4%) was the most stable according to two statistical indicators in terms of the number of formed fruits. The standard variety had corresponding indicators of σ = 2.09; V = 36.6% (Table 1).

Quantitative characteristics that determine the morphometric indicators of the fruit are important structural components of the productivity of breeding valuable eggplant samples. Namely, their length and width. As a rule, the level of these indicators has a direct correlation with the weight of the fruit of plants within a given varietal or linear population. Data based on the results of biometric measurements of fruit length are summarised in Table 2. In particular, for linear samples, the variation in the level of manifestation of the quantitative characteristic "Mean fruit length" was 12.95–14.83 cm. For the standard variety 'Almaz', this indicator was X_{med} = 15.58 ± 0.74 cm. This means that none of the tested lines exceeded the variety 'Almaz' in a statistically reliable way according to this indicator. The highest given indicator was in line Pavlotas-20 (large-fruited KSN) (X_{med} = 14.83 ± 0.68 cm), the lowest in line BC_2[F_5 (Pavlotas-20 / 'Almaz')]I_1 (X_{med} = 13.33 ± 0.48 cm) (Table 2).

Based on the manifestation of this quantitative trait, all linear samples and the 'Almaz' variety exhibited weak variation (V = 15.5... 31.2%). The most unstable line was BC_1[F_5

(Pavlotas-20 / 'Almaz')]I_1 (σ = 4.55, V = 31.2%). The line $BC_2[F_5$ (Pavlotas-20 / 'Almaz')]I_1 (σ = 2.07, V = 15.5%) was the most stable. In the standard variety, the indicators were: σ = 2.76; V = 17.7%.

Table 3 summarises the results of research on measuring and calculating the width of eggplant fruits in experimental samples. The quantitative trait 'Average fruit width' varied between 5.63 and 6.43 cm in linear genotypes. The expression levels of this trait in the two lines Pavlotas-20 (large-fruited KSN) and $BC_2[F_5$ (Pavlotas-20 / 'Almaz')]I_1 (X_{med} = 5.63 ± 0.29 cm) were almost the same as the standard variety 'Almaz' (X_{med} = 5.52 ± 0.35 cm). These lines also had the smallest fruit width (Table 3).

Table 2

Variation for "Average fruit length" in linear eggplant samples, cm (average for 2021–2023)

Sample	$X_{med} \pm m_x$	X_{min}	X_{max}	σ	V, %
Variety 'Almaz', standard	15.58 ± 0.74	10.90	20.45	2.76	17.7
Pavlotas-20 (large-fruited KSN)	14.83 ± 0.68	11.02	18.33	2.34	15.8
F_6(Pavlotas-20 / 'Almaz')I_1	12.95 ± 0.75	10.20	17.53	2.36	18.3
$BC_1[F_5$ (Pavlotas-20 / 'Almaz')I_1	14.59 ± 1.31	8.80	22.50	4.55	31.2
$BC_2[F_5$ (Pavlotas-20 / 'Almaz')I_1	13.33 ± 0.48	10.43	19.10	2.07	15.5
X_{min}	12.95	8.80	17.53	2.07	15.5
X_{max}	15.58	11.02	22.50	4.55	31.2
$A_m = X_{max} - X_{min}$	2.63	2.22	4.97	2.48	15.7

Table 3

Variation of the trait "Average fruit width" in linear eggplant samples, cm (average for 2021–2023)

Sample	$X_{med} \pm m_x$	X_{min}	X_{max}	σ	V, %
Variety 'Almaz', standard	5.52 ± 0.35	3.50	8.0	1.31	23.8
Pavlotas-20 (large-fruited KSN)	5.63 ± 0.29	4.17	7.50	1.0	17.9
F_6(Pavlotas-20 / 'Almaz')I_1	6.43 ± 0.28	4.50	7.50	0.87	13.6
$BC_1[F_5$ (Pavlotas-20 / 'Almaz')I_1	6.34 ± 0.36	4.40	8.50	1.24	19.6
$BC_2[F_5$ (Pavlotas-20 / 'Almaz')I_1	5.63 ± 0.29	4.14	9.40	1.25	22.2
X_{min}	5.52	3.50	7.50	0.87	13.6
X_{max}	6.43	4.50	9.40	1.31	23.8
$A_m = X_{max} - X_{min}$	0.91	1.0	1.90	0.44	10.2

Lines F_6(Pavlotas-20 / 'Almaz')I_1 and $BC_1[F_5$ (Pavlotas-20 / 'Almaz')]I_1 showed a statistically significant increase in fruit width of 14.85–16.48% compared to the standard variety. The fruit width measurements for line F_6(Pavlotas-20 / 'Almaz')I_1 were X_{med} = 6.43 ± 0.28 cm, while for line $BC_1[F_5$ (Pavlotas-20 / 'Almaz')]I_1 they were X_{med} = 6.34 ± 0.36 cm.

All eggplant samples examined showed a high stability in the manifestation of the trait "Average fruit width", as indicated by two statistical measures: the coefficient of variation (V) and the average standard deviation (σ). The "Mean square deviation" indicator showed discrepancies of σ = 0.87…1.31, while the coefficient of variation was V = 13.6…23.8% (refer to Table 3). The most stable line was $BC_1[F_5$ (Pavlotas-20 / 'Almaz')]I_1 (σ = 0.87; V = 13.4%). The 'Almaz' variety has the following indicators: σ = 1.31, V = 23.8%. This means that 'Almaz' was less stable in expressing the quantitative trait "Average fruit width" compared to linear genotypes.

One of the important indicators of the degree of alignment of the linear material of the eggplant is the variation of the "Fruit shape index" indicator. The results of the biometric calculations for this characteristic are summarised in Table 4. Among the investigated lines of variation of this characteristic within plant populations, there was a rather low range according to the statistical indicator – mean square deviation (σ = 0.29…0.50) and coefficient of variation (V = 14.1…18.6%). The line $BC_2[F_5$ (Pavlotas-20 / 'Almaz')]I_1 showed the highest statistical indicators of instability, with σ = 0.45 and V = 18.6%. In comparison, the standard variety 'Almaz' had σ = 0.80 and V = 26.8% (Table 4). The Pavlotas-20 line (large-fruited KSN) had the highest level of manifestation of the quantitative trait "Fruit shape index" with X_{med} = 2.70 ± 0.14, while the standard variety had X_{med} = 2.99 ± 0.21. The quantitative characteristic's range of variation for all linear samples was between 2.04 and 2.70 (Table 4).

Table 5 shows the expression levels of the trait "Average fruit weight" in linear samples and intermediate F_1 hybrids of eggplant. The results indicate that this quantitative trait is highly dependent on growing conditions and exhibits high instability of expression, as demonstrated by the range of values for statistical indicators such as "mean square deviation" (σ = 50.25…137.41) and "coefficient of variation" (V = 24.2…52.0%).

Table 4

Variation of the trait "Fruit shape index" in linear eggplant samples (average for 2021–2023)

Sample	$X_{med} \pm m_x$	X_{min}	X_{max}	σ	V, %
Variety 'Almaz', standard	2.99 ± 0.21	1.65	4.05	0.80	26.8
Pavlotas-20 (large-fruited KSN)	2.70 ± 0.14	1.67	3.30	0.50	18.4
F_6(Pavlotas-20 / 'Almaz')I_1	2.04 ± 0.09	1.58	2.65	0.29	14.1
BC_1[F_5 (Pavlotas-20 / 'Almaz')I_1	2.28 ± 0.10	1.77	2.89	0.35	15.2
BC_2[F_5 (Pavlotas-20 / 'Almaz')I_1	2.45 ± 0.10	1.70	3.34	0.45	18.6
X_{min}	2.04	1.58	2.65	0.29	14.1
X_{max}	2.99	1.77	4.05	0.80	26.8
$A_m = X_{max} - X_{min}$	0.95	0.19	1.40	0.52	12.7

Table 5

Variation of the trait "Average fruit weight" in linear eggplant samples, g (average for 2021–2023)

Sample	$X_{med} \pm m_x$	X_{min}	X_{max}	σ	V, %
Variety 'Almaz', standard	186 ± 18.61	95.50	304.0	69.65	37.5
Pavlotas-20 (large-fruited KSN)	219 ± 17.26	116.67	336.25	59.78	27.4
F_6(Pavlotas-20 / 'Almaz')I_1	208 ± 15.89	131.75	274.0	50.25	24.2
BC_1[F_5 (Pavlotas-20 / 'Almaz')I_1	292 ± 39.67	107.40	516.50	137.41	47.1
BC_2[F_5 (Pavlotas-20 / 'Almaz')I_1	204 ± 24.30	101.57	589.0	105.90	52.0
X_{min}	186	95.50	274.0	50.25	24.2
X_{max}	292	131.75	589.0	137.41	52.0
$A_m = X_{max} - X_{min}$	106	36.25	315.0	87.16	27.8

The line BC_1[F_5 (Pavlotas-20 / 'Almaz')]I_1 had the highest average fruit weight (X_{med} = 292 ± 39.67 g), which was 57.18% greater than the standard variety 'Almaz' (X_{med} = 186 ± 18.61 g). The line BC_2[F_5 (Pavlotas-20/ 'Almaz')]I_1 had the lowest manifestation of this trait with an average fruit weight of X_{med} = 204 ± 24.30 g. With the exception of the line BC_1[F_5 (Pavlotas-20 / 'Almaz')]I_1, all lines performed better than the standard variety 'Almaz' in terms of average fruit weight. However, the variation of this characteristic over the years of research did not exceed the limits of error of the experiment for the standard variety. The levels of manifestation of the quantitative trait "Average fruit weight" for the aforementioned lines were X_{med} = 204…219 g (Table 5).

Line F_6 (Pavlotas-20 / 'Almaz')I_1 demonstrated the best stability of expression with σ = 50.62 and V = 24.2%. On the other hand, line BC_2[F_5 (Pavlotas-20 / 'Almaz')]I_1 showed high instability with σ = 105.90 and V = 52.0%. In the standard variety 'Almaz', the indicators were σ = 69.65 and V = 37.5% (Table 5).

Table 6 displays the levels of manifestation of the trait "Productivity of one plant" in the studied linear samples and the eggplant standard variety. The results indicate that this quantitative trait is highly dependent on growing conditions and is unstable in its manifestation, as evidenced by the values of statistical indicators – mean square deviation (σ = 289.50…520.08) and coefficient of variation (V = 31.0…48.5%). The level of manifestation of the trait "Productivity of one plant" varied within the studied eggplant samples, with X_{med} ranging from 933 to 1168 g/plant (A_m = 235 g/plant). Plant productivity was at the standard level in lines Pavlotas-20 (large-fruited KSN), F_6 (Pavlotas-20 / 'Almaz')I_1 and BC_1[F_5 (Pavlotas-20 / 'Almaz')]I_1. The lowest productivity was observed in line F_6 (Pavlotas-20 / 'Almaz')I_1 (X_{med} = 933 ± 91.55 g/plant).

The productivity of the line BC_2[F_5 (Pavlotas-20 / 'Almaz')]I_1 (X_{med} = 1168 ± 79.31 g/plant), which additionally underwent gametophytic breeding during 2021–2023, was 18.11% higher than the standard variety. The results were statistically significant. In the 'Almaz' standard variety, the indicator was X_{med} = 989 ± 77.28 g/plant (Table 6).

Table 7 provides data on changes in the phenological phase of the eggplant development, specifically "Duration of the period from mass germination to technical fruit maturity". The information is important for the breeding process. Based on the 2021 data, the duration of this period for the entire sample ranged from 122 to 130 days (with an average of 8 days). In 2022, the duration was within 116–127 days (with an average of 11 days), and in 2023, it was within 120–139 days (with an average of 19 days). Therefore, the amplitude of variation of this quantitative characteristic (A_m) during the years of observation ranged from 8 to 19 days, depending on the growing conditions. Based on the averaged data, two linear samples were selected. These samples showed a shorter duration of the analyzed phenological phase of plant development by 2–4 days compared to the standard variety 'Almaz' (X_{med} = 126 days). Line $BC_2[F_5$ (Pavlotas-20 / 'Almaz')]I_1 (X_{med} = 122 days) had a duration shorter by 4 days than the standard variety. Line $BC_1[F_5$ (Pavlotas-20 / 'Almaz')]I_1 (X_{med} = 124 days) had a duration 2 days less than the standard variety. Based on the manifestation of this quantitative trait, all linear samples and the 'Almaz' variety exhibited a weak variation (V = 3.0…7.6%).

Table 6

Variation of the trait "Productivity of one plant" in linear samples of eggplant, g/plant (average for 2021–2023)

Sample	$X_{med} \pm m_x$	X_{min}	X_{max}	σ	V, %
Variety 'Almaz', standard	989 ± 77.28	382	1945	364.0	36.8
Pavlotas-20 (large-fruited KSN)	1070 ± 149.70	350	1989	518.56	48.5
F_6(Pavlotas-20 / 'Almaz')I_1	933 ± 91.55	542	1363	289.50	31.0
$BC_1[F_5$ (Pavlotas-20 / 'Almaz')I_1	943 ± 104.14	410	1518	360.75	38.3
$BC_2[F_5$ (Pavlotas-20 / 'Almaz')I_1	1168 ± 79.31	629	2536	520.08	44.5
X_{min}	933	350	1363	289.50	31.0
X_{max}	1168	629	2536	520.08	48.5
$A_m = X_{max} - X_{min}$	235	279	1173	230.58	17.5

The effectiveness of using linear correlation coefficients in the breeding process depends on the presence of a close to linear relationship between quantitative traits or a correlation coefficient with a large enough value. After examining the characteristics of quantitative traits in plant populations of lines and the standard eggplant variety, we conducted an analysis of the correlation between these traits. These traits reflect the morphophysiological indicators of plant growth and development. The correlation analysis used 7 quantitative traits. "Number of fruits per plant", "Average fruit length", "Average fruit width", "Fruit shape index", "Average fruit weight", "Productivity per plant", and "Duration of the period from mass germination to technical fruit maturity".

Table 7

Duration of the phenological phase of development "Duration of the period from mass emergence to technical fruit maturity" in eggplant lines of interspecies origin, days (average for 2021–2023)

Sample	Years of research				
	2021	2022	2023	X_{med}	V, %
Variety 'Almaz', standard	130	127	120	126	4,0
Pavlotas-20 (large-fruited KSN)	124	116	135	125	7,6
F_6(Pavlotas-20 / 'Almaz')I_1	130	124	139	131	5,8
$BC_1[F_5$ (Pavlotas-20 / 'Almaz')I_1	127	120	126	124	3,0
$BC_2[F_5$ (Pavlotas-20 / 'Almaz')I_1	122	117	127	122	4,1
X_{min}	122	116	120	122.0	3.0
X_{max}	130	127	139	131.0	7.6
$A_m = X_{max} - X_{min}$	8	11	19	9.0	4.6

The analysis included not only linear samples but also the standard variety 'Almaz'. Table 8 summarizes the data from the correlation analysis, which shows strong and statistically reliable correlations (± 0.7 < r_p < ± 0.99) between the examined eggplant samples. A total of 7 strong correlations were found, particularly strong direct correlations were found between the following pairs of quantitative traits: "Avarage fruit length" and "Fruit shape index" (r_p = 0.83); "Number of fruits on one plant" and "Productivity of one plant" (r_p = 0.75). The study also found several strong inverse correlations: "Number of fruits per plant" was negatively correlated with both "Average fruit width" (r_p = −0.81) and "Average fruit weight" (r_p = −0.83). Similarly, there was a negative correlation between "Average fruit width" and "Fruit shape index" (r_p = −0.88), as well as between "Average fruit width" and "Productivity of one plant" (r_p = −0.70). Additionally, there was a negative correlation between "Productivity of one plant" and "Duration of the period from mass germination to technical fruit maturity" (r_p = −0.72) (Table 8).

Table 8

Correlations between quantitative traits in the studied eggplant samples, r_p

Quantitative trait	Average fruit length	Average fruit width	Fruit shape index	Average fruit weight	Productivity of one plant	Duration of the period from mass germination to technical fruit maturity
Number of fruits per plant	−0.01	**−0.81***	0.54*	**−0.83***	**0.75***	−0.37*
Average fruit length		−0.50*	**0.83***	0.05	−0.14	−0.30*
Average fruit width			**−0.88***	0.60*	**−0.70***	0.59*
Fruit shape index				−0.44*	0.31*	−0.43*
Average fruit weight					−0.37*	−0.18
Productivity of one plant						−0.72*

* significant at 0.05 level of significance.

The correlations studied enable the prediction of inheritance of valuable quantitative traits in eggplant genotypes, particularly those that are structural components of yield, in further breeding work. It is important to note the strong inverse correlation between productivity and the duration of the period from mass germination to technical fruits maturity of the eggplants, regardless of the genotype of the line or the variety. This experimental fact indicates that the prolongation of this period is associated with unfavorable growing conditions, which have had a negative impact on the achievement of the optimum (reaction rate) of the genetic potential of eggplants in terms of their productivity in the time dimension.

Conclusions

The analysis of quantitative traits of eggplant lines of interspecies origin revealed some that were superior to the standard variety 'Almaz' in terms of both level and stability of manifestation. In particular, the following quantitative characteristics of the lines were characterised by a low variation according to the coefficient of variation indicator ($V < 33.3\%$) "Average fruit length"; "Average fruit width"; "Fruit shape index"; "Duration of the period from mass germination to technical fruit maturity". Two lines, F_6(Pavlotas-20 / 'Almaz')I_1 and $BC_2[F_5$ (Pavlotas-20 / 'Almaz')]I_1, showed a statistically significant increase in fruit width compared to the standard variety, with increases of 16.48% and 14.85%, respectively. Line $BC_2[F_5$ (Pavlotas-20 / 'Almaz')]I_1 also showed a similar increase of 18.11% in productivity compared to the standard variety. Seven strong positive and negative correlations were found between pairs of quantitative traits of the eggplans in the studied samples ($\pm 0{,}7 < r_p < \pm 0{,}99$). The trait "Productivity of one plant" showed a strong positive correlation with the trait "Number of fruits on one plant" ($r_p = 0.75$) and a strong negative correlation with the traits "Average fruit width" ($r_p = -0.70$) and "Duration of the period from mass germination to technical fruit maturity" ($r_p = -0.72$). Two lines were identified in which the period from mass germination to technical fruit maturity was 2–4 days shorter than the standard variety 'Almaz'. Line $BC_2[F_5$ (Pavlotas-20 / 'Almaz')]I_1 had a duration 4 days shorter than the standard variety, and line $BC_1[F_5$ (Pavlotas-20 / 'Almaz')]I_1 was 2 days shorter than the standard variety 'Almaz' I_1. Line $BC_2[F_5$ (Pavlotas-20 / 'Almaz')]I_1 underwent an additional stage of gametophytic breeding during 2021–2023. This resulted in a high adaptive potential to growing conditions, which was reflected in its best productivity and the shortest period for acquiring technically fruit maturity.

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Кондратенко С. І.[*1]**, Самовол О. П.**[1]**, Сергієнко О. В.**[1]**, Ткалич Ю. В.**[2]**, Марусяк А. О.**[1] Оцінка потенціалу продуктивності ліній баклажана, створених на основі міжвидової гібридизації та гаметної селекції. *Plant Varieties Studying and Protection*. 2024. Т. 20, № 1. С. 26–33. https://doi.org/10.21498/2518-1017.20.1.2024.300133

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Мета. Поліпшення генофонду культурної форми баклажана (*Solanum melongena* L.) завдяки міжвидовій гібридизації з видом *Solanum aethiopicum* L. та гаметній селекції; аналіз ліній міжвидового походження за комплексом кількісних цінних ознак, які визначають структуру врожайності. **Методи.** Дослідження з комплексного оцінювання ліній баклажана міжвидового походження здійснювали протягом 2021–2023 рр. в умовах захищеного ґрунту на експериментальній базі Інституту овочівництва і баштанництва НААН. Проведено фенологічні спостереження та біометричні вимірювання рослин чотирьох ліній. Стабільність прояву семи кількісних ознак за роками досліджень визначали методами варіаційної статистики [розрахунок середнього квадратичного відхилення (σ), коефіцієнта варіації (*V*), парної лінійної кореляції Пірсона (r_p)]. **Результати.** За результатами аналізу визначено лінії баклажана міжвидового походження, що переважали сорт-стандарт ‘Алмаз’ за рівнем і стабільністю прояву кількісних ознак. Зокрема, F_6(Павлотас-20 / ‘Алмаз’)I_1 та BC_1[F_5 (Павлотас-20 / ‘Алмаз’)]I_1 статистично достовірно перевищували сорт-стандарт за шириною плоду (на 16,48 і 14,85% відповідно); водночас лінія BC_2[F_5 (Павлотас-20 / ‘Алмаз’)] I_1 переважала його за продуктивністю (на 18,11%). За даними кореляційного аналізу, ознака «продуктивність однієї рослини» мала сильний позитивний зв’язок з ознакою «кількість плодів на одній рослині» (r_p = 0,75) та сильний негативний із «середньою шириною плоду» (r_p = –0,70) та «тривалістю періоду від масових сходів до технічної стиглості плодів» (r_p = –0,72). Виділено лінію BC_2[F_5 (Павлотас-20 / ‘Алмаз’)]I_1, у якої період від масових сходів до технічної стиглості плодів тривав на чотири доби менше, як порівняти із сортом-стандартом. **Висновки.** За комплексом кількісних ознак виділено лінію BC_2[F_5 (Павлотас-20 / ‘Алмаз’)]I_1, яка проходила додатковий етап гаметофітного добору, завдяки чому мала високий адаптивний потенціал до умов вирощування.

Ключові слова: *кількісні ознаки; генетична вирівняність; кореляційні зв’язки; гаметофітне потомство; добір.*

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