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Analysis Of The Inheritance Index (H^2) Of Plant Height In F1 Hybrid Generations Of Durum Wheat In The Rainfed Areas

Amirova Muhayyo Sobir qizi
(PhD) student, Scientific research institute of Rainfed agriculture, Uzbekistan

Karshiboev Khasan Xolbazarovich
Doctor of Philosophy (PhD) in Agricultural Sciences, Scientific research institute of Rainfed agriculture, Uzbekistan

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Abstract: This article analyzes the changes in plant height and heritability index (hp) in F1 hybrid generations of durum wheat studied in the research conducted in 2025 at the "Durum Wheat Genetics, Breeding and Seed Production" laboratory of the Lalmikor Agricultural Research Institute. The results of the study made it possible to identify promising combinations for selection work and determine the genetic advantages of parental forms. The positive or negative heritability index reflected the degree of dominant influence of parental plants in hybrids.

Keywords: Durum wheat, plant growth, heredity index, F1, dominance, positive heterosis, negative heterosis, dominance, environmental effects, genetic control, sign.

Introduction: Wheat is one of the major crops ensuring global food security. In developing countries, more than 40% of the protein and calorie intake required by the population is directly provided by wheat products. The steady annual growth of the population in our republic necessitates further advancement of scientific research conducted by plant breeders aimed at developing high-yielding wheat varieties with superior grain quality [Mameev V.V., pp. 6–9].Correctly defining the main directions for the development of grain production, strengthening the material and technical base, breeding high-yielding strong durum wheat varieties resistant to diseases, pests, and lodging, with high grain quality, organizing their primary seed production, and developing cultivation technologies adapted to regional soil and climatic conditions as well as varietal characteristics are among the most important current tasks in grain farming [Rakhimov A.R., Botirov A.R., p. 117].Studies have shown that the correlation between stem length and yield in wheat is not negative, indicating that a reduction in plant height does not adversely affect productivity [Kubayeva M., Qarshiyeva U., p. 161].In wheat breeding, plant height is one of the key morphological traits and has a significant influence on maturity period and lodging resistance. Evaluation of the inheritance of plant height in hybrid progenies obtained through crossbreeding makes it possible to identify over dominance or partial dominance (heterosis).

METHODS

The research was conducted in 2025 at the Laboratory of Genetics, Breeding and Seed Production of Durum Wheat of the Scientific Research Institute of Rainfed Agriculture. Phenological observations of F_1 hybrid progenies of durum wheat, determination and evaluation of developmental stages were carried out in accordance with the methodological guidelines of the Gallaaral branch of SEG'DO'ITI (2004). Plant cutting was performed following the method of P.P. Lukyanenko (1973), while pollination was conducted using the twell method developed by A.F. Merozhko, L.M. Ezrokhin, and A.E. Yudin (1973). Biometric analyses were carried out according to the methods of the State Commission for Variety Testing of Agricultural Crops (1985, 1989). Mathematical and statistical analyses of the obtained data were performed based on the methodology of B.A. Dospekhov (1985).A total of 24 hybrid

combinations were analyzed. Plant height data of the maternal parent, F_1 hybrid, and paternal parent were used for evaluation. For each combination, the direction and degree of inheritance (hp) were calculated.(Figure 1) The degree of dominance (inheritance index) of plant height in F_1 hybrids of durum wheat was determined using the formula proposed by F. Petr and K. Frey:

$$Hp = \frac{F1 - MP}{P - MP}$$

Where:

MP — mean value of the parental forms.

hp — index of inheritance character;

F_1 — mean value of the trait in the first-generation hybrid;

MP — mean value of the parental forms;

P — mean value of the better parent.

If hp > 0, positive dominance is recorded; if hp < 0, negative dominance is observed. When the F_1 hybrid approaches the maternal parent, dominance of maternal genes is indicated; when it approaches the paternal parent, dominance of paternal genes is observed. A sharp deviation of F_1 from both parents indicates high hybrid vigor (heterosis), whereas proximity of F_1 to MP suggests a relatively stronger environmental influence.

RESULTS AND DISCUSSION

In our studies, on average, F_1 hybrids significantly deviated from the parental mean (MP), indicating that genetic factors play a major role in the expression of plant height. According to literature data, inheritance index values reaching ±3 indicate a strong genetic effect.

Inheritance index (h^2) of plant height

Figure 1

№	Hybrid combination	Plant height.cm			hp
		Maternal parent (♀), cm	F_1 hybrid, cm	Paternal parent (♂), cm	
1	Leukurum-3 x K-8527 (Gretsiya)		0		
2	Leukurum-3 x K-9034 (Rossiya)	84,6	83,3	45	0,9
3	Leukurum-3 x №13 Zeina/Cucaraja (Livan)	80,4	75,5	56,7	0,6
4	Leukurum-3 x №22 Margherita (Livan)	86	67,9	57,5	-0,3
5	Leukurum-3 x №24 Younes/Gidara2 (Livan)	67,7	57,2	59,4	1,1
6	Yoqut-2014 x K-8527 (Gretsiya)	83,1	77,4	63,4	0,5
7	Yoqut-2014 x №29 Azeghar1/6/Zna1(Livan)	76,2	57,2	58,2	-1,8
8	Yoqut-2014 x №35 Margherita//DBA(Livan)	78,4	63,2	60,9	-0,5
9	Yoqut-2014 x №37 Margherita/Derazejihan(Livan)	86,9	76,8	56,1	0,9
10	Yoqut-2014 x №38 Margherita/3/Amedakul(Livan)	97,2	70,0	53,1	-0,3
11	Yoqut-2014 x Tilladon	76,7	87,6	92,0	0,8
12	Yoqut-2014 x Kumushdon	89,4	63,0	77,8	-3,6
13	Tilladon x №8 Sebatel 2 // Wdz 6 (Livan)	77,6	82,5	72,5	2,9
14	Tilladon x №13 Tilling / Icajihan 1(Livan)	96,1	68,5	64,4	-1,3
15	Tilladon x №13 Zeina/Cucaraja (Livan)	87,4	72,4	56,5	-0,3
16	Tilladon x №35 Margherita//DBA(Livan)	97,0	84,6	57,5	0,4
17	Tilladon x №37 Margherita/Derazejihan(Livan)	103	52,2	59,7	-1,2
18	Tilladon x №38 Margherita/3/Amedakul(Livan)	91,2	71,3	60,6	-0,3
19	Tilladon x №43 Ouassara1/Baladi(Livan)	88,4	73,7	55,1	0,1
20	Tilladon x №44 Miki3 (Livan)	87,5	67,1	76,3	-2,6
21	№5 Mrb 3/Mna 1 (Livan), Kuz-D-5 x Leukurum-3	47,9	63,7	79,5	0,0

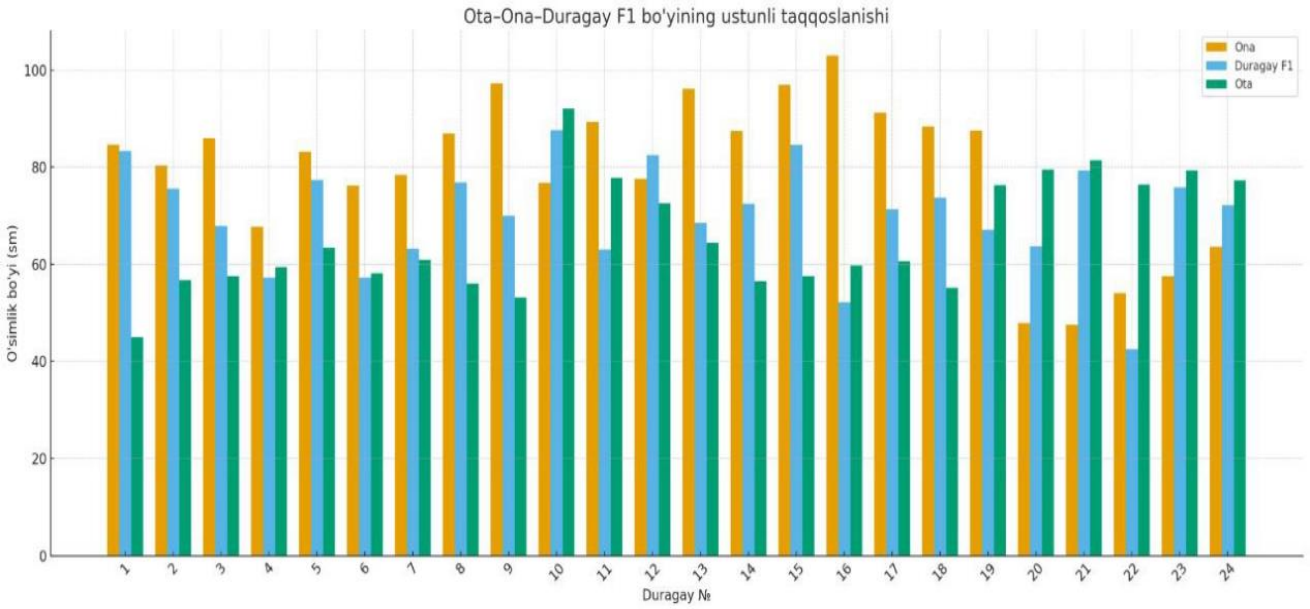
22	№5 Mrb 3/Mna 1 (Livan), Kuz-D-5 x Marvarid	47,5	79,3	81,4	0,9
23	№5 Mrb 3/Mna 1 (Livan), Kuz-D-5 x Yoqut-2014	54	42,5	76,4	-2,0
24	№5 Mrb 3/Mna 1 (Livan), Kuz-D-5 x Billurdon	57,5	75,8	79,3	0,7
25	№15Ouasloukos1/5/Gil4(Livan), Kuz-D-15 x Kumushdon	63,6	72,2	77,3	0,3

The analysis of the table shows that in most hybrid combinations, F_1 pro-genies exhibited plant height values exceeding those of one or both parents. This confirms that plant height is a highly heritable trait (approximately 70% genetic control), although environmental factors (irrigation, soil conditions, and annual climatic variability) also exert influence. The contribution of genetic factors to plant height variability in hybrids was estimated at 65–75%, while environmental factors accounted for 25–35%. Positive and negative deviations of hp values indicate genetic dominance of parental forms.

High heterosis values (hp = 2.9; 1.1; 0.9) reflect strong genetic control, whereas combinations with hp ≈ 0 indicate a relatively higher environmental influence.

Plant height of maternal, paternal parent and hybrids

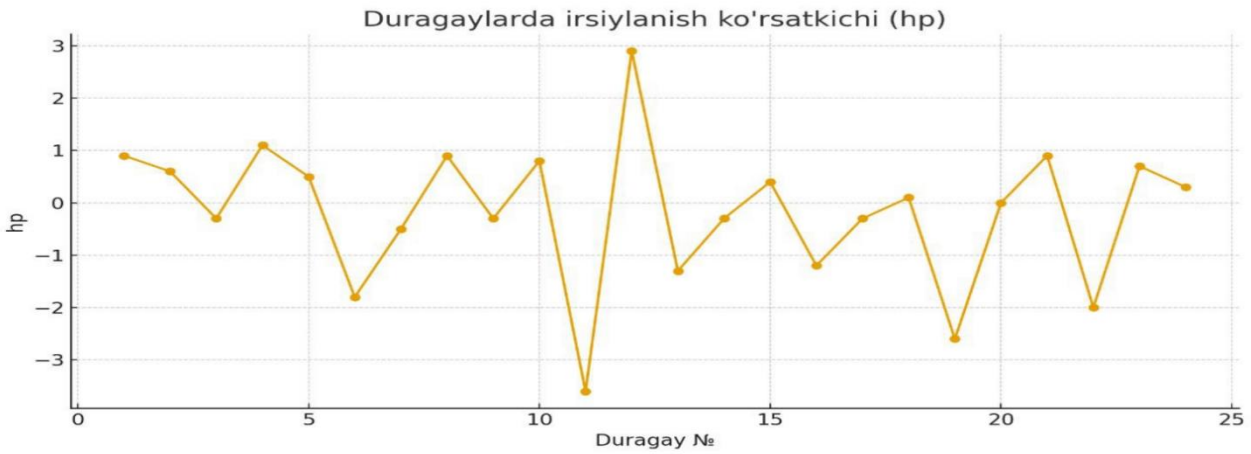
Figure 2



The bar chart analysis clearly demonstrated differences in plant height between hybridsand their parental forms(Figure 2). The comparison enabled assessment of how parental genetic combinations were expressed in F_1 progenies. In most hybrids, the maternal parent was taller than the paternal one, indicating that breeding lines were selected for increased plant height. Combinations in which the maternal parent exceeded the paternal parent in height accounted for approximately 80%, suggesting a strong maternal influence and pronounced heterosis in F_1 hybrids.Positive heterosis (F_1 > maternal or paternal parent) was observed in hybrids such as Yoqut-2014 × Tilladon, Tilladon × №13 Tilling/Icajihan-1, Tilladon × №37 Margherita/Derazejihan, and №5 Mrb3/Mna1 × Leukurum-3, indicating strong genetic compatibility and high hybrid vigor.Negative heterosis (F_1 < parents) was recorded in combinations including Yoqut-2014 × K-8527, Yoqut-2014 × №29 Azeghar1/6/Zna1, Yoqut-2014 × Kumushdon, and №5 Mrb3/Mna1 × Yoqut-2014, suggesting weaker genetic compatibility and reduced plant height.Variation in bar heights reflects the influence of polygenic traits and additive gene effects in the genetic structure of these hybrid combinations.The tallest hybrids were observed in Yoqut-2014 × Tilladon and Tilladon × №44 Miki3, where F_1 plant height exceeded 80 cm. The shortest hybrids (F_1 < 60 cm) were recorded in Leukurum-3 × №24 Younes/Gidara2, Yoqut-2014 × №29 Azeghar1/6/Zna1, and №5 Mrb3/Mna1 × Yoqut-2014.

Inheritance index of hybrids

Figure 3



Inheritance index analysis revealed strong positive dominance (hp > 1.0) in Leukurum-3 × №24 Younes/Gidara2 (hp = 1.1) and Tilladon × №8 Sebatel-2//Wdz-6 (hp = 2.9). Moderate positive dominance (0 < hp < 1) was observed in several combinations, while negative inheritance (hp < 0) was detected in hybrids such as Yoqut-2014 × Kumushdon (hp = −3.6). Near-zero inheritance (hp ≈ 0) indicated minimal differences between parental forms and hybrids.

CONCLUSION

The obtained results indicate that genetic factors exert a stronger influence on plant height than environmental factors in the studied durum wheat genotypes. The tallest F_1 hybrids were identified in Yoqut-2014 × Tilladon, Tilladon × №13, and Tilladon × №44 Miki3, with plant height exceeding 80 cm, making them promising for breeding high-biomass, tall plant types.

The shortest hybrids (F_1 < 60 cm) — Leukurum-3 × №24 Younes/Gidara2, Yoqut-2014 × №29 Azeghar1/6/Zna1, and №5 Mrb3/Mna1 × Yoqut-2014 — may be effectively used in breeding programs aimed at developing lodging-resistant, short-statured lines.

Strong positive dominance observed in Leukurum-3 × №24 Younes/Gidara2 and Tilladon × №8 Sebatel-2//Wdz-6 confirms their high potential for increasing plant height in breeding programs. Combinations with moderate positive dominance represent valuable sources of phenotypic superiority, while negatively inherited combinations may be utilized for specialized breeding objectives related to lodging resistance.

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