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INHERITANCE IN F1 AND TRANSGRESSIVE VARIABILITY IN F2 POPULATIONS OF MAIN SPIKE LENGTH SOFT WINTER WHEAT

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Abstract

The character of inheritance of the main spike length in F1 and transgressive variability in F2 populations was studied by hybridization of the maternal form of early maturing winter wheat varieties with medium early, medium early and medium late varieties. It was found that in most combinations of crosses, the inheritance of the length of the main spike was positive dominant. In 2018-2019, with the exception of the Kolchuga/Chornyava combination (2018), positive hypothetical heterosis for the length of the main spike was determined and 35 out of 40 hybrids had positive true heterosis. The significant influence of hybridization components and year conditions on the main spike length, degree of phenotypic dominance and heterosis was established. The majority of F_2 populations significantly exceeded the parental forms in terms of the extreme maximum length of the main spike, indicating a significant formation process and the possibility of conducting selections for the studied trait. In 2019-2020, 26 out of 40 F_2 populations showed a positive degree and frequency of transgressions in spike length.

Key words*: heterosis, hybrid, main spike length, F2 populations, varieties.*

INTRODUCTION

In Ukraine, winter wheat (*Triticum aestivum* L.) plays a leading role in grain production (Burdeniuk-Tarasevych & Lozinskyi, 2015; Sydiakina & Dvoretskyi, 2020) and is cultivated on an area of 6.2-6.7 million hectares (Verner, 2021), which is evidence of its important economic importance (Kiriiak & Kovalenko, 2015; Zhemela et al., 2020). The high ecological plasticity of wheat and its ability to form crops in different geographical zones and agroclimatic conditions (Burdeniuk-Tarasevych & Lozinskyi, 2015; Ray et al., 2013), as well as its excellent nutritional value, have contributed to its widespread use as a staple food (Zhemela et al., 2020; Havryliuk & Kalenych, 2018). The level of wheat yield achieved under production conditions does not meet modern requirements and indicates a low realisation of the crop's genetic potential (Bazalii et al., 2010). At the same time, climate change can have a significant impact on grain production (Tavares et al., 2015; Machold & Honeremeier, 2016). Another important task is to increase wheat production with high quality indicators.

An important factor in the stabilization and growth of winter soft wheat production is the development and introduction of new high-yielding varieties adapted to specific growing conditions (Burdeniuk-Tarasevych & Lozinskyi, 2014; Morhun et al., 2014; Egamov et al., 2021, Lozinskiy et al, 2023). The improvement of new varieties should be based on environmental sustainability, taking into account the specific interactions between environment and genotype, which will provide new approaches to the formation of highly productive agrophytocenoses (Adhikari et al., 2020; Bondareva & Vashchenko, 2021). Success in breeding and genetic research is due to many factors, the most important of which is the search for and creation of new source materials with high productivity, quality and adaptability to biotic and abiotic environmental factors (Morhun et al., 2015). At the same time, in the genetic improvement of wheat, genetic resources play a crucial role in practical breeding work.

Spike length is often used in practical breeding for the selection of valuable genotypes as it has a clear phenotypic manifestation and is a convenient morphological marker for

identifying valuable genotypes (Lozinskyi & Ustynova, 2020).

Today, transgressive breeding based on the selection of the best individuals in a hybrid population is one of the main methods of improving self-pollinated crops (Orliuk & Bazalii, 2013).

The aim of the research was to study the mode of inheritance of the length of the main spike in F1 and to establish transgressive variability in F2 populations obtained by hybridization of the maternal form of early maturing winter wheat varieties.

MATERIALS AND METHODS

The research was conducted in the experimental field of the research and production center of the Bila Tserkva National Agrarian University in 2017-2020. 20 F_1 hybrids and their F_2 populations were studied. Varieties of different maturity groups were used as parental forms: Mironovskaya early ripening (Mir. early), Kolchuga, Belotserkovskaya semi-dwarf (B.Ts. s/d.) – early ripening; Zolotokolosa (Zolotokol.), Chernyava – medium early; Stolichna, Vidrada, Antonovka, Yednist – medium ripening; Dobirna and Vdala – medium late ripening.

Seeds F_{1-2} were sown with a manual sowing machine in accordance with the scheme: mother form (♀), hybrid (population), male form (♂). The hybrid generation was worked with the pedigree method. Phenological observations were made during the wheat growing season and, after the onset of full grain maturity, biometric analysis of the study material was carried out on an average sample of 75 plants (Volkodav, 2003). The predecessor of soft winter wheat was grain mustard. The soil of the trial field is a typical deep, low-humus, coarse-dusted medium and light loamy black soil. According to the 2016 agrochemical survey, the humus content is 3.4-3.8%, alkaline hydrolyzed nitrogen is 118-134 mg/kg soil, mobile phosphorus is 180-208 and exchangeable potassium is 73-91 mg/kg soil. The reaction of the soil solution is slightly acidic and close to neutral. The main fertilizer was a phosphorus-potassium fertilizer at 60 kg/ha N in the form of superphosphate and potassium salt. Ammonium nitrate was applied at 60 kg/ha N to restore the spring vegetation. Herbicides and irrigation were not used in the nursery.

Hypothetical (Ht) and true (Hbt) heterosis by the length of the main spike in F1 was determined by Matzinger D.F. (1962) and S. Fonseca, F. Patterson (1968):

$$Ht\ (\%) = (F_1 - MP)/MP \times 100,$$
$$Hbt\ (\%) = (F_1 - BP)/BP \times 100,$$

where: F_1 – average arithmetic value of the hybrid;

BP – the highest manifestation of a trait of one of the parents;

MP – the average arithmetic value of the indicator of both parental forms.

The degree of phenotypic dominance (hp) was determined by the method B. Griffing (1950):

$$h_p = (F_1 - MP)/(BP - MP),$$

where: h_p – degree of domination;

F_1 – average arithmetic value of the hybrid;

BP – arithmetic mean of the parental component with the stronger manifestation of the trait;

MP – the average arithmetic value of the indicator of both parental forms.

The data obtained were grouped by classification G. M. Beil, R. E. Atkins (1965): positive dominance (heterosis) $h_p > +1$; partial positive dominance $+0.5 < h_p \leq +1$; intermediate inheritance $-0.5 \leq h_p \leq +0.5$; partial negative inheritance $-1 \leq h_p < -0.5$; negative dominance (depression) $h_p <-1$.

The degree (Tc) of positive transgression in F_2 populations was determined by the following method (Vasylkivskyi & Kochmarskyi, 2016):

$$Tc\ (\%) = (M_F - Mp) / Mp \times 100,$$

where: M_F – is the maximum value of a particular quantitative feature in F_2;

Mp – maximum value at the best parental form.

The frequency (Ff) of transgression was determined by the number (%) of individuals of F_2 populations exceeding (+T) the extreme manifestation of the trait in parental forms.

The results of the experimental data were statistically processed using the "Statistica" 12.0 programme.

At the time of sowing (last ten days of September), meteorological conditions in 2017-2019 were favorable for simultaneous germination and growth and development of soft winter wheat in autumn. The amount of precipitation during this period exceeded (2017) or was at the level of long-term average indicators. Soft winter wheat stopped vegetation in the autumn period on 20 November (2017), 12 November (2018) and 21 November (2019), which contributed to the successful hardening of the plant. Winter precipitation was well above the long-term average (112 mm) in the 2017/2018 and 2018/2019 growing years and was slightly lower than in 2019/2020. The winter temperature regime contributed to the successful overwintering of the plants (Table 1).

Table 1. Meteorological conditions in 2018-2020 (according to the Bila Tserkva meteorological station)

Month	Decade	Precipitation, mm					Air temperature, ºC				
		2017	2018	2019	2020	long-term data	2017	2018	2019	2020	long-term data
September		53.2	47.9	19.2		35	16.1	16.2	15.3		13.8
October		50.4	22.0	66.1		33	8.0	9.9	10.6		7.9
November		36.4	23.1	23.4		41	3.2	-0.1	5.0		2.0
December		92.3	71.1	35.1		44	1.6	-2.0	2.5		-2.4
January			30,5	56.8	22.6	35		-2.7	-4.8	0.4	-5.9
February			34,6	21.4	38.4	33		-4.2	0.4	2.2	-4.4
March			74.0	23.4	17.2	30		-2.1	4.7	5.9	0.3
April	I		1.5	-	-	14		10.3	9.6	7.9	7.0
	II		1.3	14.2	5.5	17		13.8	7.3	8.0	7.8
	III		5.3	31.3	7.7	16		15.7	13.2	11.7	10.4
May	I		3.7	26.7	30.8	16		20.4	12.1	12.8	13.3
	II		19.1	15.3	17.6	12		15.9	18.3	13.2	15.3
	III		-	12.0	53.9	18		18.8	19.3	11.5	15.8
June	I		2.2	35.3	7.1	23		19.4	21.1	18.5	17.3
	II		23.3	-.	50.4	27		21.9	23.6	23.2	17.4
	III		33.2	43.9	3.2	23		19.1	21.4	22.0	18.7

The temperature regime after the resumption of vegetation in 2018 (4 April) was characterized by elevated temperatures, which accelerated the growth and development of soft winter wheat. The average monthly temperature in April (15.5°C) was significantly higher than the long-term average (8.4°C), and the average air temperature in May and June was 3.5 and 2.3°C higher, respectively. At the same time, the amount of precipitation in April and May was less than the long-term average by 17.1 and 21.6 mm, respectively.

The vegetation of soft winter wheat from the time of recovery (02.03. - 2019, 28.02. - 2020) occurred during the month with low average monthly temperatures with their gradual increase. The amount of precipitation in March (23.4 mm) and the first two decades of April (14.2 mm) in 2019 was significantly lower than the long-term average. Precipitation in March and April 2020 was 46.6 mm below the long-term average.

Thus, the meteorological conditions during the years of research were characterized by contrasting indicators in terms of temperature and rainfall distribution.

RESULTS AND DISCUSSIONS

Experimental data show that in 2018, the length of the main spike in parental forms was 6.1-9.5 cm. According to the international classifier, short spike (6.1-7.5 cm) were formed by the varieties Yednist, Zolotokolosa, Vdala, Vidrada, Myronivska early ripening, Stolichna and Dobirna. The average spike length was observed in Antonivka, Bilotserkivska semi-dwarf, Kolchuga (7.6-8.8 cm) and Chorniava (9.5 cm). The hybrids we obtained had an average spike length (Table 2).

Table 2. Heterosis and the degree of phenotypic dominance of the main spike length in F_1 (2018 p.)

Crossing combinations	Spike length, cm			Heterosis, %		h_p
	♀	♂	F_1	Ht	Hbt	
♀ early ripening / ♂ early ripening						
Mir. early/B.Ts. s/d.	7.3	7.7	9.1	21.3	18.2	8.0
Mir. early/Kolchuga	7.3	8.8	9.9	22.2	12.5	2.5
B.Ts. s/d./ Kolchuga	7.7	8.8	8.6	3.6	-2.3	0.6
♀ early ripening / ♂ medium early						
Mir. early/Zolotokol.	7.3	6.7	8.6	22.9	17.8	5.3
Mir. early/ Chernyava	7.3	9.5	10.5	25.0	10.5	1.9
B.Ts. s/d./ Zolotokol.	7.7	6.7	8.9	23.6	15.6	3.4
B.Ts. s/d./ Chernyava	7.7	9.5	9.4	9.3	-1.1	0.9
Kolchuga/ Chernyava	8.8	9.5	8.9	-3.3	-6.3	-1.4
♀ early ripening / ♂ medium-ripening						
Mir. early/Antonovka	7.3	7.6	8.8	17.3	15.8	9.0
Mir. early /Yednist	7.3	6.1	9.7	44.8	32.9	4.6
B.Ts. s/d./ Antonovka	7.7	7.6	8.8	14.3	14.3	23.0
B.Ts. s/d./ Yednist	7.7	6.1	8.8	27.5	14.3	2.4
B.Ts. s/d./ Vidrada	7.7	7.2	8.6	14.7	11.7	5.5
Kolchuga /Antonovka	8.8	7.6	8.8	7.3	-	1.0
Kolchuga / Yednist	8.8	6.1	8.7	16.0	-1.1	0.9
Kolchuga / Vidrada	8.8	7.2	8.9	11.3	1.1	1.1
Kolchuga / Stolichna	8.8	7.5	9.7	18.3	10.2	2.4
♀ early ripening / ♂ medium late						
Mir. early / Vdala	7.3	7.0	9.6	33.3	31.5	16.3
Mir. early / Dobirna	7.3	7.5	9.0	21.6	20.0	16.0
B.Ts. s/d./ Dobirna	7.7	7.5	8.4	10.5	9.1	8.0

In most F1 hybrids the spike length exceeded that of the parent forms. In the Kolchuga/Antonovka hybridization, the studied index was at the level of the mother form with a greater manifestation of the trait. In the combinations of crossing Bilotserkivska semi-dwarf/Chernyava, Kolchuga/Yednist and Bilotserkivska semi-dwarf/Kolchuga the length of the spike approached the parental component with a greater manifestation and only in the hybrid Kolchuga/Chernyava there was an intermediate formation of the trait between the original forms.

Indicators of hypothetical heterosis for main spike length in F1 were positive, with the exception of Kolchuga/Chernyava (Ht = -3.3%), and ranged from 3.6-44.8%. Positive true heterosis (1.1-32.9%) was observed in 15 out of 20 hybrids. High values of heterosis were observed in the hybrids Myronivska early ripening/Yednist (Ht = 44.8%, Hbt = 32.9%) and Myronivska early ripening/Vdala (Ht = 33.3%, Hbt = 31.5%).

Positive superdominance for the length of the main spike (hp = 1.1-24.0) was determined in 15 out of 20 hybrids. Inheritance of partial positive dominance was observed in the crossing combinations - Bilotserkivska semi-dwarf/Kolchuga, Bilotserkivska semi-dwarf/Chernyava, Kolchuga/Yednist, Kolchuga/Antonovka, and Kolchuga/Chernyava was characterized by negative dominance.

In 2019, the length of the main spike in the parental forms ranged from 6.1 cm (Yednist) to 9.7 cm (Chernyava). Short ears (6.1-7.3 cm) were formed by varieties Yednist, Zolotokolosa, Vdala, Myronivska early ripening. The average length of the spike was observed in all other studied varieties (7.6-9.7 cm). The hybrids obtained in 2019 had some differences in the length of the main spike compared to 2018. The average spike (9.3-10.4 cm) was formed by Bilotserkivska semi-dwarf/ Yednist, Bilotserkivska semi-dwarf/Zolotokolosa, Bilotserkivska semi-dwarf/Chernyava, Myronivska early ripening/Yednist, Kolchuga/Yednist, Myronivska early ripening/Bilotserkivska semi-dwarf, Myronivska early ripening/Antonovka, Kolchuga/Vidrada, Bilotserkivska semi-dwarf/Vidrada, Myronivska early ripening/Dobirna. Other hybrids had a large spike (10.9-11.6 cm) (Table 3).

Table 3. Heterosis and the degree of phenotypic dominance of the main spike length in F_1 (2019 p.)

Crossing combinations	Spike length, cm			Heterosis, %		h_p
	♀	♂	F_1	Ht	Hbt	
♀ early ripening / ♂ early ripening						
Mir. early/B.Ts. s/d.	7.3	7.8	10.2	35.1	30.8	10.6
Mir. early/Kolchuga	7.3	9.0	10.7	31.3	18.9	3.0
B.Ts. s/d./ Kolchuga	7.8	9.0	10.9	29.8	21.1	4.2
♀ early ripening / ♂ medium early						
Mir. early/Zolotokol.	7.3	6.3	10.8	58.8	47.9	8.0
Mir. early/Chernyava	7.3	9.7	11.6	36.5	19.6	2.6
B.Ts. s/d./ Zolotokol.	7.8	6.3	9.6	36.2	23.1	3.4
B.Ts. s/d./ Chernyava	7.8	9.7	9.7	11.0	0.1	1.01
Kolchuga / Chernyava	9.0	9.7	11.4	21.9	17.5	5.9
♀ early ripening / ♂ medium-ripening						
Мир. ран./ Antonovka	7.3	7.9	10.2	34.2	29.1	8.7
Mir. early / Yednist	7.3	6.1	9.8	46.3	34.2	5.2
B.Ts. s/d./ Antonovka	7.8	7.9	11.0	40.1	39.2	63.0
B.Ts. s/d./ Yednist	7.8	6.1	9.3	33.8	19.2	2.8
B.Ts. s/d./ Vidrada	7.8	7.6	10.4	35.1	33.3	27.0
Kolchuga / Antonovka	9.0	7.9	11.4	34.9	26.7	5.4
Kolchuga / Yednist	9.0	6.1	10.0	32.5	11.1	1.7
Kolchuga / Vidrada	9.0	7.6	10.3	24.1	14.4	2.9
Kolchuga / Stolichna	9.0	7.7	11.4	36.5	26.7	4.7
♀ early ripening / ♂ medium late						
Mir. early / Vdala	7.3	6.7	10.8	54.3	47.9	12.7
Mir. early / Dobirna	7.3	8.0	10.4	35.9	30.0	7.9
B.Ts. s/d./ Dobirna	7.8	8.0	10.9	38.0	36.3	30.0

In 2019, the vast majority of F_1 hybrids obtained by using the maternal form of early maturing varieties exceeded the original forms in terms of ear length, and only in the combination Bilotserkivska semi-dwarf/Chernyava its length was at the level of the parental form with a greater manifestation of the trait.

In all F_1 hybrids, positive values of both hypothetical and true heterosis were established, the indicators of which were significantly influenced by the parental components of hybridization and the conditions of the year. The highest values of hypothetical and true heterosis were observed in hybrids: Myronivska early ripening/Zolotokolosa (Ht = 58.8%, Hbt = 47.9%); Myronivska early ripening/Vdala (Ht = 54.3%, Hbt = 47.9%); Myronivska early ripening/Yednist (Ht = 46.3%, Hbt = 34.2%); Bilotserkivska semi-dwarf/Antonovka (Ht = 40.1%, Hbt = 39.2%); Bilotserkivska semi-dwarf/Dobirna (Ht = 38.0%, Hbt = 36.3%); Myronivska early ripening/Dobirna (Ht = 35.9%, Hbt = 30.0%); Bilotserkivska semi-dwarf/Vidrada (Ht = 35.1%, Hbt = 33.3%); Myronivska early ripening/Bilotserkivska semi-dwarf (Ht = 35.1%, Hbt = 30.8%).

Positive superdominance by the length of the main spike was determined in all studied hybrids with modification of the degree of phenotypic dominance (hp = 1.01-30.0) depending on the selected parental forms.

In 2019, out of 20 crossing combinations in F_2, the average population index of the length of the main spike only in Myronivska early ripening/Kolchuga and Kolchuga/Yednist was 10.6 cm and 12.1 cm, respectively, indicating a long spike, while the rest of the spike was average (8.8-10.5 cm) (Table 4).

In 16 out of 20 F2 populations created by hybridization with the maternal form of early ripe varieties, the extreme maximum length of the main spike (10.5-15.0 cm) significantly exceeded the parental forms (9.0-10.5 cm), indicating a significant formation process and the possibility of conducting selections for the studied trait. In the populations Bilotserkivska semi-dwarf/Kolchuga and Myronivska early ripening/Chernyava the maximum values were at the level of parental forms with a greater manifestation of the trait. It should be noted that the length of the main spike (10.3-12.1 cm) was observed in populations where Kolchuga was used as the mother form. The extreme maximum values reached 13.0-15.0 cm.

Table 4. The degree and frequency of positive transgressions in the length of the main spike in populations F_2 (2019 p.)

Population F_2	Length of the main spike, cm					Transgression,%	
	average			maximum expression			
	♀	♂	F_2	P	F_2	Tc	Th
♀ early ripening / ♂ early ripening							
Mir. early B.Ts. s/d	7.3	7.8	10.3	10.0	12.5	25.0	50.0
Mir. early/Kolchuga	7.3	9.0	10.6	10.5	12.0	14.3	40.0
♀ early ripening / ♂ medium early							
Mir. early/ Zolotokol.	7.3	6.3	10.3	9.0	11.5	27.3	86.7
B.Ts. s/d./ Zolotokol	7.8	6.3	9.3	10.0	12.0	20.0	13.3
♀ early ripening / ♂ medium-ripening							
Mir. early/Antonovka	7.3	7.9	10.1	9.0	12.5	38.9	86.7
Mir. early / Yednist	7.3	6.1	9.6	9.0	11.5	27.8	63.3
B.Ts. s/d./ Antonovka	7.8	7.9	10.1	10.0	12.0	20.0	46.6
B.Ts. s/d./ Yednist	7.8	6.1	9.9	10.0	12.0	20.0	27.6
B.Ts. s/d./ Vidrada	7.8	7.6	9.5	10.0	10.5	5.0	3.3
Kolchuga/Antonovka	9.0	7.9	10.3	10.5	13.0	23.8	40.0
Kolchuga / Yednist	9.0	6.1	12.1	10.5	15.0	42.9	83.3
Kolchuga / Vidrada	9.0	7.6	10.5	10.5	13.0	23.8	48.1
Kolchuga / Stolichna	9.0	7.7	10.5	10.5	13.0	23.8	33.3
♀ early ripening / ♂ medium late							
Мир. ран./ Vdala	7.3	6.7	10.2	9.0	12.0	33.3	86.7
Мир. ран./ Dobirna	7.3	8.0	9.8	9.5	11.0	15.8	60.7
B.Ts. s/d./ Dobirna	7.8	8.0	9.3	10.0	11.0	10.0	10.0

The conducted studies show that in 16 out of 20 F_2 populations a positive degree and frequency of transgressions in the length of the main spike was established. High rates were noted in the populations of: Kolchuga/Yednist (Tc = 42.9%; Th = 83.3%); Myronivska early ripening/Antonovka (Tc = 38.9%; Th = 86.7%); Myronivska early ripening/Vdala (Tc = 33.3%; Th = 86.7); Myronivska early ripening/Yednist (Tc = 27.8%; Th = 63.3%); Myronivska early ripening/Zolotokolosa (Tc = 27.3%; Tc = 86.7%); Myronivska early ripening/Bilotserkivska semi-dwarf (Tc = 25.0%; Th = 50.0%).

In 2020, the average length of the main spikelet in F_2 populations (8.9 cm) was significantly lower than in 2019 – 10.1 cm, with the average population index of 8.6-10.1 cm. At the same time, in the Bilotserkivska semi-dwarf/Kolchuga population, the average length of the main spike in 2020 (9.2 cm) was 0.4 cm longer than last year (Table 5).

Table 5. The degree and frequency of positive transgressions in the length of the main spike in populations F_2 (2020 p.)

Population F_2	Length of the main spike, cm					Transgression, %	
	average			maximum expression			
	♀	♂	F_2	P	F_2	Tc	Th
♀ early ripening / ♂ early ripening							
B.Ts. s/d./ Kolchuga	8.4	9.4	9.2	10.5	11.0	4.8	3.3
♀ early ripening / ♂ medium early							
Mir. early/Zolotokol.	8.7	8.5	9.2	10.0	11.0	10.0	3.3
Mir. early/Chernyava	8.7	10.5	10.1	12.5	14.0	12.0	6.7
B.Ts. s/d./ Zolotokol.	8.4	8.5	8.9	10.0	11.5	15.0	16.7
♀ early ripening / ♂ medium-ripening							
B.Ts. s/d./ Vidrada	8.4	7.1	8.6	9.5	10.0	5.3	3.3
Kolchuga/Antonovka	9.4	8.7	8.9	10.5	11.0	4.8	3.3
Kolchuga/Stolichna	9.4	8.3	9.3	10.5	11.0	4.8	10.0
♀ early ripening / ♂ medium late							
Mir. Early/Vdala	8.7	8.5	9.4	10.0	11.0	10.0	10.0
Mir. early / Dobirna	8.7	9.1	8.9	10.0	11.0	10.0	10.0
B.Ts. s/d./ Dobirna	8.4	9.1	8.9	10.0	10.5	5.0	3.3

Exceeding the extreme maximum manifestation in the length of the main spike of parental forms and a positive degree of transgression in 2020 was determined in 10 out of 20 populations with indicators ranging from 4.8% to 15.0% and a recombinant frequency of 3.3-26.7%, which is significantly lower compared to 2019 and indicates the influence of the year's conditions. The following combinations stood out among the populations with a positive degree of transgression: Bilotserkivska semi-dwarf/Zolotokolosa (Tc = 15.0%; Th = 16.7%), Myronivska early ripening / Vdala (Tc =

10.0%; Th = 10.0%) i Myronivska early ripening/Dobirna (Tc = 10.0%; Th = 10.0%).

Within two years, a positive degree of transgression was found in all populations obtained by crossing early ripening varieties with medium late varieties and in combinations Myronivska early ripening/Zolotokolosa, Bilotserkivska semi-dwarf/Zolotokolosa, Bilotserkivska semi-dwarf/Vidrada, Kolchuga/Antonovka, Kolchuga/Stolichna, which indicates a stable increase of long spike recombinants in them regardless of meteorological factors.

Inclusion of early maturing winter wheat varieties in maternal hybridization with medium early, medium early and medium late varieties promotes the formation of F_2 populations by main spike length, with the possibility of selecting F_2 genotypes that combine high main spike length with other economically valuable traits and characteristics.

CONCLUSIONS

The formation of the length of the main spike in F_1 in 2018-2019 and indicators of heterosis and the degree of phenotypic dominance are due to the components selected for hybridization and the conditions of the year.

Stably high positive indices of hypothetical and true heterosis in 2018-2019 by the length of the main spike were determined in the combinations of crosses Myronivska early ripening/Yednist (Ht = 44.8-46.3%, Hbt = 32.9-34.2%) and Myronivska early ripening/Vdala (Ht = 33.3-54.3%, Hbt = 31.5-47.9%).

Using the maternal form in hybridization of early maturing winter wheat varieties with medium early, medium early and medium late varieties with different combinations of parental pairs, it was found that positive dominance was the most common type of inheritance, established in 39 out of 40 hybrids studied.

Indicators of the degree and frequency of positive recombinants for the length of the main spike in F_2 populations are determined by both hybridization components and year conditions. Thus, in 2019 a significantly higher number of second generation hybrid populations (80.0%) with a positive degree of transgression was identified compared to 2020 – 50.0%. In most of these populations, the frequency of positive recombinants was also higher in 2019.

In 2019-2020, 26 out of 40 F_2 populations showed a positive degree of transgression (4.8-42.9%) by the length of the main spike. The frequency of transgressive recombinants was 3.3-86.7%, depending on the parental forms involved in the hybridization.

The involvement of early-ripening winter soft wheat varieties in hybridization with medium-early, medium-ripening and medium-late varieties by the mother form significantly extends the formation process in terms of the length of the main ear.

The prospect of further research is to evaluate the conducted selections of soft winter wheat for a number of economically valuable traits to create a new source material with high productivity and adaptability to the unfavorable conditions of the Forest-Steppe Ukraine.

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