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LEVEL OF MANIFESTATION AND ASSESSMENT OF SPRING BARLEY VARIETIES BASED ON THE CORRELATION OF QUANTITATIVE TRAITS

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Topicality. *The dependence of the main trait, according to which selection is carried out, on other quantitative traits of plant is important for the successful spring barley breeding. The patterns of interrelationship between such quantitative traits as plant productivity and its elements are of particular importance.* ***Purpose.*** *To identify patterns of the level of manifestation and the interrelationship between productivity, yield attributes and morphological traits of two-row spring barley in the Southern Forest-Steppe of Ukraine.* ***Materials and Methods.*** *The research was conducted in the laboratory and field conditions of Ustymivka Experimental Station of Plant Production of the Yuriev Plant Production Institute of NAAS of Ukraine during 2019–2021. The research material consisted of 25 genotypes of spring barley (Hordeum vulgare* L.*) of the two-row subspecies, originating from six countries around the world. Laboratory-field and mathematical-statistical methods were used.* ***Results.*** *Twenty typical plants were selected for each of the 25 genotypes of spring two-row barley varieties. Spring barley samples were examined for the following characteristics: plant height, spike length, number of spikelets and grains per spike, 1000-grain weight, grain weight per spike and plant, and yield. Significant differences were found in terms of yield levels, yield attributes, and morphological characteristics. Samples with increased yield and yield attributes were identified. Three years of research have established a significant correlation between the spike length and the number of spikelets per spike (r = 0.51–0.77), the number of grains per spike (r = 0.57–0.73) and the spike productivity (r = 0.64–0.77). There is a significant positive correlation between such traits as grain weight per spike and plant height (r = 0.50), grain weight per spike and spike length and number of grains in the main spike and number of spikelets per spike (r = 0.58–0.60), grain weight per plant with spike length (r = 0.55), and grain weight per plant with productive tillering (r = 0.57). Grain weight per plant correlated reliably with productive tillering in all years of the study (r = 0.59–0.79).* ***Conclusions.*** *Barley samples MIP Tytul, MIP Sharm, MIP Deviz (UKR), Arthur (CZE), Velykan (KAZ), CDC Carter (CAN) are of practical interest for breeding work, as they stand out for their complex of characteristics. A close and moderate correlation between quantitative plant productivity traits and its structural elements was reliably determined, which makes selection based on trait relationships in the studied varieties expedient.*

Key words: *spring barley, yield attributes, level of manifestation, correlations.*

Introduction. Successful breeding of spring barley requires knowledge of the main quantitative traits used for selection. The patterns of interrelationship between such quantitative traits as plant productivity and its structural elements are of particular importance [1, 2]. The yield of spring barley, like other grain crops, is a component of a number of quantitative traits. Therefore, for further genetic improvement of plants and increase in yield, we need to have information not only about the level of the trait manifestation, but also about the individual yield attributes and their interrelationships [3]. The study of the correlation of certain quantitative characteristics of barley related to yield has been the subject of many publications by both domestic [4–10] and foreign researchers [11–17]. In these studies, the results obtained vary depending on the location of the research and the genetic material [18].

The correlation coefficient between certain characteristics may also vary depending on weather conditions during the growing season, biotic load, etc. [2, 3]. Given the ambiguity of research results, the determination of the nature of correlations and analysis of spring barley productivity is relevant today.

The research was aimed at identifying

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patterns in the level of manifestation and interrelationships between productivity, yield attributes, and morphological traits of two-row spring barley in the conditions of the Southern Forest-Steppe zone of Ukraine.

Materials and Methods. The research was conducted in the collection nursery of the Grain Crops Department of the Ustymivka Experimental Station of Plant Production of the V. Ya. Yuriev Plant Production Institute of NAAS of Ukraine (hereinafter referred to as the UESPP) during 2019–2021. The research material consisted of 25 genotypes of spring barley (*Hordeum vulgare* L.) of the two-row subspecies, which originated from six countries: Ukraine (UKR), Canada (CAN), Kazakhstan (KAZ), the Czech Republic (CZE), Australia (AUS), and Germany (DEU). The experiments were conducted, and the data obtained were evaluated and analysed in terms of yield indicators in accordance with Methodology for Field Research [19] and Guideline (method) for plant varieties examination for distinctness, uniformity and stability (DUS) [20]. Sowing was carried out with SSFK-7 plot seeder to a depth of 4–6 cm in three repetitions at the optimal dates. The plot area was 2 m^2, the seed rate was 500 seeds per 1 m^2, and the row spacing was 15 cm. Structural analysis was performed in three repetitions on twenty typical spikes. In field conditions, plant height, general and productive tillering values were determined in the full ripeness stage of barley samples. In laboratory conditions, structural analysis was carried out according to such quantitative characteristics as spike length, number of spikelets and grains per spike, grain weight per spike and plant, and yield. Pairwise correlation coefficients (r) between quantitative characteristics of barley varieties were determined using the Statistica 6.0 software package. The hydrothermal conditions during the research period (2019–2021) differed from the long-term average in terms of temperature, precipitation, and its distribution in certain stages of plant growth and development (Table 1).

The spring-summer (April–July) growing season for spring barley in 2020 was characterised by insufficient moisture and excessive heat. During the period from sowing to seedling emergence, the average daily temperature was 10.8 °C (the long-term average is 8.9 °C), and precipitation totalled 11.9 mm (the long-term average is 44.0 mm). Weather conditions during the period from tillering to stem elongation were wet. Precipitation in May 2020 was 31.2 mm above the norm, and the average daily temperature during this period was 14.8 ℃ compared to 15.9 ℃. Due to the elevated average daily temperature in the third ten days of June and the first ten days of July during the grain filling stage, the seedling-ripening period was significantly reduced in barley samples. In 2019 and 2021, weather conditions during the growing season for spring barley were favourable for plant growth and development. These years were warm and sufficiently humid, which contributed to the formation of the barley crop. During the period from sowing to seedlings in 2019 and 2021, the average daily air temperature was 10 ℃, which did not exceed the long-

Table 1. Hydrothermal regime during growing season of spring barley, 2019–2021

Month	Ten-day period	Average daily air temperature, °C				Precipitation, mm			
		X	2019	2020	2021	X	2019	2020	2021
April	I	8.9	11.2	9.4	7.7	44	0.0	0.0	9.6
	II		8.9	10.1	10.0		26.0	3.3	5.0
	III		14.7	12.8	9.7		2.6	8.6	12.4
May	I	15.9	14.1	15.8	14.3	50	49.6	15.3	15.4
	II		20.2	14.8	17.3		7.6	13.1	14.6
	III		21.1	13.7	18.6		73.5	52.8	34.3
June	I	19.5	23.8	19.5	16.5	57	61.6	17.4	36.7
	II		25.9	26.6	22.1		0.0	4.2	64.3
	III		24.0	25.5	25.8		1.1	6.1	0.0
July	I	21.0	22.5	25.9	25.9	72	5.6	15.4	4.8
	II		20.9	21.6	26.5		4.3	16.0	16.8
	III		23.5	24.5	25.3		46.4	0.0	17.2
For period			19.2	18.4	18.3		278.3	152.2	231.1

term average. In 2019, the total precipitation was 28.6 mm, and in 2021, it was 27.0 mm. During the period of tillering and stem elongation of barley plants, the air temperature increased by 2.6 ℃ in 2019 and by 0.8 ℃ in 2021. During the same period, there was a sufficient amount of precipitation – 130.7 mm in 2019, which exceeded the long-term average by 80.7 mm. Precipitation was at the long-term average level in 2021. This allowed the plants to tiller normally, elongate stem and develop good spikes. During the period from heading to full maturity, the air temperature in 2019 and 2021 significantly exceeded the long-term average (by 5.0 ℃ and 2.2 ℃, respectively). In 2019, precipitation was at the long-term average level (62.7 mm), and it was 44.0 mm higher in 2021. Thus, growing seasons of 2019 – 2021 were favourable for the spring barley growth and development.

Results and Discussion. In 2021, the plant height (X) in the studies was the highest – 79.1 cm with a range of variation (R) – 40.0 cm, with a maximum value (max) of 90.0 cm in the MIP Tytul (UKR) variety and a minimum (min) of 50.0 cm in the Kaputar (AUS) variety. In 2019, the lowest plant height was recorded – X = 62.7 cm, R = 45.0 cm, max = 85.0 cm in the Velykan (KAZ) variety, min = 40.0 cm in the Kaputar (AUS) variety. In 2020, the plant height was X = 73.8 cm, R = 46.0 cm, max = 97.0 cm for the Velikan (KAZ) variety, min = 51.0 cm for the MIP Myroslav (UKR) variety. Over the three years of the study, on average, the plant height was as follows: X = 71.9 cm, R = 36.7 cm, max = 89.0 cm for the Velykan (KAZ) variety, min = 52.3 cm for the Kaputar (AUS) variety. The maximum plant height (75.3–78.0 cm) was observed in the varieties Diantus (UKR), Roseland, CDC Carter, CDC Hilose (CAN), and Polygena (CZE) on average over three years of study. The lowest plant height (62.3–38.7 cm) was observed in the varieties MIP Myroslav, Berkut, MIP Deviz, MIP Sharm, Kontrast (UKR), Lilly (DEU).

In 2021, the indicator of productive tillering was the highest on average over the years of research – X = 4.2 stems/plant, R = 2.7 pcs, max = 5.8 pcs – in the Tobol (KAZ) variety, min = 3.1 pcs in the Velykan (KAZ) variety. In 2020, the average productive tillering was slightly lower than in 2021 – X = 3.7 stems/plant, R = 15.2 pcs, max = 33.2 pcs in the CDC Hilose 2.2 pcs, max = 4.5 pcs in the Tselinnyi (KAZ) variety, min = 2.3 pcs in the MIP Zakhysnyk (UKR) variety. In 2019, the lowest indicator of productive tillering was recorded – X = 3.4 stems/plant, R = 2.4 pcs, max = 4.5 pcs in the Kontrast (UKR) variety, min = 2.1 pcs in the Lider (UKR) variety. On average over three years, productive tillering had a value of X = 3.8 stems/plant, R = 1.5 pcs, max = 4.5 pcs in the Deviz (UKR) variety, min = 3.0 pcs in the Berkut (UKR) variety. The largest number of productive stems (3.9–4.5 stems) was formed by the varieties Harant Premium, Diantus, MIP Deviz, Kontrast, MIP Sharm (UKR), CDC Carter (CAN), Arthur (CZE), Tselinnyi and Tobol (KAZ), Lilly (DEU), Kaputar (AUS).

Spike length indicators by year: 2019 – X = 9.5 cm, R = 5.6 cm, max = 11.9 cm in the CDC Tercel (CAN) variety, min = 6.3 cm in the Kontrast (UKR) variety; 2020 – X = 8.8 cm, R = 4.8 cm, max = 11.0 cm in the Velykan variety (KAZ), min = 6.2 cm in the Kaputar variety (AUS); 2021 – X = 9.0 cm, R = 4.84 cm, max = 11.2 cm in the CDC Hilose (CAN) variety, min – 6.8 cm in the Kaputar (AUS) variety; over three years – X = 9.1 cm, R = 3.5 cm, max = 10.8 cm – in the Velykan (KAZ) variety, min = 7.3 cm – in the Merlin (CAN) variety. The maximum spike length (9.0–11.1 cm) was observed in the varieties MIP Tytul (UKR), Tercel, CDC Carter, CDC Hilose, Condor (CAN), and Velykan (KAZ).

The number of spikelets per spike was characterised by the following values: 2019 – X = 25.7 pcs, R = 14.4 pcs, max = 31.4 pcs in the CDC Tercel (CAN) variety, min = 14.0 pcs in the Kaputar (AUS) variety; 2020 – X = 25.5 pcs, R = 16.4 pcs, max = 32.2 pcs in the Velykan variety (KAZ), min = 15.8 pcs in the Kontrast variety (UKR); 2021 – X = 24.6 pcs, R = 17.2 pcs, max = 33.2 pcs in the CDC Carter (CAN) variety, min = 16.0 pcs in the Kaputar (AUS) variety; over three years – X = 25.2 pcs, R = 12.4 pcs, max = 31.3 pcs in the CDC Carter (CAN) variety, min = 18.9 pcs – in the Kontrast (UKR) variety. The largest number of spikelets per spike was observed in the varieties MIP Tytul (UKR), Tercel, CDC Hilose (CAN), Velykan (KAZ), and CDC Carter (CAN).

In 2021, the highest number of grains per main spike (grain content) was X = 24.1 pcs, R = (CAN) variety, min. = 18.0 pcs in the Harant

Premium (UKR) variety. In 2019, the lowest number of grains per main spike was X = 23.0 pcs, R = 13.4 pcs, with max. = 27.6 pcs in the Velykan variety (KAZ) and min. = 14.2 pcs in the Kontrast variety (UKR). In 2020, the number of grains per main spike was X = 23.2, R = 12.0, max = 29.2 in the Velykan (KAZ) variety and min = 17.2 in the Harant Premium (UKR) variety. On average over three years, X = 23.4 pcs, R = 11.3 pcs, max. = 28.3 pcs for the Velykan (KAZ) variety, min. = 17.1 pcs for the Kontrast (UKR) variety. The highest number of grains per spike was observed in the varieties MIP Tytul, Berkut, Aristey (UKR), CDC Carter, CDC Hilose, Condor (CAN), and Velykan (KAZ).

The grain weight per main spike had the following indicators by year: 2019 – X = 1.1 g, R = 1.0 g, max = 1.5 g in the Velykan (KAZ) variety, min = 0.5 g in the Kontrast (UKR) variety; 2020 – X = 0.9 g, R = 0.9 g, max = 1.4 g in the Velykan (KAZ) variety, min = 0.5 g in the Kaputar (AUS) variety; 2021 – X = 1.1 g, R = 0.6 g, max = 1.5 g in the Velikan variety (KAZ), min = 0.9 g in the Roseland variety (CAN). The average grain weight per main spike over three years was – X = 1.0 g, R = 0.7 g, max = 1.5 g in the Velykan (KAZ) variety, min = 0.8 g in the Kontrast (UKR) and Roseland (CAN) varieties. The grain weight per plant was higher on average in 2021 – X = 4.7 g, R = 3.3 g, max = 6.4 g for the Tobol (KAZ) variety, min = 3.1 g for the Roseland (CAN) variety. The grain weight per plant was equal in 2019 and 2020, respectively – X = 3.5 g, R = 2.7 g, max = 4.8 g in the Velikan variety (KAZ), min = 2.1 g in the Lider (UKR) variety, and X = 3.4 g, R = 3.5 g, max = 5.3 g in the Velykan (KAZ) variety, min = 1.8 g in the MIP Zakhysnyk (UKR) variety. On average, over the years of research, plant productivity was X = 3.9 g, R = 2.2 g, max = 4.9 g for the Velykan (KAZ) variety, min = 2.7 g for the Berkut (UKR) variety. The most productive plants (4.0–4.7 g) were identified in the varieties Stymul, MIP Deviz, MIP Tytul, MIP Sharm (UKR), CDC Carter, Merlin (CAN), Arthur (CZE), Velykan, Tselinnyi, Tobol (KAZ), Lilly (DEU). On average over the years of research, the 1,000-grain weight was highest in 2021 – X = 42.0 g, R = 17.6 g, max = 50.8 g in the Lider (UKR) variety, min = 33.2 g in the MIP Myroslav (UKR) variety. In 2019, the 1,000-grain weight was slightly lower than in 2021 – X = 40.9 g, R = 20.4 g, max = 52.0 g in the Leader (UKR) variety, min = 31.6 g in the Roseland (CAN) variety. The lowest 1,000-grain weight was recorded in 2020 – X = 38.7 g, R = 20.4 g, max = 49.6 g in the Lider (UKR) variety, min = 29.2 g in the Roseland (CAN) variety. The average weight of 1,000 grains over three years was X = 40.5 g, R = 19.2 g, max = 50.8 g for the Lider variety (UKR), min = 31.6 g for the Roseland variety (CAN). The varieties Harant Premium, Lider, MIP Zakhysnyk, Aristey (UKR), Velykan (KAZ), and Merlin (CAN) were characterised by large grain content (40.0–50.8 g).

On average, the highest yield in the experiment was in 2021 – X = 451.5 g/m2, R = 305 g/m2, max = 550 g/m2 for the MIP Tytul (UKR) variety, min = 245 g/m2 for the CDC Hilose (CAN) variety. The lowest values were recorded in 2020 – X = 390.5 g/m2, R = 270 g/m2, max = 500 g/m2 for the Harant Premium (UKR) variety, min = 230 g/m2 for the CDC Hilose (CAN) variety. In 2019, the yield was X = 444.2 g/m2, R = 230 g/m2, max = 545 g/m2 for the Stymul (UKR) variety, min = 315 g/m2 for the CDC Hilose (CAN) variety. On average over the three years of the study, the yield had the following values: X = 428.7 g/m2, R = 240 g/m2, max = 503.3 g/m2 for the Lider (UKR) variety, min = 263.3 g/m2 for the CDC Hilose (CAN) variety. The highest yields (403–503 g/m2) were shown by the varieties Lider, Dianthus, MIP Tytul, MIP Sharm, Harant Premium (UKR), Merlin (CAN), Velykan (KAZ), Arthur (CZE).

Parameters of yield, productivity and grain size of the best spring barley samples for 2019–2021 are presented in Table 2.

The suitability of a trait for reliable assessment is usually determined by the correlation coefficient, which allows establishing the strength of the linear relationship between the quantitative traits of spring barley plants [22] and determining the quantitative parameters of the variety. Correlation coefficients depend on the type of crop, variety, growing conditions, and the trait under study [2]. Paired correlation coefficients for this sampling, depending on the conditions of the year, are given in Table 3. Both a reliably positive and a reliably negative relationship between trait indicators were found.

In 2019, productive tillering had a positive and significant correlation with grain weight per

Table 2. Grain yield, productivity and grain size of the best samples of spring barley (average for 2019–2021)

Variety	Country of origin	Grain yield, g/m^2	Productive tillering, pcs	Grain weight per spike, g	Grain weight per plant, g	1000-seed grains, g
Komandor (standard)	UKR	503	3.6	1.0	3.72	44.5
Berkut	UKR	373	3.0	1.0	2.7	32.9
Harant Premium	UKR	488	3.9	1.0	3.74	46.9
Stymul	UKR	455	4.2	1.0	4.17	43.7
Diantus	UKR	480	3.9	1.0	3.74	42.4
Lider	UKR	503	3.5	1.0	3.3	50.8
MIP Deviz	UKR	433	4.5	1.0	4.68	40.4
MIP Zakhysnyk	UKR	448	3.4	1.1	3.59	45.9
MIP Tytul	UKR	480	3.5	1.2	4.36	39.2
MIP Sharm	UKR	494	4.3	1.1	4.59	41.7
Aristei	UKR	405	3.6	1.1	3.88	39.7
CDC Carter	CAN	368	4.0	1.1	4.27	36.3
Condor	CAN	442	3.5	1.0	3.38	37.0
Merlin	CAN	480	3.5	1.1	4.0	40.0
Polygena	CZE	465	3.5	1.0	3.65	40.9
Arthur	CZE	481	3.9	1.1	4.12	38.4
Velykan	KAZ	483	3.4	1.5	4.94	47.2
Tselinnyi	KAZ	423	4.4	1.0	4.51	41.3
Tobol	KAZ	381	4.3	1.0	4.41	38.4
Lilly	DEU	440	3.8	1.1	4.02	41
X		428.7	3.7	1.0	3.9	40.5
min		263.3	3.0	0.8	2.7	31.6
max		503.3	4.5	1.5	4.9	50.8
R (max-min)		240.0	1.5	0.7	2.2	19.2

Notes. X – average, min – minimum, max – maximum, R (max-min) – range of variation for 25 samples.

plant (r=0.59) and general tillering (r=0.70), negative relationship with spike length (r= -0.54 with a low unreliable coefficient between traits in 2021 and a moderate coefficient r= 0.35 in 2020), in 2020 – positive relationship with grain weight per plant (r=0.67), general tillering (r=0.82), in 2021 – positive relationship with grain weight per plant (r=0.79), general tillering (r=0.55).

The spike length correlated positively and significantly with the number of spikelets per spike in 2019 (r=0.51), 2020 (r=0.60), and 2021 (r=0.77); the number of grains per spike in 2019 (r=0.57), 2020 (r=0.60), and 2021 (r=0.73), the grain weight per spike (in 2019 – r=0.64, 2020 – r=0.77, 2021 – r=0.70) and the 1,000-grain weight (r=0.50, with an unreliably low value in 2020 – r=-0.18 and in 2021 – r=-0.20); and in 2020, it was positively correlated with the grain weight per plant (r=0.77, with an unreliably low value in 2021 – r=0.07 and in 2019 – r=0.25).

In 2019, the number of grains per spike correlated positively and significantly with the grain weight per spike (r=0.69, with a trend in 2020 of r=0.49 and in 2021 of – r=0.45), spike length (r=0.57), and number of spikelets per spike (r=0.57); and in 2020, it correlated positively with the spike length (r=0.60) and the number of spikelets per spike (r=0.90); and in 2021, it correlated positively with the spike length (r=0.73) and the number of spikelets per spike (r=0.76).

Productivity (grain weight) per plant positively and significantly correlated with productive tillering (r=0.59) and grain weight per spike (r=0.77) in 2019, in 2020 – with productive tillering (r=0.67), spike length (r=0.77) and grain weight per spike (r=0.83); in 2021 – with productive tillering (r=0.79).

In 2019, grain weight per spike positively and significantly correlated with spike length (r=0.64 with a low insignificant coefficient in 2021 – r=0.23), the number of grains per spike (r=0.69 with a trend in 2020 – r=0.49), and grain weight per plant (r=0.77 with a trend in 2021 – r=0.35).

In 2019, the 1,000-grain weight had a

Table 3. Correlation coefficients of quantitative characteristics of spring barley

Trait	Year	Plant height	Productive tillering	Spike length	Number of spikelets per spike	Number of grains per spike	Grain weight per spike	Grain weight per plant
Productive tillering	2019	-0.17						
	2020	0.38	-					
	2021	0.01						
Spike length	2019	0.36	-0.54					
	2020	0.39	0.35	-				
	2021	0.41	-0.08					
Number of spikelets per spike	2019	0.40	-0.45	**0.51***				
	2020	0.18	-0.03	**0.60***	-			
	2021	0.46	-0.20	**0.77**				
Number of grains per spike	2019	0.10	-0.42	**0.57***	**0.57**			
	2020	0.19	-0.01	**0.60***	**0.90***	-		
	2021	0.25	-0.32	**0.73**	**0.76**			
Grain weight per spike	2019	0.29	-0.33	**0.64***	0.26	**0.69**		
	2020	0.31	0.15	**0.77***	0.44	0.49	-	
	2021	0.14	-0.28	**0.70**	0.25	**0.45**		
Grain weight per plant		0.36	**0.59***	0.25	-0.04	0.43	**0.77**	
	2020	0.44	**0.67**	**0.77***	0.31	0.36	**0.83**	-
	2021	0.33	**0.79**	0.07	-0.09	-0.09	0.35	
1,000-grain weight	2019	0.34	-0.21	**0.50***	0.20	0.23	**0.59**	0.43
	2020	0.16	0.26	-0.18	-0.41	**-0.50**	**0.54**	0.15
	2021	-0.04	0.02	-0.20	-0.53	-0.44	**0.51**	0.05

Note: correlation coefficient from 0.10 to 0.29 is assessed as weak relationship; from 0.30 to 0.49 – moderate; from 0.50 to 0.69 – significant; from 0.70 to 0.89 – strong; 0.90 and above – very strong. In practice, moderate, significant, strong and very strong relationships are used.

positive and significant correlation with spike length (r=0.50, compared to an insignificantly low r= -0.18 in 2020 and r=-0.20 in 2021 – r=-0.20), and grain weight per spike (r=0.59) with an unreliably low value in 2020 – r=0.02 and 2021 – r=11).

Our studies for 2019–2021 have identified a positive and strong correlation between the number of spikelets per spike and spike length (r=0.79), the number of grains per spike and spike length and the number of spikelets per spike (r=0.69–0.88), and the grain weight per plant with the grain weight per spike (r=0.72) are shown in Table 4. Significant positive correlations were observed between such traits as grain weight per spike and plant height (r=0.50), grain weight per spike and spike length and number of grains per main spike and number of spikelets per spike (r=0.58–0.60), grain weight per plant and spike length (r=0.55), grain weight per plant and productive tillering (r=0.57). Some correlations between productivity elements not only have moderate and weak strengths, but also reverse their sign, indicating the influence of growing conditions on structural interactions between individual traits and, as a result, the redistribution of their shares in the formation of variety productivity [22].

During the years of research, a negative correlation ranging from weak to moderate (r= -0.41–-0.44) was established between the 1,000-grain weight and the number of seeds per main spike and the number of spikelets per spike; productive tillering and the number of seeds per main spike and the number of spikelets per spike; grain yield – the number of grains per main spike and the number of spikelets per spike.

Over three years of observation, spike length had a significant average correlation with plant height (r = 0.36; 0.39; 0.41), i.e., an increase in stem length was associated with longer spikes in plants. A significant direct correlation (significant and strong) was noted over the years of research between the number of grains in the spike and the length of the spike (r = 0.57; 0.60; 0.73). Thus, the selection of plants with long

Table 4. Correlation coefficients of quantitative characteristics of spring barley, average for 2019–2021

Trait	Plant height	Productive tillering	Spike length	Number of spikelets per spike	Number of grains per spike	Grain weight per spike	Grain weight per plant
Productive tillering	-0.13	-					
Spike length	0.49	-0.05	-				
Number of spikelets per spike	0.44	-0.27	**0.79**	-			
Number of grains per spike	0.27	-0.37	**0.69**	**0.88**	-		
Grain weight per spike	**0.50**	-0.15	**0.60**	**0.58**	**0.60**	-	
Grain weight per plant	0.32	**0.57**	**0.55**	0.31	0.27	**0.72**	-
1,000-grain weight	0.16	0.18	0.00	-0.42	-0.41	**0.50**	0.34

spikes can result in an increase in the number of grains in the spike. The grain weight from the spike had a significant positive correlation with the spike length over three years (r = 0.64; 0.77; 0.70). Since the grain weight per spike significantly depended on the spike length (r = 0.64; 0.77; 0.70) and the number of grains per spike (r = 0.69; 0.49; 0.45), a significant increase in the productivity of the main spike on a plant is expected.

A direct moderate correlation between productivity and plant height (r = 0.36; 0.44; 0.33) and a significant and strong correlation with the number of productive stems (r = 0.59; 0.67; 0.79) were also established. A moderate correlation with grain weight per plant (r = 0.44; 0.37; 0.35) and 1,000-grain weight (r = 0.53; 0.41; 0.53) was established in all three years of the study. The grain number per spike (r = 0.10; 0.19; 0.25) and grain weight per spike (r = 0.29; 0.31; 0.14) had a weak correlation with plant height in all three years of the study. This correlation is not favourable because selection based on productivity factors (number of grains and grain weight per spike) can result in increasing plant height and, consequently, lodging of spring barley, which will decrease the yield. Thus, selection should be aimed at selecting plants with a combination of short stems and long productive spikes. A significant direct average correlation between grain weight per spike and grain size has been established over three years (r = 0.59; 0.54; 0.51), which suggests that highly productive genotypes with large, uniform spring barley grains can be selected.

Conclusions. The selected genotypes with increased manifestation of valuable breeding traits should be used as genetic sources for the development of new breeding material. A positive and strong correlation was found between the number of spikelets per spike and spike length (r=0.79), the number of grains per spike with spike length and the number of spikelets per spike (r=0.69–0.88), and grain weight per plant with grain weight per spike (r=0.72). Significant positive correlation was observed between such traits as grain weight per spike and plant height (r=0.50), grain weight per spike and spike length and number of grains per main spike and number of spikelets per spike (r=0.58–0.60), grain weight per plant and spike length (r=0.55), grain weight per plant and productive tillering (r=0.57).

The levels of manifestation of traits in terms of productivity and yield attributes were determined and it allowed selecting samples of different ecological and geographical origin: MIP Tytul, MIP Sharm, MIP Deviz (UKR), Arthur (CZE), Velykan (KAZ), CDC Carter (CAN) for their involvement in breeding programmes as source material. Correlation coefficients between productivity and yield indicators of spring barley were determined, providing a basis for assessing the impact of individual traits studied on the formation of yield levels.

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Холод С. М. , Іллічов Ю. Г. , Кір'ян В. М. , Роговий О. Ю. , Ільїчов О. Г. Рівень прояву та оцінка сортів ячменю ярого на основі кореляції кількісних ознак. *Зернові культури. 2025. 9 (1). 75–83.*
Устимівська дослідна станція рослинництва Інституту рослинництва імені В. Я. Юр'єва НААН, с. Устимівка, Глобинський р-н, Полтавська обл., 39074, Україна

Актуальність. Для успішної селекції ячменю ярого важливо знати залежність основної ознаки, за якою проводять добір, від інших кількісних ознак рослин. Особливе значення мають закономірності взаємозв‘язку таких кількісних ознак як продуктивність рослини та її структурні елементи. **Мета.** Виявити закономірності рівня прояву та взаємозв'язку між продуктивністю, елементами структури врожаю і морфологічними ознаками ячменю ярого дворядного в зоні Південного Лісостепу України. **Матеріали і методи**. Дослідження проведено протягом 2019–2021 рр. у лабораторних і польових умовах Устимівської дослідної станції рослинництва Інституту рослинництва ім. В. Я. Юр'єва НААН України. Матеріалом для досліджень слугували 25 генотипів ячменю ярого (*Hordeum vulgare* L.) дворядного підвиду, походженням із шести країн світу. Використовували лабораторно-польові та математично-статистичні методи. **Результати.** Для кожного з 25 генотипів сортів ярого дворядного ячменю було відібрано по 20 типових рослин. Зразки ячменю ярого досліджувалися за наступними ознаками: висотою рослин, довжиною колоса, кількістю колосків і зерен у колосі, масою 1000 зерен, масою зерна з колоса та рослини, врожайність. Виявлено значні відмінності за рівнями прояву врожайності, елементів структури врожаю та морфологічних ознак. Виділено зразки з підвищеною врожайністю та елементами структури врожаю. За три роки досліджень установлено істотну кореляцію довжини колоса з кількістю колосків в колосі (r = 0,51–0,77), кількістю зерен в колосі (r = 0,57–0,73) та продуктивністю колоса (r = 0,64–0,77). Спостерігається значна позитивна кореляційна залежність між такими ознаками, як маса зерна з колоса з висотою рослини (r=0,50), маса зерна з колоса з довжиною колоса й кількістю зерен з головного колоса та кіль-кістю колосків в колосі (r=0,58–0,60), маса зерна з рослини з довжиною колоса (r=0,55), маса зерна з рослини з продуктивним кущінням (r=0,57). Маса зерна з рослини в усі роки досліджень достовірно корелювала з продуктивною кущистістю (r = 0,59–0,79). **Висновки.** Практичний інтерес для селекційної роботи становлять зразки, які виділилися за комплексом ознак: МІП Титул, МІП Шарм, МІП Девіз (UKR), Arthur (CZE), Великан (KAZ), CDC Carter (CAN). Визна-чено достовірно як тісну, так і середню кореляцію між кількісними ознаками продуктивності рослини та її структурними елементами, що робить доцільним добори за зв'язками між ознаками у сортів, що досліджувалися.

Ключові слова: *ячмінь ярий, елементи структури врожаю, рівень прояву, кореляції*