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Estimation of correlation coefficient between traits of winter wheat (*Triticum aestivum L.*) varieties under the influence of mineral fertilizers and growth regulator, Furolan

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Abstract

This study to estimate the correlation coefficient between quantitative traits in three varieties of winter wheat namely; Bat'ko, Deya and Krasnodarskaya 99 was carried at the All-Russian Rice Research Institute, Belozerny, Krasnodar, Russia. The understanding of correlation lies in the combination of variation of two or more traits. More often than not, only correlation between two traits was usually investigated. In this study, only coefficients of rectilinear dependence among traits were shown in the matrix of correlation links. All positive correlation coefficients were arranged in three groups: those with high, average and weak interrelation links. Results were calculated by method of Doc Statpak in the program of regression analysis. High correlation of 0.942 was established between the traits: yield and weight of grain ear^{-1}. Yield and number of productive stalks m^{-2} showed high correlation 0.813. Determination of coefficient in all of them was 0.660. It could be reasoned that these two correlated traits in 66 % of cases were formed at the expense of their genotypic manifestation and in 34 % of cases their values depended on others such as ecological factors.

Keywords: Wheat; Correlation coefficient; Quantitative traits; Correlation coefficient Matrix; Yield; Yield- related attributes

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1. Introduction

Breeders in their work on selection often use the values of correlation coefficients between quantitative traits. In carrying out selection, plants were sampled from hybridized populations and used as indirect test of correlation coefficients among traits. On the basis of the detailed analysis of intra- and inter-quality correlation coefficient as determined from the basic economic-valuable traits, the breeder could assess the factors which were closely linked. The understanding of correlation lies in the combination of the variation of two or more traits. More often than not only correlation between two traits was investigated.

To obtain the best combinations of attributes in wheat crop for higher return per unit area depends on the determination of correlation coefficients between various characters. At both genotypic and phenotypic levels a number of studies (Shah et al., 1999; Silva et al., 1998; Dokuyueu and Akkaya, 1999; Amar, 1999; Nabi et al., 1998) observed a positive correlation of grain yield with grains per spike, 1000- grain weight, plant height and number of tillers per plant. To improve crops yields, a know-how regarding the magnitude and nature of association among plant traits is essential. Wheat grain yield was observed by Singh et al. (1995) to be positively correlated with flag leaf area and productive tillers. Also, both at genotypic and phenotypic levels, Richards (1996) observed significant positive association of number of spikes bearing tillers plant^{-1} with grain yield plant^{-1}. Grain yield plant^{-1} as noted by Rickman and Klepper (1991) had a positive genetic correlation with1000-kernel weight and number of spikes plant^{-1}. Similarly, grain yield as observed by Shahid et al. (2002) had significant positive genotypic correlation with spike length. At both the genotypic and phenotypic levels, Saleem et al. (2006) observed that grain yield showed highly significant and positive correlation with spikelets spike^{-1} and tillering capacity. At genotypic level, Kashif and Khaliq (2004) observed that the following traits: spikelets spike^{-1}, 1000-grain weight, spike length and plant height were significantly and positively correlated with grain yield.

The theory of selection was mainly postulated on the notion of correlation links in a plant. There are few data about correlation links of yield or other important quantitative traits winter wheat varieties in the local and foreign literature. For breeding practice there is great value in the knowledge of interrelation trend of basic selection traits on which basis the breeder could make models of selection of valuable genotypes for creation of a new variety leading to breeding pairs for crossing on the account of conjugation between traits. In the conditions of Krasnodar territory, and also in the Central zone, there are few data on correlation links between quantitative traits of winter wheat varieties especially in multi-factorial experiments. Therefore, the objective of this study is to analyze the correlations among yield traits of three wheat cultivars in field conditions.

2. Materials and methods

The tests were performed under field conditions in the experimental field of All-Russian Rice Research Institute, Belozerny, Krasnodar, Russia from 2007 to 2009. The laboratory tests were performed in the laboratories of the Research institute. The doses of mineral fertilizers were applied according to the following scheme : $N_{50}P_{90}K_{40}$ for the basic soil treatment plus N_{60} – top-dressing in spring and N_{30} – foliar topdressing during the ear formation phase. During the elongation phase, towards the time of harvest the winter wheat plants were sprayed (at the rate of 300 dm^3/hectare) with 5 g/hectare dose of Furolan (growth regulator) in water solution with the aid of dosimeter device. The experimental plot was 3 m x 8 m = 24 m^2 in three replicates. The plots were completely randomized. The seeds were sown at 5 million grains per hectare. The precursor plant was winter barley.

At maturity ten guarded plants were randomly selected from each replication and data were collected for plant height, 1000-grain weight, spike length, number of tillers per plant, number of spikelets per spike, and grain yield per plant etc. For the estimation of the correlation coefficient between quantitative traits in the three winter wheat varieties 12 variants were considered. 10 spikes were taken for analysis from each plot. In the laboratory, the spikes were threshed and the grains weighed. The varieties were arranged according to yield (the bigger to the smaller) from the results obtained from weighing the grains. This analysis showed variation of yield in this study. For study of correlation interrelation among quantitative traits values of the factors were taken of variants in all varieties. Correlation coefficient was varied from 0 to +1 for positive links and from 0 to -1 − for negative. Correlation of values 0.5-0.699 represented average interrelation. Correlation less than 0.5 represented lower links. These values were arranged on the basis of variation rows of fourteen traits. Results were calculated by method of Doc Statpak in the program of regression analysis. Each of the 14 variation rows consisted of 12 replicates.

3. Results and discussion

Only coefficients of rectilinear dependence among traits were shown in the matrix of correlation links. All positive correlation coefficients were arranged in three groups: those with high, average and weak interrelation links. Of all correlation coefficient matrix of 36 pairs of correlated traits showed high (strong) interrelation which have not only theoretical value, but also could be used in practical work in selection of the necessary plants or choice of valuable selected samples. Yield of variety − is an important integral trait which characterizes it (variety) economically. The functional trait (yield) in this study highly correlated with seven characteristics of winter wheat varieties. Thus, yield and productive stalks showed correlation of 0.878 (Table 2). It means that with increase in productive bushiness yield increased (Table 3). The determination of coefficient (square of correlation coefficient) $0.878^2 = 0.770$ could be used to explain biological interrelation. The interpretation of the value of these correlated traits - yield and productive bushiness – was that in 77 % of cases they were controlled by genotypes of varieties and in 23 % of cases their quantity depended on other factors.

Yield and number of productive stalks m^2 showed high correlation 0.813. These results were partially supported by findings of other researchers (Nabi et al., 1998; Silva et al., 1998; Amar, 1999; Dokuyueu and Akkaya, 1999; Shah et al., 1999) who generally observed positive relationship of grain yield with plant traits. While grain yield had positive relationship with 1000-grain weight, number of tillers, spikelets per spike and grains per spike, it was, however, noted that the traits which contributed significantly towards grain yield were 1000-grain weight and grains per spike. Determination of coefficient in them was 0.660. It was estimated that these two correlated traits in 66 % of cases were formed at the expense of manifestation of their genotypes and in 34 % of cases of their values depended on other factors such as, the ecological ones.

Table 1. Characteristics of winter soft wheat varieties by quantitative traits on account of the influence of doses of mineral fertilizers and Furolan (2007 – 2009)

Variety (**factor A**)	Dose of Mineral fertilizers, kg added per 1 hectare (**factor B**)	Growth regulator (**factor C**)	**Y**	**PH**	**PB**	**NP**	**NPS**	**EL**	**ED**	**NC/E**	**NG/E**	**NG/P**	**GW/E**	**GW/P**	**1000-GW**	**GW/M^2**
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
Bat'ko	Control	Control	56.3	91	1.6	288	458	9.3	4.16	17.3	38.7	61.8	1.19	1.98	38.6	578
		Furolan	61.7	92	1.6	305	484	1.7	3.63	17.8	38.8	63.9	1.23	2.00	39.3	628
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring + N_{30} at Ear formation	Control	65.3	94	1.7	314	527	10.8	3.68	18.3	39.8	67.6	1.27	2.15	39.4	675
		Furolan	74.2	97	1.8	318	567	11.5	3.50	18.5	40.3	68.6	1.31	2.36	39.9	758
Deya	Control	Control	46.6	103	1.5	281	415	7.9	4.69	16.4	37.0	55.6	1.12	1.68	38.5	473
		Furolan	53.8	105	1.6	297	461	8.2	4.61	16.9	37.8	60.5	1.16	1.86	38.7	541
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring + N_{30} at Ear formation	Control	57.9	107	1.6	310	482	8.3	4.55	17.5	38.0	64.6	1.18	1.89	38.9	586
		Furolan	65.7	109	1.6	317	523	8.4	4.56	17.9	38.3	68.9	1.20	1.92	39.3	689
Krasno dar-skaya 99	Control	Control	51.8	89	1.6	291	455	9.4	3.97	17,5	37.5	63.4	1.14	1.82	37.8	530
		Furolan	53.9	91	1.6	297	467	9.7	3.91	17.9	37.9	68.2	1.18	1.89	37.9	561
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring + N_{30} at Ear formation	Control	58.1	93	1.6	311	503	10.1	3.83	18.4	38.7	73.5	1.20	1.92	38.3	597
		Furolan	67.8	95	1.7	319	542	10.5	3.75	18.7	39.4	78.8	1.25	2.12	38.6	693

Yield, kg/hectare (Y), Plant height, cm (PH), Productive bushiness(PB), Number of Plants m^2, pieces (NP), Number of productive stalks m^2, pieces (NPS), Ear length, cm (EL), Ear density (ED), Number of cones ear^{-1}, pieces. (NC/E), Number of grains ear^{-1} , pieces (NG/E), Number of grains plant^{-1} , pieces.(NG/P), Grain weight ear^{-1}, g (GW/E), Grain weight plant^{-1}, g (GW/P), 1000–Grain weight, g (1000-GW), Grain weight m^{-2}, **g** (GW/M^2)

Table 2. Matrix of correlation coefficient among some quantitative traits of winter soft wheat varieties depending on the doses of mineral fertilizers and growth regulator, Furolan (2007 – 2009)

S/№	Traits / Traits	**Y**	**PH**	**PB**	**NP**	**NPS**	**EL**	**ED**	**NC/E**	**NG/E**	**NG/P**	**GW/E**	**GW/P**	**1000-GW**	**GW/M^2**
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	**Y**	1.00													
2	**PH**	0.018	1.00												
3	**PB**	0.878*	-0.198	1.00											
4	**NP**	0.365	0.531	0.010	1.00										
5	**NPS**	0.926*	-0.020	0.927*	0.224	1.00									
6	**EL**	0.696	-0.648	0.784	-0.219	0.700	1.00								
7	**ED**	-0.582	0.759	-0.695	0.279	-0.590	-0.983	1.00							
8	**NC/E**	0.813*	-0.349	0.765	0.181*	0.755*	0.806	-0.780	1.00						
9	**NG/E**	0.903	-0.238	0.891*	0.044	0.853	0.836*	-0.733	0.797*	1.00					
10	**NG/E**	0.661	-0.221	0.575	0.239	0.578	0.573	-0.563	0.919	0.597	1.00				
11	**GW/E**	0.942*	-0.192	0.911	0.097	0.895	0.847*	-0.744	0.804	0.982*	0.599	1.00			
12	**GW/P**	0.919	-0.235	0.963*	0.023	0.913*	0.837	-0.737	0.771*	0.968	0.551	0.976	1.00		
13	**1000-GW**	0.475	0.195	0.131	0.769*	0.348	0.117	-0.071	0.359	0.257	0.288*	0.311	0.222	1.00	
14	**GW/M^2**	0.996*	0.010	0.860	0.416	0.915	0.688	-0.578	0.826	0.896*	0.676	0.932	0.904*	0.526	1.00

Yield, kg/hectare (Y), Plant height, cm (PH), Productive bushiness(PB), Number of Plants m^2, pieces (NP), Number of productive stalks m^2, pieces (NPS), Ear length, cm (EL), Ear density (ED), Number of cones ear^{-1}, pieces. (NC/E), Number of grains ear^{-1} , pieces (NG/E), Number of grains plant^{-1} , pieces.(NG/P), Grain weight ear^{-1}, g (GW/E), Grain weight plant^{-1}, g (GW/P), 1000–Grain weight, g (1000-GW), Grain weight m^{-2}**, g** (GW/M^2**)**

*significant at 5% level of probability

With high reliability, the number of productive stalks per m^2 in field conditions could easily be counted. From results obtained one could predict yield. High correlation of 0.942 was established between traits: yield and grain weight ear^{-1}. The determination of coefficient was 0.887. It means that these two traits in 88.7 % of cases were formed at the expense of the manifestation of genotypes of varieties and in 11.3 % of cases they depended on other factors. Selection of plots, variants according to yield could be carried out using the value of this correlation between these traits.

The trait- number of grains $spike^{-1}$ is easy to determine in the field or laboratories. For example, a breeder investigating a total of 1000 number in controlled nursery. Before harvesting an average of one ear was selected from each sample of plots. From each ear the number of grains was determined by crushing in palms of the hand. Grains were counted. After the analysis variation of rows was made according to quantity of grains $spike^{-1}$ from the bigger to the smaller grains. According to these results, samples with small quantity of grains $spike^{-1}$ were discarded or rejected. This is graphic example of the use of correlation coefficient between traits as test for selection of high-yielding numbers for selection purposes.

In this study, the analysis showed variation of yield. High positive rectilinear interrelation of 0.907 was established between traits: productivity and number of grains $spike^{-1}$. In this regard, there was a distinct theoretical conditionality: increase in number of grains $spike^{-1}$ resulted to increase in yield. The determination of coefficient amounted to 0.822. It means that the two investigated traits i.e. grain yield and grains number ear^{-1} in 82.2 % of cases were formed at the expense of manifestation of genotypes of variety and in 17.8 % of cases their values depended on other factors.

4. Conclusion

The functional trait (yield) in this study highly correlated with seven characteristics of winter wheat varieties. Thus, yield and productive stalks showed correlation of 0.878. The determination of coefficient (square of correlation coefficient) $0.878^2 = 0.770$ could be used to explain biological interrelation. The interpretation of the value of these correlated traits - yield and productive bushiness – is that in 77 % of cases they were controlled by genotypes of varieties and in 23 % of cases their quantity depended on other factors. High correlation of 0.942 was established between traits: yield and grain weight ear^{-1}. The determination of coefficient was 0.887. It means that these two traits in 88.7 % of cases were formed at the expense of the manifestation of genotypes of varieties and in 11.3 % of cases they depended on other factors.

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