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CORRELATION AND PATH ANALYSIS IN TRITICALE

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ABSTRACT

Study on genotypic and phenotypic correlations in triticale indicated that spike length, harvest index, and grains per spike were positively associated with grain yield. Path-coefficient analysis revealed that spike length, flag leaf area, days to heading, spikelets per spike and 1000-grain weight were the major characters influencing grain yield directly and indirectly. The results suggested that spike length could be taken as the most reliable and effective selection criterion for yield improvement.

Key words: Correlation, path analysis, triticale.

Most of the characters of breeder's interest are complex and are the result of interaction of a number of components. Understanding the relationships among yield and yield components is of paramount importance for making the best use of these relationships in selection. The correlation coefficient may be confounded with indirect effect due to common association inherent in trait interrelationships. Therefore, information derived from the correlation coefficients can be augmented by partitioning correlations into direct and indirect effects by path-coefficient analysis. The aim of this study was to workout interrelationships among sixteen traits in triticale, and their direct and indirect effects on grain yield.

MATERIALS AND METHODS

Twenty-five elite lines of triticale along with breadwheat cultivar Sonalika were evaluated in a randomized complete block design with three replications. Each plot consisted of six rows of 3 m length with interrow and intrarow spacings of 25 cm and 15 cm, respectively. Observations recorded on ten random plants for sixteen quantitative traits were subjected to the standard statistical analysis (Table 1). Correlation coefficients were

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subjected to path-coefficient analysis, and the direct and indirect effects were estimated as described by Dewey and Lu [1].

RESULTS AND DISCUSSION

The data presented in Table 1 revealed that genotypic correlations were, in general, slightly greater in magnitude than phenotypic ones which is in conformity with earlier reports [2, 3]. Since environmental correlation coefficients were low and nonsignificant for all the combinations with exception in three cases (between days to heading and days to flowering, spike length and spikelets per spike, and harvest index and grain yield), phenotypic correlation coefficients would be good indices of genotypic correlation coefficients. Therefore, only phenotypic correlations are referred here. Moreover, characters which were genotypically but not phenotypically correlated may not be of practical value in selection since selection is based on the phenotype as observed in case of relationship between plant height and grain yield.

Table 1. Phenotypic (upper diagonal) and genotypic (lower diagonal)

Characters	Days to heading	Days to flowering	Days to maturity	Spikes per half m^2	Tillers per plant	Plant height	Spike length
Days to heading	—	0.98**	0.89**	-0.21	-0.21	-0.18	0.43*
Days to flowering	0.99	—	0.90**	-0.18	-0.19	-0.16	0.40*
Days to maturity	0.92	0.93	—	-0.30	-0.25	-0.14	0.39*
Spikes/half m^2	-0.24	-0.22	-0.31	—	0.32	-0.03	-0.28
Tillers/plant	-0.22	-0.25	-0.37	0.44	—	0.13	-0.23
Plant height	-0.18	-0.16	-0.14	-0.01	0.15	—	0.16
Spike length	0.47	0.44	0.44	-0.32	-0.33	0.16	—
Spikelets/spike	0.65	0.66	0.73	-0.37	-0.31	0.29	0.85
Grains/spike	0.75	0.74	0.83	-0.31	-0.40	-0.22	0.61
1000-grain, weight	-0.56	-0.63	-0.63	0.10	0.24	0.27	0.09
Harvest index	0.39	0.38	0.35	-0.11	-0.32	-0.60	0.35
Grain plumpness	-0.47	-0.51	-0.45	0.02	0.11	0.02	0.11
Grain hardness	-0.39	-0.38	-0.24	-0.31	0.15	0.22	-0.20
Flag leaf area	-0.68	-0.67	-0.64	-0.29	0.20	0.11	-0.36
General leaf area	0.37	0.35	0.36	-0.49	-0.06	0.03	0.38
Grain yield/plant	0.17	0.15	0.02	0.07	-0.04	-0.39	0.50

*,**Significant at 5% and 1% levels, respectively.

Grain yield exhibited significant positive correlation with spike length [2, 4, 5] and harvest index [3] which, in turn, were positively associated with grains per spike. A substantial positive correlation was also reported between grain yield and grains per spike [2–6].

Important negative correlations existed between plant height and harvest index (r = – 0.50), and grains per spike and 1000- grain weight (r = – 0.43), while positive associations between 1000-grain weight and grain plumpness (r = 0.62), and harvest index and grains per spike (r = 0.45) were recorded. Negative association of harvest index with plant height may be due to the fact that an increase in plant height leads to an increase in biological yield thereby decreasing the harvest index. Negative association between grains per spike and 1000-grain weight indicated a compensatory relationship between them. More grains per spike could result in the reduction of the average seed size because of competition among seeds for limited food reserves [1]. Highly positive correlation between 1000-grain weight and grain plumpness was expected because of the low weight of shrivelled grains [7].

correlation coefficients for different quantitative traits in triticale

Spikelets per spike	Grains per spike	1000-grain weight	Harvest index	Grain plump-ness	Grain hard-ness	Flag leaf area	General leaf area	Grain yield
0.61**	0.73**	– 0.55**	0.36	– 0.36	– 0.36	– 0.62**	0.30	0.17
0.60**	0.71**	– 0.60**	0.34	– 0.40*	– 0.34	– 0.62**	0.29	0.15
0.58**	0.80**	– 0.60**	0.34	– 0.39*	– 0.22	– 0.59**	0.28	0.02
– 0.34	– 0.29	0.10	– 0.10	0.02	– 0.25	– 0.22	– 0.42*	0.07
– 0.22	– 0.30	0.20	– 0.18	– 0.01	0.13	0.16	– 0.07	– 0.04
0.27	– 0.18	0.25	– 0.50**	0.01	0.22	0.09	0.07	– 0.33
0.81**	0.58**	0.07	0.33	0.11	– 0.17	– 0.28	0.35	0.47*
—	0.61**	– 0.27	0.21	– 0.14	– 0.14	– 0.41*	0.32	0.14
0.70	—	– 0.43*	0.45*	– 0.29	– 0.15	– 0.49*	0.38	0.31
– 0.30	– 0.47	—	– 0.30	0.62**	0.24	0.40*	– 0.01	0.05
0.21	0.47	– 0.34	—	– 0.11	– 0.40*	– 0.33	0.11	0.52**
– 0.22	– 0.34	0.76	– 0.08	—	–0.03	0.18	– 0.03	0.14
– 0.18	– 0.19	0.25	– 0.49	– 0.02	—	0.52**	0.06	– 0.33
– 0.49	– 0.54	0.45	– 0.40	0.21	0.65	—	0.25	– 0.19
0.43	0.45	0.01	0.02	0.03	0.08	0.27	—	0.02
0.16	0.33	0.05	0.56	0.14	– 0.36	– 0.21	0.03	—

Flag leaf area had positive correlation with 1000-grain weight, and negative correlation with grains per spike and spikelets per spike. It was not entirely unexpected since ear and flag leaf emerged at the interval of 5 – 10 days resulting in a competition among spikelets, grains and flag leaf for food supply from general leaves. Afterwards, flag leaf starts supporting food supply to ear which resulted in higher grain weight [8].

Days to heading, flowering and maturity, spike length, number of spikelets and grains per spike were positively interrelated with each other [2, 3]. Longer spikes provide sites for more spikelets and thereby increase the grain number [8]. Therefore, the close relationship between spike length, spikelets/spike and grains/spike might be expected.

The direct and indirect effects of fifteen characters on grain yield are given in Table 2. All the direct effects with the exception of one were less than one, indicating that inflation due to multicolinearity was minimal [9]. The direct effect of spike length was positive and highest followed by flag leaf area, days to heading, grain plumpness, spikes per half m^2,

Table 2. Direct (in bold) and indirect effects of different

Characters	Spike length	Flag leaf area	Days to heading	Grain plump-ness	Spikes per half m^2	Grains per spike	Tilles per plant	Spikelets per spike
Spike length	**2.10**	– 0.23	0.24	0.05	– 0.11	0.15	– 0.07	– 1.34
Flag leaf area	– 0.75	**0.65**	– 0.36	0.09	– 0.10	– 0.12	0.04	0.78
Days to heading	0.98	– 0.44	**0.53**	– 0.19	– 0.08	0.19	– 0.05	– 1.03
Grain plumpness	0.23	0.14	– 0.25	**0.41**	0.01	– 0.08	0.02	0.35
Spikes/half m^2	– 0.68	– 0.19	– 0.12	0.01	**0.33**	– 0.08	0.10	0.60
Grains per spike	1.29	– 0.35	0.39	– 0.14	– 0.10	**0.25**	– 0.09	– 1.11
Tillers/plant	– 0.69	0.13	– 0.12	0.04	0.15	– 0.10	**0.22**	0.50
Spikelets/spike	1.73	– 0.32	0.35	– 0.08	– 0.12	0.18	– 0.07	**– 1.59**
1000-grain weight	0.19	0.29	– 0.30	0.31	0.03	– 0.12	0.05	0.47
General leaf area	0.79	0.18	0.20	0.01	– 0.16	0.11	– 0.01	– 0.68
Days to flowering	0.93	– 0.44	0.52	– 0.21	– 0.07	0.17	– 0.05	– 1.05
Plant height	0.34	0.07	– 0.09	0.01	0.00	– 0.06	0.03	– 0.46
Days to maturity	0.92	– 0.42	0.48	– 0.18	– 0.10	0.21	– 0.08	– 1.16
Grain hardness	– 0.43	0.43	– 0.20	– 0.01	– 0.10	– 0.05	0.03	0.28
Harvest index	0.74	– 0.26	0.20	– 0.03	– 0.04	0.12	– 0.07	– 0.33

*,** Significant at 5% and 1% levels, respectively.

grains per spike and tillers per plant. A strong negative indirect effect of spike length on grain yield was observed through spikelets/spike.

The correlation coefficients between flag leaf area and grain yield (r = – 0.21) gives the impression that flag leaf area had little to do with grain yield, whereas the path analysis exposes flag leaf area as one of the major pathways. The reverse was true between harvest index and grain yield. Despite having virtually negligible direct and indirect effects on grain yield, harvest index had positive correlation with grain yield because of its positive indirect effect through spike length, 1000-grain weight and days to heading.

The direct effects of spikelets per spike, 1000-grain weight and general leaf area were high and negative. However, their indirect effects through spike length were positive. Of particular concern to the breeders is the fact that the indirect effects on grain yield via spike length and spikelets per spike were opposite in direction for all the traits except grain plumpness and 1000-grain weight.

quantitative traits and their correlation with grain yield in triticale

1000-grain weight	General leaf area	Days to flowering	Plant height	Days to maturity	Grain hard-ness	Harvest index	Genotypic corr-elation with grain yield
– 0.09	– 0.13	– 0.06	0.00	0.00	0.00	– 0.01	0.50**
– 0.44	– 0.10	0.09	0.00	0.00	0.00	0.01	– 0.21
0.26	– 0.13	0.14	0.00	0.00	0.00	– 0.01	0.17
– 0.75	– 0.01	0.07	0.00	0.00	0.00	0.00	0.14
– 0.10	0.18	0.03	0.00	0.00	0.00	– 0.01	0.07
0.46	– 0.16	– 0.10	0.00	0.00	0.00	– 0.01	0.33
– 0.24	0.02	0.02	0.00	0.00	0.00	0.01	– 0.04
0.29	– 0.13	– 0.09	0.01	0.00	0.00	0.00	0.16
– 0.98	0.00	0.09	0.01	0.00	0.00	0.01	0.05
– 0.01	**– 0.35**	– 0.05	0.00	0.00	0.00	0.00	0.03
0.62	– 0.12	**– 0.14**	0.00	0.00	0.00	– 0.01	0.15
– 0.26	**– 0.01**	**0.02**	**0.02**	0.00	0.00	0.00	– 0.39*
0.62	– 0.13	– 0.13	0.00	**0.00**	0.00	– 0.01	0.02
– 0.24	– 0.03	**– 0.05**	**0.01**	**0.00**	**– 0.01**	0.01	– 0.36
0.32	– 0.01	– 0.05	– 0.01	0.00	0.00	**– 0.02**	0.56**

An examination of the data presented in Table 2 reveals that spike length, flag leaf area, days to heading, spikelets per spike and 1000-grain weight were the main traits that exerted maximum influence both directly and indirectly upon grain yield whereas days to flowering, plant height, days to maturity, grain hardness and harvest index had virtually negligible direct and indirect effects on grain yield.

Spike length had not only positive correlation with grain yield but also exerted the greatest influence both directly and indirectly on grain yield. Therefore, spike length could be taken as selection criteria for improvement of grain yield in triticale.

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