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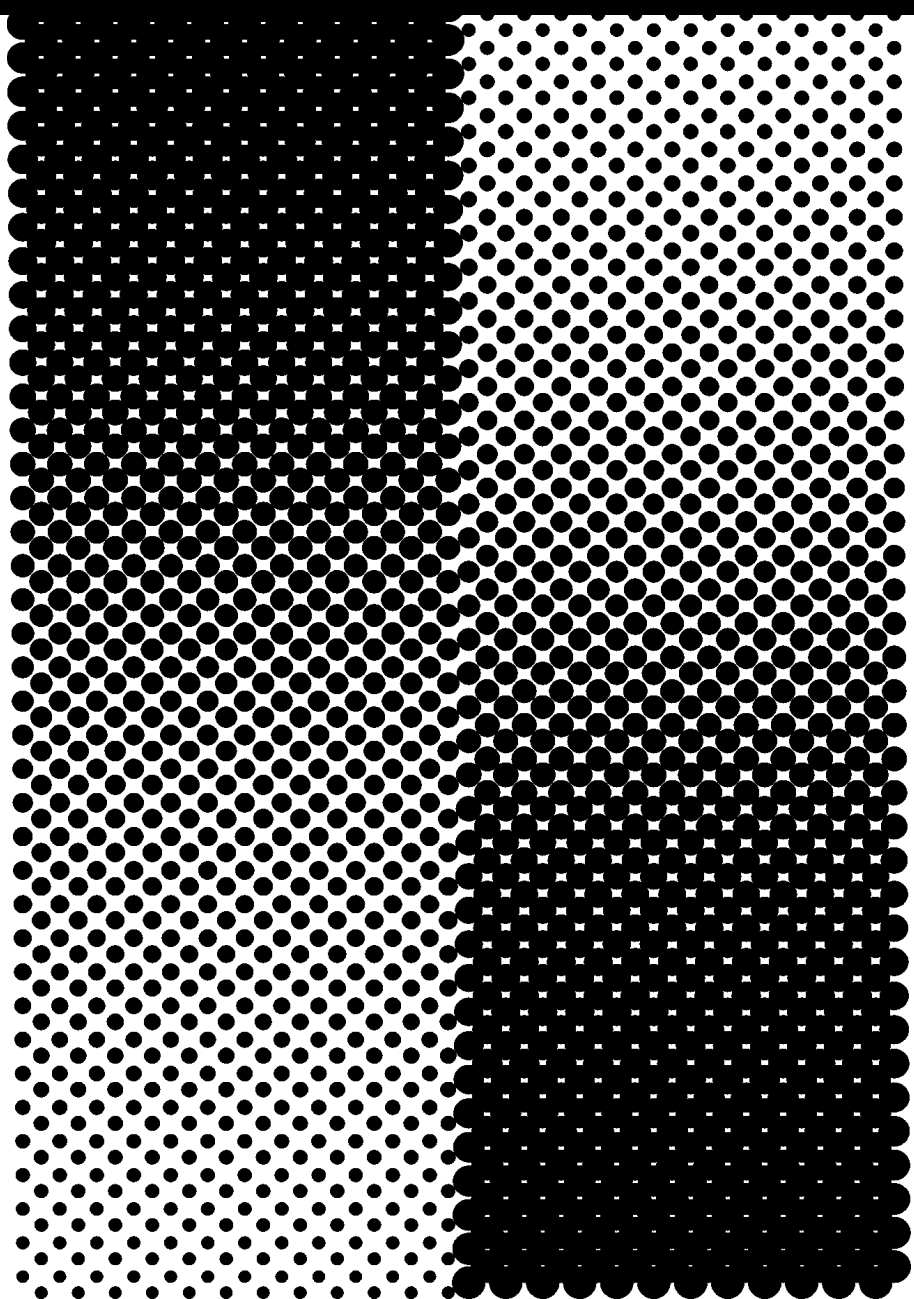

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Ecologically friendly oxidation processes

CORRELATION AND PATH COEFFICIENT ANALYSIS FOR YIELD AND SOME YIELD COMPONENTS OF WHEAT (*Triticum aestivum* L.)

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ABSTRACT

The experiment was conducted to determine the relationship among yield and some yield components using correlation and path coefficient analysis. This study was performed under Mardin conditions the years of 2011–2012 and 2012–2013. Fifteen bread wheat varieties were used in the experiments. The randomised complete blocks design with 3 replications was used. The characteristics such as plant height, spike height, numbers of seed per spike, seed yield, harvest index, biological yield and 1000 seed weight were investigated in the study. Positive and statistically significant ($p < 0.01$) relationships were determined between seed yield, spike height, numbers of seed per spike, biological yield and harvest index. According to path coefficient analysis, there were strong direct effects of the biological yield and harvest index on the seed yield, $p = 0.53549$ and 0.548321, respectively. The results of this study indicate that numbers of seed per spike, biological yield and harvest index affected seed yield and it was concluded that these characters should be considered as significant selection criteria in wheat breeding for yield under the regional conditions of southeast Turkey.

Keywords: wheat, correlation, path coefficient, yield, yield components.

AIMS AND BACKGROUND

Wheat is the most consumed and grown common varieties of grain in the world and in many parts of the world for human nutrition carbohydrates and basic food, wheat is the main source of protein and minerals. Many grown wheat varieties are classified as hard wheat (*Triticum durum*) and soft wheat (*Triticum aestivum* L.). Generally hard

* For correspondence.

wheat is mostly used in making pasta while soft wheat in bread[1]. The resistance of common wheat *T. aestivum* to toxic pollutants such as arsenic, cadmium, mercury was also reported[2]. The wheat is at the first rank in cereals in the world and Turkey. The wheat which has 217 mil. ha sowing area and 653 mil. t of production in the world, has 8.1 mil. ha sowing area and 19 mil. ton of production in Turkey. 2427 ha per kg average yield of Turkey is some lower than world average yield (3006 kg ha^{-1}) (Ref. 3).

Determining seed and hay yield components will provide important benefits in wheat breeding studies in the future. However, simple correlation coefficients between yield and yield components may not give satisfactory results. On the other hand, in practice, selection criteria will contribute to selection based on direct effects. Path coefficient analyses have been used to evaluate selection criteria in several crops. This technique is useful in determining the direct influence of one variable on another, and also separates the correlation coefficient into its components of direct and indirect effects[4]. Path coefficient analysis separates the direct effects from the indirect effects through other related characters by partitioning the correlation coefficient[5]. Path analysis is used when we want to determine the amount of direct and indirect effects of the causal component on the effect component[6]. The path coefficient analysis initially suggested by Wright[7] and described by Dewey and Lu[8] allows partitioning of correlation coefficient into direct and indirect effects of various traits towards dependent variable and thus helps in assessing the cause effect relationship as well as effective selection.

Abderrahmane et al.[9] reported that total biomass, number of spikes per plant, number of grains per spike are positively correlated with grain yield. Seed yield per plant was positively correlated with grains per spike, harvest index, spikes per plant, spike length and 1000 seed weight[10]. In this study, relationships among yield and yield components were examined to determine the association of seed yield with its components and some developmental traits, using path coefficient analysis.

EXPERIMENTAL

Fifteen bread wheat varieties (Tosunbey, Bezostaja 1, Ekiz, Pehlivan, Bayraktar 2000, Konya 2002, Dogu 88, Nurkent, Cemre, Karacadag-98, Adana-99, Ceyhan-99, Karatopak, Basribey-95 and Gonen-98) were used in the experiments. All the varieties were sown in a randomised complete block design with three replications. In each replication, 15 treatments were grown in 5 m long rows and the spacing of 20 cm between rows. The plants were at 0.5 m in the beginning and the end of the parcel boundary. 150 kg ha^{-1} diammonium phosphate was applied to each parcel[11]. The data, which consisted of 7 different characters, including plant height, spike height, numbers of seed per spike, seed yield, harvest index, biological yield and 1000 seed weight were recorded. Data on seed and biological yields of wheat were recorded from the whole plot, but the yield components data were recorded from randomly selected 10 plants in each plot.

In 2011–2012 and 2012–2013, precipitation throughout the season was 478.3 and 814.1 mm, respectively, and the average over the long-term for the same period was 626.5 mm (Table 1). Average temperature was 8.98°C in the first year and 10.50°C in the second and increase in average temperature relative to long term average of 9.14°C. Average relative humidity was 60.28 and 54.27% in the first, and 56.94% in the second vegetation period[12].

Table 1. Meteorological data for the growing seasons of 2011–2012, 2012–2013 and long-term averages in Mardin, Turkey

Months	Average temperature (°C)			Precipitation (mm)			Relative humidity (%)		
	2011–2012	2012–2013	LTA*	2011–2012	2012–2013	LTA*	2011–2012	2012–2013	LTA*
November	6.7	13.0	10.7	51.7	93.1	69.7	50.1	52.1	57
December	5.8	5.2	5.3	37.5	192.5	106.9	48.6	66.4	67
January	3.8	4.9	3.0	130.1	152.7	112.3	77.5	68.0	70
February	2.7	6.6	4.0	101.2	105.4	108.2	59.0	71.0	66
March	6.1	9.1	8.0	77.8	53.7	96.8	64.9	52.1	61
April	17.5	15.2	13.4	35.3	62.3	83.6	49.4	46.0	56
May	20.3	19.5	19.6	44.7	154.4	40.4	30.4	43.0	45
Total				478.3	814.1	626.5			
Mean	8.98	10.50	9.14				54.27	56.94	60.28

*LTA – long-term average.

Lands where the trial was established were deep almost flat and straight soils in which materials were mostly alluvial materials. Colour is typical red colour and texture is clay. The salt content was measured as 0.059%, pH 7.59, lime content 29.6% organic matter content, 1.69% phosphorus (57.8 ppm) and potassium (1.66 me/100 g) (Table 2).

Table 2. Some soil properties of the research area

Depth (cm)	Texture	pH	Lime (%)	Phosphorus (ppm)	N (me/100g)	Organic matter (%)	Salt (%)
0–30	Clay	7.59	29.6	57.8	0.096	1.69	0.059

RESULTS AND DISCUSSION

Simple correlation coefficients among the examined characters are shown in Table 3. Seed yield was significantly and positively correlated with spike height (r = 0.7587**), numbers of seed per spike (r = 0.7893**), biological yield (r = 0.9044**) and harvest index (r = 0.9094**) that plants with more numbers of seed per spike plenty of spikelets and produce higher seed yield. The above findings conform with earlier reports[13,14]. Harvest index showed no significant correlation with plant height.

Similarly, 1000 seed weight showed no significant ($P > 0.05$) correlation with spike height and numbers of seed per spike.

Table 3. Correlation coefficients among the characteristics in 15 wheat cultivars ($n = 90$)

Characters	1	2	3	4	5	6	7
1. Seed yield (kg ha^{-1})	1.00						
2. Plant height (cm)	0.2635 ns	1.00					
3. Spike height (cm)	0.7587**	0.2708 ns	1.00				
4. Numbers of seed per spike	0.7893**	0.1525 ns	0.5915**	1.00			
5. 1000 seed weight	0.3752 ns	0.4430**	0.2643 ns	0.0999 ns	1.00		
6. Biological yield (kg ha^{-1})	0.9044**	0.2182 ns	0.5969**	0.6689**	0.4197**	1.00	
7. Harvest index (%)	0.9094**	0.2444 ns	0.7812**	0.7671**	0.2533 ns	0.6537**	1.00

ns – non-significant; ** significant at 1%.

The direct and indirect effects of six examined characters on seed yield were estimated by path coefficient and shown in Table 4.

Harvest index had the greatest direct effect on seed yield (path coefficient (p.c.) = 0.54832). Also, its indirect effects on seed yield were positive through numbers of seed per spike and 1000 seed weight. The second highest biological yield on seed yield was of the harvest index (p.c. = 0.53459). The main reason for strong direct effect of biological yield was due to the strong positive correlation ($r = 0.9044$) of this character with seed yield. Plant height (p.c. = 0.00786) and numbers of seed per spike (p.c. = 0.00754) were the third highest positive direct contributors to seed yield following biological yield and harvest index. The present findings are similar to those of Baser et al.[16] and Inamullah et al.[17] 1000 seed weight had a low but positive direct effect on seed yield (p.c. = 0.00281). The indirect effects on seed yield were positive and high via biological yield (p.c. = 0.31911) and harvest index (p.c. = 0.42836). The numbers of seed per spike contributed positive indirect effect towards seed yield only through number of spikelet/plant. Knowledge of correlation alone is often misleading as the correlation observed may not be always true. Two characters may show correlation just because they are correlated with a common third one. In such cases, it becomes necessary to use a method which takes into account the causal relationship between the variables, in addition to the degree of such relationship. Path coefficient analysis measures the direct influence of one variable upon the other, and permits separation of correlation coefficients into components of direct and indirect effects. Portioning of total correlation into direct and indirect effects provide actual information on contribution of characters and thus form the basis for selection to improve the yield[15].

Table 4. Path analysis showing direct and indirect effects of six characters on wheat yield

Characters	Indirect effects												Corr. value with yield
	1	%	2	%	3	%	4	%	5	%	6	%	
1. Plant height (cm)	**(0.00786)**	2.985431	0.00213	0.28086	0.00120	0.15202	0.00348	0.92900	0.00171	0.18984	0.00192	0.21155	**0.2635**
2. Spike height (cm)	0.00076	0.289475	**(0.00281)**	0.37127	0.00166	0.21105	0.00074	0.19853	0.00168	0.18597	0.00220	0.24200	**0.7585****
3. Numbers of seed per spike	0.00115	0.436300	0.00446	0.58782	**(0.00754)**	0.95519	0.00075	0.20093	0.00504	0.55771	0.00578	0.63597	**0.7893****
4. 1000 seed weight	0.00308	1.170422	0.00184	0.24264	0.00069	0.08817	**(0.00696)**	1.85560	0.00292	0.32319	0.00176	0.19395	**0.3752**
5. Biological yield (kg ha^{-1})	0.11665	44.25753	0.31911	42.0592	0.35763	45.3063	0.22438	59.7965	**(0.53459)**	59.1099	0.34947	38.4263	**0.9044****
6. Harvest index (%)	0.13405	50.86083	0.42836	56.4581	0.42063	53.28725	0.138912	37.01941	0.35844	39.6333	**(0.54832)**	60.29017	**0.9094****
Total	0.26358	100	0.75873	100	0.789369	100	0.375241	100	0.90441	100	0.90947	100	

** Significant at 1%; figures in parentheses are direct effect on seed yield; p.c. – path coefficient.

CONCLUSIONS

In conclusion, determining the linear relations (correlations) among components affecting seed yield was insufficient to indicate selection criteria in wheat breeding activities. A positive and significant correlation was found between spike height, numbers of seed per spike, biological yield and harvest index affected seed yield positively. The results of this study indicate that biological yield and harvest index affected seed yield and it was concluded that these characters should be considered as significant selection criteria in wheat breeding for yield under the regional conditions of Mardin.

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