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Studies of genetic diversity for yield and yield contributing characters in durum wheat (*Triticum durum* Desf.) under limited irrigation condition

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Abstract
Current research was conducted with objective to study association of cause and effect relationship of yield contributing characters on yield under limited irrigation condition. This study involves forty three genotypes of wheat evaluated at Agriculture Research Station, Niphad during *Rabi* 2018-19 in a Randomized Block Design with two replications. Correlation study revealed that, grain yield showed strong significant and positive correlation with productive tillers per meter, 1000 grains weight, peduncle length, number of flower per spike, flag leaf length, number of grains per spike and number of spikelets per spike. While spike length, coleoptile length and plant height showing non-significant positive correlation with grain yield. Grain yield showed significant negative correlation with days to maturity and days to 50% heading. In the present study, the correlation analysis revealed the association pattern of different yield components with grain yield represents the correlation coefficient between the characters with seed yield at both genotypic and phenotypic levels. In the present study, Path coefficient analysis was carried out at genotypic level taking grain yield as dependent character and all the characters which exhibited significant association with grain yield were considered as independent characters. Positive direct effect of seed weight on yield per plant was noticed and this was supplemented by positive indirect effects through stem girth, length of inflorescence.

Keywords: Correlation, path coefficient analysis, durum wheat

1. Introduction
Wheat is one of the important cereal crops of the world. The durum wheat growing countries are United States, China, Russia, Canada, France, India and countries of West Asia and North Africa. In India *viz*., *Triticum aestivum* L. (2n=42) is known as Bread wheat, *Triticum dicoccum* (2n=28) is known as Emmer wheat, *Triticum durum* Desf. (2n=28) is known as Macroni wheat. Durum is an important species of wheat as its adoption to semi-arid environment. It's high in protein gluten content as well as its strength make durum wheat good for special uses. Wheat is cool season crop, it requires average temperature of 18^0C-22^0C. Wheat grows well in areas having annual rainfall of 750-1600 mm. Water requirement of wheat crop is about 40 cm, however the durum wheat can be grown as rainfed crop. Yield is polygenically controlled complex character. Thus, the effective selection for yield is a complex process. Study of correlation is prerequisite for breeding programme designed to manipulate the plant architecture. Knowledge of association between yield and its component characters and among the component characters themselves can improve the efficiency of selection.

2. Material and Methods
The current research was conducted at Agricultural Research Station, Niphad during season Rabi 2018-2019 to study association of cause and effect relationship of yield contributing characters on yield for forty one genotypes with two checks of Durum wheat. Randomized block design (RBD) was used for experiment with two replications in two rows of 6.00 meter length having spacing of 20 cm between the rows. Hand drilling was used for planting on November 5, 2018. Recommended fertilizer rate was of 60:30:00 kg/ha (N:P:K). Observations were recorded for 14 characters *viz*.; days to 50% heading, coleoptile length, days to maturity, plant height (cm), tiller per meter, peduncle length, flag leaf length (cm), flag leaf breadth (mm), spike length, number of spikelets, number of flower per spike, grains per spike,1000 grains weight (g), and grain yield per running meter (q/ha).

Statistical analysis was performed by methods proposed by Panse and Sukhatme (1985) [6]. Path coefficient analysis was done according to the procedure suggested by Dewey and Lu (1959) [3].

3. Result and Discussion

Correlation coefficient: In the present study, the correlation analysis revealed the association pattern of different yield components with grain yield represents the correlation coefficient between the characters with seed yield at both genotypic and phenotypic levels. It was observed that, grain yield per running meter had significant positive correlation with tiller per meter, peduncle length, flag leaf length, spikelet per spike, flower per spike, grain per spike and 1000 grains weight at both genotypic and phenotypic levels. Coleoptile length character shows positive correlation with grain yield, it means long coleoptile length genotypes shows tolerance to moisture deficient condition. Due to long coleoptile length it withdraws moisture from soil for long period as compaired to short length genotype. The interrelationship among the economic characters is of immense help in effective selection programme. Simultaneous improvement in two or more characters is possible when positive correlations were observed, whereas negative associations indicate the need to compromise between desirable characters. The results of this study are confirmatory with Monpara (2009) [5] for tillers per plant while the reports of Dogan (2009) [4] are inline of present study for grain number per spike, 1000 grain weight, plant height and test weight had significant direct effect on grain yield.

Path Coefficient: Path coefficient analysis was carried out to find out the direct and indirect contribution of each character towards the grain yield per plot. In the present study, it was carried out at genotypic level taking grain yield as dependent character and all the characters which exhibited significant association with grain yield were considered as independent characters. The results of analysis shows that flower per spike, tiller per meter, spike length, days to 50% heading had higher magnitude of positive and direct effects on grain yield. 1000 grain weight, coleoptile length and flag leaf length had showed low but positive direct effect on grain yield. Highest positive direct effect was exerted by flower per spike on grain yield followed by days to 50% heading, tiller per meter, spike length, 1000 grain weight, coleoptile length and flag leaf length which is in conformity with the reports of Deshmukh *et al.* (1990) [2] and Zeeshan *et al.* (2013) [8] wherein they observed appreciable positive direct effect of 1000 grains weight. Direct selection for 1000 grains weight alone can bring about considerable improvement in the grain yield due to its high direct effect, positive and indirect effects through all the major yield contributing characters on seed yield. Positive direct effect of seed weight on yield per plant was noticed and this was supplemented by positive indirect effects through stem girth, length of inflorescence. The results of this study also confirm the earlier reports *viz*., Talebi *et al.* (2010) [7] for grain yield with the number of seed per spike, Bilgin *et al.* (2011) [1] for positive and significant correlations of grain weight per spike, test weight, plant height, grains per spike, spikelets per spike, 1000-grain weight and spike length with gain yield.

Table 1: Estimates of phenotypic (above diagonal) and genotypic correlation (below diagonal) for different quantitative characters of wheat

Sr. No.	Characters	Days to 50% heading	Days to maturity	Coleoptile length (mm)	Plant height (cm)	Tiller per meter	Peduncle length (cm)	Flag leaf length (cm)	Flag Leaf breadh (cm)	Spike Length (cm)	Spikelets / spike	Flower/ spike	Grain Per spike	1000 Grain wt (gm)	Grain yield / meter (g)
1	Days to 50% heading	1.0000	0.9178**	-0.2541*	0.1085	0.0640	-0.3434**	0.0486	0.1534	0.1991	0.838	0.1020	-0.0024	-0.3196**	-0.1303
2	Days to maturity	0.9667**	1.0000	-0.1278	0.1088	0.1109	-0.3252**	0.0480	0.1664	0.2067	0.0518	0.0443	-0.0753	-0.3075**	-0.1001
3	Coleoptile length (mm)	-0.3568**	-0.1979	1.0000	-0.0525	-0.0456	0.0489	-0.1106	0.0365	0.0900	0.0108	0.0653	0.0542	0.1748	0.0387
4	Plant height (cm)	0.1176	0.1634	-0.1095	1.0000	0.1235	-0.0026	0.0864	0.0001	-0.1004	0.0764	-0.0347	-0.1289	0.0217	0.0552
5	Tiller per running meter	0.0604	0.1183	-0.0825	0.1600	1.0000	0.3386**	0.2645*	0.0445	-0.2266*	-0.0962	-0.0696	-0.1426	-0.2706*	0.6886**
6	Peduncle length (cm)	-0.3993**	-0.3810**	0.2278*	-0.0093	0.4199**	1.0000	0.3691**	-0.0635	-0.0175	0.2840**	0.2866**	0.2525*	-0.0267	0.3631**
7	Flag leaf length (cm)	0.0567	0.0614	-0.1476	0.2409*	0.3123**	0.5250**	1.0000	0.1244	0.2976**	0. 3104**	0.3238**	0.2647*	-0.0723	0.3154**
8	Flag leaf breadth (cm)	0.2491*	0.2780**	0.3096**	-0.2708*	0.1253	-0.0399	0.3911**	1.0000	0.2037	0.2159*	0.1781	0.1718	-0.0226	0.1122
9	Spike length (cm)	0.2583*	0.2507*	-0.0485	-0.1319	-0.3425**	-0.0513	0.3959**	0.5611**	1.0000	0.4950**	0.4764**	0.04705**	0.1843	0.0664
10	Spikelet per spike	0.0825	0.0440	0.1155	0.0971	-0.1648	0.2772**	0.5804**	0.2311**	0.6797**	1.0000	0.8981**	0.8204**	0.0760	0.2492*
11	Flower per spike	0.0765	0.0411	0.1399	-0.1165	-0.0696	0.3377**	0.4830**	0.0606	0.6663**	0.9730**	1.0000	0.9419**	0.1630	0.3581**
12	Grains per spike	-0.0215	-0.0911	0.1091	-0.2673*	-0.1351	0.2747*	0.3789**	0.0934	0.6417**	0.9228**	0.9720**	1.0000	0.1858	0.3380**
13	1000 grain weight (gm)	-0.3387**	-0.3090**	0.2583*	-0.0048	-0.3043**	0.0083	-0.0669	-0.1105	0.3260**	0.1193	0.2013	0.2014	1.0000	0.3964**
14	Grain yield / meter (g)	-0.0946	0.0636	0.0387	-0.1536	0.683**	0.455**	0.399**	0.1474	0.0856	0.2441*	0.399**	0.353**	0.379**	

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

Table 2: Direct and indirect effect of different quantitative and nutritional characters on grain yield of Durum wheat

Sr. No.	Characters	Days to 50% heading	Days to maturity	Coleoptile length (mm)	Plant height (cm)	Tillers /meter	Peduncle length (cm)	Flag leaf length (cm)	Flag leaf breadth (cm)	Spike length (cm)	Spikelets / spike	Flower / spike	Grain / spike	1000 grain wt (g)	Grain yield / meter (g)
1.	Days to 50% heading	2.209	-2.608	-0.2450	-0.0150	0.0748	0.2655	0.0257	-0.1021	0.1812	-0.0718	0.1751	0.0356	-0.0782	-0.1536
2.	Days to maturity	2.1358	-2.6984	-0.1359	-0.0208	0.1464	0.2533	0.0278	-0.1140	0.1759	-0.0383	0.0940	0.1508	-0.0714	-0.0946
3.	Coleoptile length (mm)	-0.7883	0.5339	0.6867	0.0139	-0.1021	-0.1515	-0.0669	-0.1269	-0.0340	-0.1004	0.3202	-0.1806	0.0596	0.0636
4.	Plant height (cm)	0.2598	-0.4410	-0.0752	-0.1273	0.1980	0.0062	0.1092	0.1110	-0.0925	-0.0844	-0.2667	0.4425	-0.0011	0.0387
5.	Tiller/meter	0.1334	-0.3192	-0.0567	-0.0204	1.2376	-0.2792	0.1416	-0.0514	-0.2403	0.1433	-0.1592	0.2237	-0.0703	0.6831
6.	Peduncle length (cm)	-0.8822	1.0280	0.1565	0.0012	0.5196	-0.6649	0.2379	0.0164	-0.0360	-0.2410	0.7727	-0.4548	0.0019	0.4553

7.	Flag leaf length (cm)	0.1253	-0.1658	-0.1013	-0.0307	0.3866	-0.3491	0.4532	-0.1603	0.2778	-0.5048	1.1052	-0.6273	-0.0154	0.3933
8.	Flag leaf breadth (cm)	0.5504	-0.7500	0.2126	0.0345	0.1550	0.0265	0.1772	-0.4100	0.3937	-0.2010	0.1387	-0.1546	-0.0255	0.1474
9.	Spike length (cm)	0.5706	-0.6763	-0.0333	0.0168	-0.4239	0.0341	0.1794	-0.2301	0.7016	-0.5910	1.5248	-1.0625	0.0753	0.0856
10.	Spikelet /spike	0.1823	-0.1188	0.0793	-0.0124	-0.2040	-0.1843	0.2631	-0.0948	0.4769	-0.8696	2.2267	-1.5279	0.0275	0.2441
11.	Flower / spike	0.1690	-0.1108	0.0961	0.0148	-0.0861	-0.2245	0.2189	-0.0248	0.4675	-0.8462	2.2884	-1.6094	0.0465	0.3993
12.	Grain / spike	-0.0475	0.2458	0.0749	0.0340	-0.1672	-0.1826	0.1717	-0.0383	0.4502	-0.8025	2.2244	-1.6557	0.0465	0.3538
13.	1000 grain wt. (g)	-0.7483	0.8338	0.1774	0.0006	-0.3766	-0.0055	-0.0303	0.0453	0.2287	-0.1037	0.4606	-0.3335	0.2309	0.3794

4. Conclusion

From above discussed results the genotypes AKDW 2997-16, NIDW 15, NIDW 1470, NIDW 1479, NIDW 1490, NIDW 1458, NIDW 1462 in the present studies, deserve to be considered as potent parents for future crossing programme for improvement of grain yield and yield contributing characters under limited irrigation condition, especially a genotype AKDW 2997-16 (Sharad) and NIDW 15 (Panchavati) may prove fruitful in producing desirable segregants. Also, NIDW 1485, NIDW 15 and NIDW 1489 shows long coleoptile length with only one irrigation after 40 days of sowing under limited irrigation condition. This results indicated the relative resistance power of the genotype studied in the experiment under limited irrigation condition. This study states that investigating the impact of such traits which not only boost up the yield but also shows potential towards water stress resistance in durum wheat.

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