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CHARACTER ASSOCIATION STUDIES IN OATS (*AVENA SATIVA* L.) FOR GREEN FODDER AND GRAIN YIELD

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SUMMARY

Correlation and path analysis for grain and fodder production in oats (*Avena sativa* L.) were studied for 30 genotypes of oats. Correlation of grain yield was positive and significant at phenotypic and genotypic levels with characters viz., plant height, tillers per metre row length, dry matter yield (q/ha), seed index, straw yield (q/ha) and green fodder yield (q/ha). Path analysis revealed that direct effect of seed index, dry matter yield (q/ha) and plant height were of high magnitude. The high positive association of other characters with grain yield per plant (g) was also due to high indirect effect through these characters. This indicated that grain yield was mainly a product of direct and indirect effects of seed index, dry matter yield (q/ha) and plant height. The high positive association of other characters with green fodder yield (q/ha) was also due to high indirect effect through dry matter yield (q/ha) and plant height. This indicated that green fodder yield was mainly a product of direct and indirect effects of dry matter yield (q/ha) and plant height.

Key words : Correlation, path analysis, oats

Oat (*Avena sativa* L.) is a cereal crop that is used worldwide for human food and animal feed. Compared to other cereal crops, oat is better suited for production under marginal environments, including cool wet climates and soils with low fertility (Hoffmann, 1995). But its food grain use is now more focused on its benefits as a health food. Oat is a constituent of breakfast cereal in most developed countries.

Correlation estimates between yield and other characters are useful in selecting desired plant types in designing an effective breeding programme. When change in one variable causes the change in other variable, the variables are said to be correlated. Correlation coefficient measures the degree of association, genetic or non-genetic relationship between two or more characters which forms the basis for selection. Path analysis simply splits the correlation coefficient into the measures of direct and indirect effects of a set of independent variables on the dependent variables.

MATERIALS AND METHODS

The present investigation was undertaken at Agriculture Research Station, Beechwal, Bikaner during **rabi** season of 2013-14. The climate of the region is typically hyper-arid which is characterized by extremes of temperature during summer and winter with aridity of atmosphere and salinity of rhizosphere. The average rainfall is about 260 mm, which is mostly received during July-September. The experimental material comprised 30 genotypes of oats (*Avena sativa* L.) obtained from AICRP on Forage Crops, ARS, Bikaner. The experimental material was laid out in a randomized block design (RBD) with three replications during rabi 2013-14. Each plot consisted of two rows each of 4.0 m length. The spacing between row to row was 25 cm. Normal and uniform cultural operations were followed during the crop season to raise a good crop. The experiment was sown on 20 Novmber, 2013 under irrigated conditions with the basal application of 40 kg N+40 kg P_2O_5/ha. While 40 kg N/ha was applied as top dressed 30 DAS. The observations were recorded on individual plant basis on five competitive randomly selected plants from each replication for plant height, leaf length leaf width, panicle length, and grains per panicle. While data were recorded on plot basis for days to 50 per cent panicle emergence, green fodder yield, dry matter yield, days to maturity, straw yield, seed index and grain yield. The phenotypic and genotypic correlation coefficients were computed from the phenotypic and genotypic variances and covariances according to Searle (1961). The direct and indirect effects were estimated through path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959).

RESULTS AND DISCUSSION

In general, the genotypic correlation coefficients were higher than the respective phenotypic correlation coefficients which might be from the modifying effect of environment on the association of characters at genotypic level. Selection of yield as such may not be effective since there may be number of genes for yield *per se* and yield may be resultant of interaction among various components. Knowledge of relation between yield and its components is essential and selection for one component may bring about a simultaneous change in the other. Therefore, for a rational approach to improve yield is to collect information on character association. Hence, under the present investigation, the phenotypic and genotypic correlation coefficients were worked out for grain yield (q/ha) and yield related characters.

The correlations of grain yield were positive and significant at phenotypic and genotypic levels with characters viz., plant height, tillers per metre row length, dry matter yield (q/ha), seed index, straw yield (q/ha) and green fodder yield (q/ha) (Table 1). It showed significant and positive correlation with leaf length and dry matter per cent at genotypic level only, while significant and negative correlation was observed with leaf : stem ratio at phenotypic and genotypic levels. This trait was non-significantly negatively correlated with days to 50 per cent flowering and days to maturity traits.

These characters need due consideration during any selection programme. Similar findings of positive and significant correlation had been reported by number of workers for grain yield with yield components, namely, Kumar *et al.* (2004), Pundir *et al.* (2005) and Aslfa *et al.* (2009).

Path-coefficient analysis was used to partition the genotypic and phenotypic correlation coefficient of 15 characters studied with seed yield into direct and indirect effects. At phenotypic level, highest direct positive effect on seed yield was observed for tillers per metre row length followed by seed index and plant height. While highest direct negative effect was recorded for green fodder yield followed by days to maturity and panicle length (Table 2).

At genotypic level, highest direct positive effect on seed yield was observed for seed index followed by dry matter yield, days to 50 per cent flowering, plant height, tillers per metre row length and grains per panicle. While highest direct negative effect was recorded for days to maturity followed by panicle length and leaf length.

Path analysis further revealed that direct effect of seed index, dry matter yield (q/ha) and plant height was of high magnitude. The high positive association of other characters with grain yield per plant (g) was also due to high indirect effect through these characters. This indicated that grain yield was mainly a product of direct and indirect effects of seed index, dry matter yield (q/ha) and plant height. Path analysis further revealed that days to 50 per cent flowering and days to maturity were negatively associated with grain yield per plant (g) which was due to the negative direct and indirect effects of days to maturity.

Path-coefficient analysis was also used to partition the genotypic and phenotypic correlation coefficient of nine characters studied with green fodder yield into direct and indirect effects (Table 3). At phenotypic level, the highest direct positive effect on green fodder yield (q/ha) was observed for dry matter yield followed by plant height and leaf : stem ratio .While highest direct negative effect was recorded for dry matter per cent followed by tillers per metre row length and panicle length.

At genotypic level, the highest direct positive effect on green fodder yield (q/ha) was observed for dry matter yield (0.9578) followed by plant height (0.3138) and panicle length (0.0478).While the highest direct negative effect was recorded for tillers per metre row length (-0.2156) followed by dry matter per cent (-0.1433) and leaf width (-0.0648).

Path analysis further revealed that direct effect of dry matter yield (q/ha) and plant height was of high magnitude. The high positive association of other characters with green fodder yield (q/ha) was also due to high indirect effect through these characters. This indicated that green fodder yield was mainly a product of direct and indirect effects of dry matter yield (q/ha) and plant height. Path analysis further revealed that days

TABLE 1

Estimation of phenotypic (P) and genotypic (G) correlation coefficient for 15 characters in oat

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	Tillers/ metre row length	Leaf : stem ratio	Leaf length (cm)	Leaf width (cm)	Panicle length (cm)	Grains/ panicle	Dry matter (%)	Dry matter yield (q/ha)	Seed index (q/ha)	Straw yield (q/ha)	Grain fodder yield (q/ha)	Grain yield (q/ha)
Days to 50% flowering	P	1.000	0.970**	-0.119	0.059	0.300	0.032	0.066	0.399*	0.416*	-0.021	-0.182	-0.051	-0.092	-0.179	-0.065
	G	1.000	0.996**	-0.218	-0.144	0.630**	0.349*	-0.130	0.524**	0.597**	-0.137	-0.308	-0.128	-0.174	-0.287	-0.133
Days to maturity	P		1.000	-0.105	-0.051	0.250	0.050	0.119	0.398*	0.412*	0.024	-0.153	-0.037	-0.071	-0.160	-0.055
	G		1.000	-0.205	-0.129	0.622**	0.420**	-0.009	0.560**	0.627**	-0.070	-0.285	-0.104	-0.152	-0.273	-0.118
Plant height (cm)	P			1.000	0.975**	-0.505**	0.139	0.003	-0.128	-0.089	0.154	0.960**	0.967**	0.973**	0.981**	0.979**
	G			1.000	0.983**	-0.583**	0.268	0.107	-0.196	-0.157	0.297	0.983**	0.982**	0.986**	0.991**	0.991**
Tillers/metre row length	P				1.000	-0.486**	0.178	0.001	-0.060	-0.026	0.148	0.928**	0.979**	0.960**	0.942**	0.992**
	G				1.000	-0.554**	0.334*	0.111	-0.107	-0.061	0.281	0.246	0.286	0.969**	0.951**	0.997**
Leaf : stem ratio	P					1.000	-0.178	-0.059	0.198	0.176	-0.044	-0.526**	-0.473**	-0.513**	-0.530**	-0.473**
	G					1.000	-0.289	-0.249	0.240	0.230	-0.166	-0.604**	-0.559**	-0.596**	-0.6**	-0.555**
Leaf length (cm)	P						1.000	-0.244	0.197	0.194	-0.112	0.061	0.201	0.196	0.105	0.176
	G						1.000	-0.342*	0.431**	0.456**	-0.209	0.166	0.377*	0.364*	0.21	0.328*
Leaf width (cm)	P							1.000	0.118	0.129	0.167	0.062	-0.026	-0.029	0.021	-0.011
	G							1.000	0.246	0.339*	0.444**	0.240	0.088	0.089	0.158	0.103
Panicle length (cm)	P								1.000	0.967**	-0.083	-0.174	-0.083	-0.108	-0.166	-0.078
	G								1.000	0.988**	-0.205	-0.229	-0.152	-0.187	-0.214	-0.139
Grains/panicle	P									1.000	-0.053	-0.139	-0.049	-0.072	-0.135	-0.042
	G									1.000	-0.182	-0.195	-0.108	-0.151	-0.182	-0.094
Dry matter (%)	P										1.000	0.341*	0.181	0.164	0.144	0.159
	G										1.000	0.414**	0.295	0.268	0.266	0.308*
Dry matter yield (q/ha)	P											1.000	0.932**	0.950**	0.976**	0.935**
	G											1.000	0.952**	0.965**	0.987**	0.963**
Seed index	P												1.000	0.985**	0.943**	0.990**
	G												1.000	0.991**	0.959**	0.995**
Straw yield (q/ha)	P													1.000	0.966**	0.976**
	G													1.000	0.979**	0.985**
Green fodder yield (q/ha)	P														1.000	0.951**
	G														1.000	0.967**
Grain yield (q/ha)	P															1.000
	G															1.000

*, **Significant at P=0.05 and P=0.01 levels, respectively.

TABLE 2

Phenotypic (P) and genotypic (G) path coefficients of various characters on seed yield

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	Tillers/ metre row length	Leaf : stem ratio	Leaf length (cm)	Leaf width (cm)	Panicle length (cm)	Grains/ panicle	Dry matter (%)	Dry matter yield (q/ha)	Seed index (q/ha)	Straw yield (q/ha)	Grain fodder yield (q/ha)	Grain yield (q/ha)
Days to 50% flowering	P	0.0197	-0.0275	-0.0168	-0.0293	0.0055	-0.0002	0.0002	-0.0072	0.0075	0.0002	0.0057	-0.0175	-0.0083	0.0143	-0.065
	G	0.2685	-0.2732	-0.0526	-0.022	-0.0017	-0.0161	0.0037	-0.0389	0.0836	0.0037	-0.1287	-0.0775	-0.0155	0.1329	-0.133
Days to maturity	P	0.0191	-0.0283	-0.0149	-0.0253	0.0046	-0.0003	0.0003	-0.0072	0.0074	-0.0003	-0.0048	-0.0126	0.0064	0.0127	-0.055
	G	0.2677	-0.2741	-0.0495	-0.0198	-0.0016	-0.0193	0.0003	-0.0416	0.0878	0.0019	-0.1192	-0.0633	-0.0136	0.1262	-0.118
Plant height (cm)	P	-0.0023	0.003	0.1407	0.4838	-0.0092	-0.0009	0	0.0023	-0.0016	-0.0017	0.0303	0.3259	0.0873	-0.078	0.979**
	G	-0.0587	0.0564	0.2408	0.1501	0.0015	-0.0124	-0.0031	0.0145	-0.022	-0.0081	0.4105	0.5923	0.0876	-0.4584	0.991**
Tillers/metre row length	P	-0.0012	0.0014	0.1372	0.4959	-0.0089	-0.0012	0	0.0011	-0.0005	-0.0017	0.0292	0.3302	0.0862	-0.075	0.992**
	G	-0.0387	0.0356	0.2368	0.1527	0.0015	-0.0154	-0.0032	0.0079	-0.0085	-0.0077	0.3952	0.5949	0.0861	-0.4399	0.997**
Leaf : stem ratio	P	0.0059	-0.0071	-0.0711	-0.2412	0.0183	0.0012	-0.0002	-0.0036	0.0032	0.0005	-0.0166	-0.1594	-0.046	0.0421	-0.473**
	G	0.1692	-0.1705	-0.1406	-0.0847	-0.0027	0.0133	0.0071	-0.0179	0.0322	0.0045	-0.2525	-0.3373	-0.0529	0.2775	-0.555**
Leaf length (cm)	P	0.0006	-0.0014	0.0196	0.0883	-0.0033	-0.0067	-0.0007	-0.0036	0.0035	0.0013	0.0019	0.068	0.0176	-0.0084	0.176
	G	0.0938	-0.1152	0.0647	0.051	0.0008	-0.046	0.0098	-0.032	0.0639	0.0057	0.0696	0.2277	0.0324	-0.0974	0.328*
Leaf width (cm)	P	0.0013	-0.0034	-0.0005	0.0005	-0.0011	0.0017	0.0027	-0.0021	0.0023	-0.0019	0.002	-0.0088	0.0027	-0.0017	-0.011
	G	-0.0351	0.0027	0.0258	0.017	0.0007	0.0157	-0.0285	-0.0182	0.0475	-0.0121	0.1002	0.0531	0.0079	-0.0733	0.103
Panicle length (cm)	P	0.0079	-0.0113	-0.0181	-0.0299	0.0036	-0.0013	0.0003	-0.018	0.0175	0.0009	0.0055	-0.028	-0.0097	0.0133	-0.078
	G	0.1409	-0.1537	-0.0472	-0.0164	-0.0006	-0.0198	-0.007	-0.0741	0.1383	0.0056	-0.0959	-0.0919	-0.0166	0.0989	-0.139
Grains per panicle	P	0.0082	-0.0117	0.0126	-0.0129	0.0032	-0.013	0.0004	-0.0174	0.0181	0.0006	-0.0044	-0.0168	-0.0065	0.0106	-0.042
	G	0.1604	-0.1719	-0.0379	-0.0093	-0.0006	-0.021	-0.0097	-0.0733	0.14	0.005	-0.0815	-0.0654	-0.0134	0.0842	-0.094
Dry matter (%)	P	-0.0004	-0.0007	0.0217	0.0738	-0.0008	0.0008	0.0005	0.0015	-0.001	-0.0112	0.0108	0.0611	0.0148	-0.0115	0.159
	G	-0.0369	0.0193	0.0717	0.043	0.0004	0.0096	-0.0127	0.0152	-0.0256	-0.0271	0.1728	0.178	0.0239	-0.1231	0.308*
Dry matter yield (q/ha)	P	-0.0036	0.0043	0.1351	0.4591	-0.0096	-0.0004	0.0002	0.0031	-0.0025	-0.0038	0.0315	0.3142	0.0853	-0.0776	0.935**
	G	-0.0828	0.0783	0.2368	0.1445	0.0016	-0.0077	-0.0068	0.017	-0.0273	-0.0112	0.4174	0.5739	0.0857	-0.4562	0.963**
Seed index	P	-0.001	0.0011	0.1361	0.4858	-0.0086	-0.0014	-0.0001	0.0015	-0.0009	-0.002	0.0294	0.337	0.0885	-0.075	0.99**
	G	-0.0345	0.0288	0.2366	0.1506	0.0015	-0.0174	-0.0025	0.0113	-0.0152	-0.008	0.3974	0.6029	0.088	-0.4435	0.995**
Straw yield (q/ha)	P	-0.0018	0.002	0.1369	0.4764	-0.0094	-0.0013	-0.0001	0.002	-0.0013	-0.0018	0.03	0.3322	0.0897	-0.0768	0.976**
	G	-0.0468	0.0419	0.2376	0.148	0.0016	-0.0168	-0.0025	0.0139	-0.0212	-0.0073	0.4029	0.5975	0.0888	-0.4525	0.985**
Green fodder yield (q/ha)	P	-0.0035	0.0045	0.1381	0.4676	-0.0097	-0.0007	0.0001	0.003	-0.0024	-0.0016	0.0308	0.318	0.0867	-0.0795	0.951**
	G	-0.0772	0.0748	0.2388	0.1453	0.0016	-0.0098	-0.0045	0.0159	-0.0255	-0.0072	0.412	0.5785	0.0869	-0.4622	0.967**

Residual effect : Phenotype = 0.0725 and genotype = 0.0479. *,**Significant at P=0.05 and P=0.01 levels, respectively.

TABLE 3

Phenotypic (P) and genotypic (G) path coefficients of various characters on green fodder yield

Characters		Days to 50% flowering	Plant height (cm)	Tillers/ metre row length	Leaf : stem ratio	Leaf length (cm)	Leaf width (cm)	Panicle length (cm)	Dry matter (%)	Dry matter yield (q/ha)	Green fodder yield (q/ha)
Days to 50% flowering	P	0.0013	-0.034	0.0072	0.0046	0.0006	0.0003	-0.0025	0.004	-0.1607	-0.1793
	G	0.0641	-0.0686	0.0311	-0.0452	-0.027	0.0085	0.0251	0.0197	-0.2953	-0.2875
Plant height (cm)	P	-0.0002	0.2851	-0.1187	-0.007	0.0025	0	0.0008	-0.0281	0.848	0.981**
	G	-0.014	0.3138	-0.2121	0.0419	-0.0208	-0.0069	-0.0094	-0.0427	0.9419	0.991**
Tillers per meter row length	P	-0.0001	0.2781	-0.1217	-0.0074	0.0031	0	0.0004	-0.027	0.8176	0.942**
	G	-0.0093	0.3087	-0.2156	0.0398	-0.0258	-0.0072	-0.0051	-0.0404	0.9067	0.951**
Leaf: stem ratio	P	0.0004	-0.144	0.0592	0.0153	-0.0031	-0.0003	-0.0012	0.0081	-0.4645	-0.530**
	G	0.0404	-0.1832	0.1196	-0.0717	0.0223	0.0161	0.0115	0.0239	-0.5793	-0.600**
Leaf length (cm)	P	0	0.0397	-0.0217	-0.0027	0.0176	-0.0011	-0.0012	0.0204	0.0543	0.105
	G	0.0224	0.0843	-0.0721	0.0207	-0.0772	0.0222	0.0207	0.03	0.1598	0.210
Leaf width (cm)	P	0.0001	-0.0011	-0.0001	-0.0009	-0.0043	0.0043	-0.0007	-0.0305	0.0547	0.021
	G	-0.0084	0.0337	-0.0241	0.0179	0.0264	-0.0648	0.0118	-0.0639	0.23	0.158
Panicle length (cm)	P	0.0005	-0.0367	0.0073	0.003	0.0035	0.0005	-0.0063	0.0152	-0.1541	-0.166
	G	0.0337	-0.0616	0.0231	-0.0173	-0.0333	-0.016	0.0478	0.0295	-0.22	-0.214
Dry matter %	P	0	0.044	-0.0181	-0.0007	-0.002	0.0007	0.0005	-0.1817	0.3018	0.144
	G	-0.0088	0.0934	-0.0608	0.012	0.0162	-0.0289	-0.0098	-0.1433	0.3965	0.266
Dry matter yield (q/ha)	P	-0.0002	0.2737	-0.1127	-0.008	0.0011	0.0003	0.0011	-0.0621	0.8831	0.976**
	G	-0.0198	0.3086	-0.2041	0.0434	-0.0129	-0.0156	-0.011	-0.0593	0.9578	0.987**

Residual effect : Phenotype = 0.0664 and genotype = 0.03316. **Significant at P=0.01 level.

to 50 per cent flowering was negatively associated with green fodder yield which was due to the negative indirect effects of dry matter yield (q/ha). These results are in accordance with earlier findings of Bhandari *et al.* (2003), Pundir *et al.* (2003) and Pundir *et al.* (2005) and Singh and Singh (2011). They found significance of plant height, leaf length, leaf width, stem girth, green and dry leaf and stem weight and dry yield for improvement of green fodder yield.

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