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Comprehensive Study of Selection Parameters in Oat Genotypes for Fodder and Grain Yield

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ABSTRACT: The correlation and path coefficient analysis is most important selection parameters for oat improvement. Proper study of these selection parameters has not been made earlier. That's the reason oat improvement not getting a flow for its improvement. So the goal of this study was to determine the characters association in order to identify suitable genotypes for future breeding programmes of oat improvement. The current study was conducted during the rabi seasons of 2021 at the CSAUA&T, Kanpur. The experiment was set up in a three-replication using randomized block design, with a plot size of 3 ×1 m^2 and row-to-row and plant-to-plant spacing of 30 and 5 cm, respectively. Grain yield per plant showed positive and significant correlation with dry weight, harvest index at both genotypic and phenotypic level. Fodder yield/fresh weight per plant showed positive significant correlation with plant height, tiller per plant, leaf per plant, leaf length, leaf width at both genotypic and phenotypic levels. Phenotypic path coefficient analysis values revealed high direct effects on grain yield per plant were exerted by leaf area, dry weight and harvest index and at genotypic level high direct effect on grain yield per plant were exerted by plant height, leaf area index, dry weight, harvest index indicating the best selection indices for future breeding programme to increase fresh fodder yield and seed yield in oat genotypes.

Keywords: Path coefficient, Correlation coefficient.

INTRODUCTION

The common oat (*Avena sativa* L.) is cereal crop grown primarily for its green fodder and grains. Oats grain are suitable for human consumption whereas green and dry fodder is used as livestock feed. It belongs to family Poaceae and has three naturally occurring ploidy levels namely; diploid (2n=2x=14 having A and C genome), tetraploid (2n=4x= 28 with AB and AC genome) and hexaploid (2n=6x=42 containing ACD genome) (Loskutov, 2008). Oat is grown in 25.3 m ha area of the world producing 49.6 mt. of grains globally with a productivity of 1963 kg per hectare. The country's total oat-growing area is estimated to be around 5,000 acres. Uttar Pradesh has the most area under cultivation (34 percent), followed by Punjab (20 percent), Bihar (16 percent), Haryana (9 percent), and Madhya Pradesh (6 percent) (IGFRI, 2019).Whole (unhusked) oats produce/feeds have a high protein (12%), fat (5%), fibre (12–15%), and carbohydrate content when compared to other grains (about 64 percent).Oat green fodder contains 20 % dry matter, 10 % crude protein and 91 % organic matter. Oat straw is more nutritious and palatable than wheat straw as well as an important supplementary feed. It contains high amount of important vitamins and minerals such as vitamin E, Vitamins B, calcium, phosphorus, magnesium and potassium. The amino acid profile of proteins in oats kernel is considered to be in perfect proportion (Nanda *et al.*, 2017). Oat protein is nearly equivalent in quality to soy protein, meat, milk and egg proteins which has been reported by WHO. The protein content of the hull-less oat kernel ranges from 12 to 24 per cent, which is the highest among cereals (Lasztity, 1999). Oat is also an important winter forage crop in many parts of the world. It includes total dietary fibre, including the soluble fibre -glucan, and is high in antioxidants such as -tocotrienol, -tocopherol, and avenanthramides, unlike other cereal grains such as wheat and barley (Oliver *et al.*, 2010). Animal feeding systems are primarily based on grazed native grasslands, which are declining in terms of productivity and quality, as well as varying seasonally, resulting in poor animal performance. Despite the importance of livestock, poor animal nutrition is a prevalent problem in developing nations and a key stumbling block to the development of viable livestock industry. In India, the available feed supply is only one-third of what animals require (Younas and Yaqoob 2005). In order to harness potential production of oat, it is facing number of constraints including biotic, abiotic and agronomic stress. The study was conducted to vanquish all these hurdles and provide all necessary information regarding character association present in germplasm for researchers to speedup breeding programme for both fodder and seed production.

MATERIAL AND METHODS

The current study was conducted during the rabi seasons of 2021 at the CSAUA&T, Kanpur, student instructional farm plot No. 41. The 38 genotypes were obtained from the Jhansi-based Indian Grassland and Fodder Research Institute. The experiment was set up in a three replication using randomized block design, with a plot size of 3 × 1 m^2 and row-to-row and plant-to-plant spacing of 30 and 5 cm, respectively. Observations were recorded for: Days to 50% flowering, plant height (cm), tillers per plant, leaves per plant, leaf length (cm), leaf width (cm), fresh plant weight (g), leaf area (cm^2), leaf area index, dry weight/plant (g), HI (percent), and grain yield per plant were all measured on three randomly selected competitive plants in each replication (g). The phenotypic, genotypic, and environmental coefficients of correlation were calculated using Al-Jibouri *et al.* (1958) technique. The significance of the phenotypic coefficient of correlation at (g–2) degrees of freedom and the environmental coefficient of correlation at [(r–1) (g–1) –1] degrees of freedom, where r and g stand for number of replication and genotypes, respectively, was tested against the table (r) values of correlation coefficients at a 5% level of significance (Fisher and Yates 1963). The path coefficient is a standardized partial regression coefficient that allows the direct and indirect effects of a set of variables (component characters) on a dependent variable to be partitioned. As recommended by Dewey and Lu (1959), direct and indirect effects of component characters on green forage yield were calculated using appropriate correlation coefficients of distinct component characters.

RESULT AND DISCUSSION

The following are some of the components of the current study that have been discussed: correlation studies, and path coefficient analyses, with list of potential genotypes for each character. On the basis or mean performance of all 38 genotypes for all 12 features the observed potential genotype can be used for breeding programs are given in Table 1. The efficiency of any breeding or selection programme is determined by the type and relationship between yield and other characteristics. The coefficients of correlation are provided in Table 2. The phenotypic and genotypic path coefficient analysis is given Table 3 and 4 respectively.

Correlation Analysis: The Correlation studies provide details about the nature and magnitude of the association of different component characters with grain yield. Ultimately this could help the breeder to design selection strategies to improve grain and green fodder yield. Genotypic correlation coefficient was generally higher than phenotypic correlation coefficient for all the traits combination. High genotypic correlation compared to its respective phenotypic correlation Kumar *et al*. (2016). Low phenotypic correlations can be explained due to masking or modifying effects of environment on genetic association between characters. These results are in accordance with reports of Krishna *et al*. (2014); Poonia *et al*. (2018); Negi *et al*. (2019); Gandahi *et al.* (2021); Altuner (2021).

Table 1: On the basis of the mean values of each attribute, potential genotypes were found.

Sr. No.	Characters	Genotypes
1.	Plant height(cm)	OS-403,HJ-8,RO-19,NDO-2, OL-14, JHO-2010-1, etc.
2.	Tillers per plant	PS-7, OL-1869-1/OL-13,OS-403, HO-851, OS-377,,
3.	Leaves per plant	UPO-94, RO-19, OL-14, OL-1760/OL-11, OL-10,
4.	Leaf length(cm)	HJ-8,NDO-711, OL-1804, OS-377, PLP-1,
5.	Leaf width(cm)	HJ-8,NDO-711, OL-1804, OS-377, PLP-1,
6.	Fresh weight (g)	OS-403, HJ-8, NDO-711, RO-19, OL-804,
7.	Leaf area(cm2)	HJ-8, NDO-711, OS-377, PLP-1, RO-19,OL-14,
8.	Leaf area index	HJ-8, NDO-711, OS-377, PLP-1, RO-19, OL-14,
9.	Dry weight (g.)	OL-424,OL-1902-1/OL-12,OS-403,NDO-10,
10.	Harvest index (g)	NDO-2.
11.	Days of 50% flowering	OL-1869-1/OL-13,OL-1769-1,NDO-711,OL-1804,
12.	Grain weight (g)	OS-424,OS-403,OL-1804,RO-19,OL-10,OS-346.

Table 2: Analyses of the correlation coefficient between several variables in oat genotypes at the phenotypic (upper diagonal) and genotypic (lower diagonal) levels.

PG	Plant height (cm)	Tillers per plant	Leaves per plant	Leaf length (cm)	Leaf width(cm)	Fresh weight (g)	Leaf area (cm^2)	Leaf area index	Dry weight (g.)	Harvest index (g)	Days of 50% flowering	Grain weight (g)
Plant height(cm)		-0.028	0.270	0.593*	0.256	0.639*	0.495*	0.509*	0.307*	-0.064	0.040	0.232
Tillers per plant	-0.026		0.801*	0.169	0.018	0.414*	0.531*	0.523*	-0.105	-0.066	0.022	-0.188
Leaf per plant	0.308*	0.788*		0.408*	0.178	0.726*	0.772*	0.772*	0.140	-0.241	0.060	-0.108
Leaf Length(cm)	0.604*	0.183	0.460*		0.274	0.494*	0.599*	0.598*	0.121	-0.038	-0.111	0.014
Leaf width(cm)	0.267	0.039	0.227	0.278		0.461*	0.552*	0.566*	-0.036	-0.189	0.174	-0.285
Fresh weight (g)	0.655*	0.457*	0.812*	0.513*	0.497*		0.862*	0.876*	0.248	-0.356*	0.171	-0.111
Leaf area(cm^2)	0.502*	0.599*	0.866*	0.619*	0.590*	0.897*		0.986*	0.150	-0.280	0.115	-0.160
Leaf area index	0.513*	0.590*	0.856*	0.613*	0.591*	0.904*	1.000		0.187	-0.316*	0.124	-0.168
Dry weight (g.)	0.309*	-0.128	0.153	0.124	-0.027	0.257	0.155	0.189		-0.486*	0.134	0.531*
Harvest index (g)	-0.063	-0.077	-0.272	-0.039	-0.194	-0.367	-0.283	-0.318*	-0.494*		-0.204	0.412*
Days of 50% flowering	0.039	0.010	0.042	-0.120	0.193	0.184	0.123	0.129	0.139	-0.212		0.007
Grain weight (g)	0.231	-0.205	-0.111	0.019	-0.296	-0.122	-0.165	-0.171	0.538*	0.417*	0.011	

* Significant at 5%

Correlation between grain yield and its associated traits: At genotypic level the grain yield per plant showed a positive and significant correlation with plant dry weight (0.538), harvest index (0.417). Negative non-significant correlation with grain yield is reported with tiller per plant (-0.205), leaf per plant (-0.111), leaf width (-0.296), leaf area (-0.165), leaf area index (-0.171) and non-significant positive correlation observed with leaf length (0.019), days of 50% flowering (0.011). Similar result were observed by Deep *et al* (2019); Tessema and Getinet (2020); Mecha *et al*. (2017); Baye *et al*. (2020) for harvest index. Bibi *et al.* (2012), Kumar *et al.* (2016) for tillers per plant. At phenotypic level the grain yield per plant showed a positive and significant correlation with plant dry weight (0.531), harvest index (0.412). Negative non-significant correlation with grain yield is reported with tiller per plant (-0.188), leaf per plant (-0.108), leaf width (-0.285), leaf area (-0.160), leaf area index (-0.168) and Non-significant positive correlation observed with leaf length (0.014), days of 50% flowering (0.007). The correlation result for one or more characters observed in study in accordance to the finding of Nehvi *et al.* (2000); Choubey *et al.* (2001; Tiwari and Pandey (2014); Kumar *et al.*, (2004); Bibi *et al.* (2012) also reported same result for tiller per plant.

Correlation between green fodder/fresh weight yield and its component traits: After grain yield green fodder yield is the second most important traits in which breeders are interested to improve. Oat as a fodder has more desirable in relation of its palatable and nutritional quality compared to the other crop straw. Fodder yield association studied on total six characters. At genotypic level for green fodder/fresh weight the positive and significant correlation were observed with plant height (0.655), tillers per plant (0.457) leaf per plant (0.812), leaf length (0.513) and leaf width (0.497). For tiller per plant similar result were observed by Gandahi *et al*. (2021). At phenotypic level for green fodder /fresh weight the positive and significant correlation were observed with plant height (0.639), tillers per plant (0.414), leaf per plant (0.726), leaf length (0.494), leaf width (0.461). At both genotypic and phenotypic level positive and significant correlation for green fodder /fresh weight, the similar result were observed by Bibi *et al.* (2012) for number of tillers per plant, Dubey *et al.* (2014) for tillers per plant, leaf per plant, Devi *et al*. (2018) for tillers per plant, leaf per plant, Choudhary *et al*. (2020) for plant height, Negi *et al.* (2019) for tillers per plant.

Path Coefficient analysis: Path coefficient analysis Wright, (1921), Dewey and Lu, (1959) is useful for partitioning correlations into direct and indirect effects of a single causal factor, determining the degree of relationship between yield and its component effects, and examining specific factors that provide a given correlation.

The direct genotypic effect on grain yield were exerted by leaf per plant (0.585), Leaf area index (1.417), dry weight (0.886), harvest index (0.895). The negative significant direct effect observed by fresh weight (-0.359), leaf area (-1.652). Positive non-significant direct effect observed for plant height (0.198), leaf width (0.037), Days of 50% flowering (0.118) and negative non-significant effect were observed for characters tillers per plant (-0.149), leaf length (-0.074). The result observed in study in accordance to the finding of Dubey *et al*. (2014); Krishna *et al*. (2014);

Jaipal and Shekhawat (2016).

At phenotypic level the direct positive significant effect on grain yield were observed by leaf area (0.447), dry weight (0.926), harvest index (0.840). The negative significant direct effect observed for leaf area index (0.440). The negative non-significant direct effect observed for character tiller per plant (-0.046), leaf length (-0.067), leaf width (-0.077), fresh weight (-0.016) and positive non- significant direct effect observed for plant height (0.080), leaf per plant (0.066), days of 50% flowering (0.068).

Table 3: Assessments of the direct and indirect effects of various features on grain production in oat genotypes at the phenotypic level.

	Plant height (cm)	Tillers per plant	Leaf per plant	Leaf length (cm)	Leaf width (cm)	Fresh weight (g)	Leaf area (cm^2)	Leaf area index	Dry weight (g.)	Harvest index (g)	Days of 50% flowering	Phenotypic correlation with grain yield/plant
Plant height(cm)	**0.080**	0.001	0.018	-0.040	-0.020	-0.010	0.221	-0.252	0.284	-0.053	0.003	0.232
Tillers per plant	-0.002	**-0.046**	0.053	-0.011	-0.001	-0.007	0.237	-0.259	-0.098	-0.055	0.002	-0.188
Leaf per plant	0.021	-0.037	**0.066**	-0.027	-0.014	-0.012	0.345	-0.382	0.130	-0.202	0.004	-0.108
Leaf length(cm)	0.047	-0.008	0.027	**-0.067**	-0.021	-0.008	0.267	-0.296	0.112	-0.032	-0.008	0.014
Leaf width(cm)	0.020	-0.001	0.012	-0.018	**-0.077**	-0.008	0.247	-0.280	-0.003	-0.159	0.012	-0.285
Fresh weight (g)	0.051	-0.019	0.048	-0.033	-0.036	**-0.016**	0.385	-0.433	0.230	-0.299	0.012	-0.111
Leaf area(cm^2)	0.039	-0.025	0.051	-0.040	-0.043	-0.014	**0.447**	-0.488	0.139	-0.235	0.008	-0.160*
Leaf area index	0.041	-0.024	0.051	-0.040	-0.044	-0.014	0.440	**-0.495**	0.173	-0.265	0.008	-0.168*
Dry weight (g.)	0.024	0.005	0.009	-0.008	0.003	-0.004	0.067	-0.093	**0.926**	-0.408	0.009	0.531*
Harvest index (g)	-0.005	0.003	-0.016	0.003	0.015	0.006	-0.125	0.156	-0.450	**0.840**	-0.014	0.412*
Days of 50% flowering	0.003	-0.001	0.004	0.007	-0.013	-0.003	0.051	-0.061	0.124	-0.171	**0.068**	0.007

*Significant at 5%; Bold values showed direct effect

Table 4: Assessments of the direct and indirect effects of various features on grain production in oat genotypes at the genotypic level.

	Plant height (cm)	Tillers per plant	Leaf per plant	Leaf length (cm)	Leaf width (cm)	Fresh weight (g)	Leaf area (cm^2)	Leaf area index	Dry weight (g.)	Harvest index (g)	Days of 50% flowering	Genotypic correlation with grain yield/plant
Plant height(cm)	**0.198**	0.004	0.180	0.044	0.010	-0.235	-0.829	0.727	0.273	-0.057	0.005	0.231
Tillers per plant	-0.005	**-0.149**	0.461	-0.013	0.001	-0.164	-990	0.835	-0.113	0.069	0.001	-0.205
Leaf per plant	0.061	-0.117	**0.585**	-0.034	0.008	-0.292	-1.431	1.212	0.135	-0.244	0.005	-0.111
Leaf length(cm)	0.119	-0.027	0.269	**-0.074**	0.010	-0.184	-1.023	0.868	0.110	-0.035	-0.014	0.019
Leaf width(cm)	0.053	-0.006	0.133	-0.020	**0.037**	-0.179	-0.975	0.837	-0.024	-0.174	0.023	-0.296
Fresh weight (g)	0.130	-0.068	0.475	-0.038	0.019	**-0.359**	-1.483	1.281	0.228	-0.328	0.022	-0.122
Leaf area(cm^2)	0.099	-0.089	0.506	-0.046	0.022	-0.322	**-1.652**	1.417	0.138	-0.253	0.014	-0.165
Leaf area index	0.102	-0.088	0.500	-0.045	0.022	-0.325	-1.653	**1.417**	0.168	-0.284	0.015	-0.171
Dry weight (g.)	0.061	0.019	0.089	-0.009	-0.001	-0.092	-0.257	0.268	**0.886**	-0.442	0.016	0.538
Harvest index (g)	-0.013	0.011	-0.159	0.003	-0.007	0.132	0.467	-0.450	-0.437	**0.895**	-0.025	0.417
Days of 50% flowering	0.008	-0.001	0.025	0.009	0.007	-0.066	-0.203	0.183	0.123	-0.190	**0.118**	0.011

*Significant at 5%
Bold values showed direct effect

CONCLUSION

On the basis of mean performance, genotypes OS-403, HJ-8, NDO-711, RO-19, OL-804, OS-377,RO-19,OL-14, OL-1760/OL-11,OL-10, CSAOFC-14-4, JHO-2010-1, NDO-10, UPO-212, OL-1802, OL-1876-2, UPO-06-1, OS-405, RO-11-1, OS-346 were found superior for fresh fodder yield compared to the best checks (KENT and OS-6) and OS-424, OS-403, OL-1804, RO-19, OL-10, OS-346 for grain yield per plant as compared to the best checks (KENT). After a detailed study of genotypic and phenotypic coefficient with path coefficient analysis for both grain and green fodder/fresh weight by selecting 12 characters on 38 germplasm of oat we observed some of characters are best selection parameters. As a result, the optimal selection indices dry weight, harvest index, plant height, tiller per plant, leaf per plant, leaf length, leaf width, leaf area, ,leaf area index for improving both green fresh fodder yield/fresh weight and seed yield per plant would be these. The study provides the opportunity to identify suitable genotypes and selection parameter to be used in future breeding programme.

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Conflict of Interest. None.

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