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# GENETIC VARIABILITY AND ASSOCIATION STUDY FROM EXOTIC GERMPLASM ACCESSIONS IN FODDER OATS (*AVENA SATIVA* L.)

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## SUMMARY

The present study was conducted with 25 exotic germplasm accessions along with three checks at Forage Research Farm, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana during *Rabi* season 2019-2020. The objective of the study was to determine the extent of correlation among green fodder yield with contributing traits and their effects. The high value of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) was observed for number of leaves followed by green fodder yield and number of tillers. High heritability was estimated for percent crude protein content (99.68%), number of leaves (97.84%) and acid detergent fiber (97.09%). Higher genetic advance was observed for number of leaves (98.70%) and green fodder yield (79.38%). Traits like plant height (0.533), leaf length (0.416) and leaf width (0.292) had positive and significant correlation with green fodder yield. Positive and direct effect of plant height (0.942) and number of leaves (0.218) on green fodder yield. The results suggest that traits like plant height, leaf length and leaf width are the main fodder yield components. So, selection for these traits should be practised in future breeding programme for improving the green fodder yield in oats.

**Key words :** Oats, Association studies, Heritability, Genetic advance, Path analysis

Oats (*Avena sativa* L.) is an important winter cereal crop which belongs to the genus *Avena* and family Poaceae. The cultivated oats are allohexaploid (2n=6x=42) with a basic chromosome number of n=7. Oats are mainly cultivated for fodder purpose to fulfill the need for green fodder of the livestock animals as it contains high amount of proteins, minerals and fiber (Kumar *et al.,* 2010). Oats contain around 11-15% protein and it has relatively well balanced amino acid composition (Poonia *et al.*, 2017). In global scenario, Oats ranks sixth in production after wheat, maize, rice, barley and sorghum. Oats grains are rich in nutrients such as phosphorous, zinc, calcium, manganese, silicon and in some vitamins such as A, $B_1$, $B_2$ and E (Krishna *et al.*, 2014).

As the demand for the green fodder has been increasing, there is a greater need to identify the superior germplasm lines which have the potential to meet this increasing demand in the future. So, there is a major challenge for oat breeders to identify the potential donors with good genetic make-ups that are superior in green fodder yield. The basic requirement to cope with this challenge is to have adequate information about heritability, variability and degree of association among different traits (Kapoor, 2018). The expected improvement of a trait under consideration can be evaluated by the genotypic coefficient of variation (GCV) and heritability estimates together as suggested by the Burton and De Vane (1953). To make the selection effective, the assessment of genetic parameters such as phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance is a pre-requisite. The causes of correlation between characters are mainly linkage or pleiotropy. Recombination can help to overcome the correlation due to linkage but it would be impossible to overcome the correlation due to pleiotropy (Kumar *et al.*, 2016).

Determination of correlation helps in taking the decision related to selection strategies. Simple correlation coefficients provide association (positive and negative) between characters but it does not give causal basis of such associations. Path analysis provides the information on direct and indirect effects of various independent components on the dependent character (Poonia *et al.,* 2017). So, taking all these aspects into consideration, an attempt was made to study the genetic variability, correlation and path coefficient analysis in a set of 25 exotic germplasm lines of oats.

## MATERIALS AND METHODS

The present study was conducted during the *Rabi* season of 2019-2020 with 25 exotic genotypes being maintained at Forage Section, Punjab Agricultural University, Ludhiana and is situated at 30.56° N latitude, 75.52° E longitude, at an height of 247 m above mean sea level and represents the Indo-Gangetic Alluvial Plains. The average annual rainfall of the area is 705 mm and a greater amount is received during the monsoon season *i.e.* from July to September. The weather was favourable during the growth period of the crop. The material was evaluated in randomized block design (Panse and Sukhatme, 1985) in single row of two meter with row to row spacing 30 cm along with three checks *i.e.* OL-10, OL-1876-2 and UPO-212 in three replications. Recommended package of practices was followed to raise a good crop. Observations were recorded on five random plants selected from each entry for nine quantitative characters *viz.,* plant height (cm), leaf length (cm), leaf width (cm), number of leaves, number of tillers, ADF%, percent crude protein content (A.O.A.C., 1990) and green fodder yield (kg/plot). The data was analyzed for correlation and path coefficient study. Statistical procedure for estimating phenotypic and genotypic coefficient of variation (Burton and De Vane (1953), heritability in broad sense (Hanson *et al.,* 1956), genetic advance (Allard, 1960), correlation (Johnson *et al.,* 1955) and path analysis (Dewey and Lu, 1959) were followed in the present study.

## RESULTS AND DISCUSSION

Green fodder yield is a complex trait and it is affected by many characters. Being a quantitative trait, it is affected by the different environments. So, there is a need to deeply understand the interrelationship between green fodder yield and its contributing traits.

### Genetic Variability

The estimates of phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the traits under study (Table 1), which indicates the influence of environment on the expression of these traits. The highest value of PCV was observed for number of leaves (51.95) followed by green fodder yield (40.85) and number of tillers (32.26). The highest value of GCV was observed for number of leaves (51.38) followed by green fodder yield (39.68) and number of tillers (30.92). These results were in the accordance to the results obtained by Wagh *et al.* (2018) and Singh and Singh (2010). The low GCV was observed for leaf width (8.15) followed by plant height (12.94) and leaf length (13.93). Kapoor (2018), Shankar *et al.* (2002) also reported low value of GCV for the characters such as leaf width and plant height in fodder oats. Above results suggested that due to higher values

TABLE 1

Estimates of various variability parameters for eight different traits in set of exotic germplasm accessions for fodder oats

| Traits | $h^2$ (%) | GA (%) | PCV | GCV | GM | Range | |
|---|---|---|---|---|---|---|---|
| | | | | | | Min. | Max. |
| PH | 63.63 | 21.26 | 16.22 | 12.94 | 58.23 | 42.33 | 74.67 |
| LL | 49.44 | 20.18 | 19.82 | 13.93 | 39.83 | 26.33 | 55.17 |
| LW | 22.28 | 8.15 | 17.28 | 8.27 | 1.44 | 1.20 | 1.87 |
| NOL | 97.84 | 98.70 | 51.95 | 51.38 | 22.44 | 11.67 | 53.33 |
| NOT | 91.82 | 61.03 | 32.26 | 30.92 | 19.15 | 12.67 | 32.67 |
| ADF | 97.09 | 32.32 | 16.16 | 15.92 | 0.49 | 0.34 | 0.69 |
| CP | 99.68 | 51.87 | 25.26 | 25.22 | 11.99 | 8.30 | 6.26 |
| GFY | 94.32 | 79.38 | 40.85 | 39.68 | 1238.33 | 781.67 | 2196.67 |

PH= plant height (cm), LL= leaf length (cm), LW= leaf width (cm), NOL= number of leaves, NOT= number of tillers/plant, ADF= acid detergent fibre (%), CP= crude protein (%), GFY= green fodder yield (gm/plot), h2= heritability in broad sense, GA (%) = genetic advance percent over mean, PCV= phenotypic coefficient of variation, GCV= genotypic coefficient of variation, GM= grand mean.

of PCV and GCV for number of leaves, green fodder yield and number of tillers, so selection for these traits will be effective in future for increasing the green fodder yield.

**Heritability and Genetic Advance**

Perusal from the Table 1 indicates that high heritability was present for the characters such as percent crude protein content (99.68%) followed by number of leaves (97.84%) and ADF (97.09%), whereas moderate heritability was present for the characters such as plant height (63.63%) and number of leaves (49.44%), whereas low heritability was recorded for leaf width (22.28%). Similar results were reported by Krishna *et al.* (2014).The highest genetic advance was observed for number of leaves (98.70%) and green fodder yield (79.38%) whereas moderate genetic advance was recorded for number of tillers (61.03%). The low genetic advance was recorded for leaf width (8.15%) and leaf length (20.18%). Kapoor *et al.* (2011) also reported similar results in their study.

In the present study, high heritability combined with high genetic advance for number of leaves as well as number of tillers was observed, which were important parameters for improvement in green fodder yield. So, more focus should be directed towards the improvement of these traits so that green fodder yield can be ultimately increased. From these results, it can be concluded that there is low environmental influence on these traits and genes act additively in the expression of these traits. Moderate or low heritability combined with low genetic advance were recorded for the leaf width which indicates that this trait is governed by non- additive gene action and there is a greater environmental influence on the expression of this trait. So, direct selection for leaf width would not improve green fodder yield.

**Genotypic and Phenotypic correlation**

Green fodder yield is a complex trait affected by the number of other traits which might have positive as well as negative effects on this trait. So, for improvement in green fodder yield and its components, knowledge of the mechanism of association, effects and cause of relationship will be helpful for the selection of breeding method for increasing green fodder yield.

Correlation analysis clearly revealed that the magnitude of phenotypic correlation is lower than the genotypic correlation but they have similar trend in direction. Low phenotypic correlation means that the expression of these traits is influenced by the environment. Correlation coefficient among various traits is presented in the Table 2. Green fodder yield had significantly high and positive correlation with plant height (0.533) followed by leaf length (0.416) and leaf width (0.292) which indicates that direct selection for these traits will be helpful for the improvement of green fodder yield in oats. Similar results were obtained by Rohila *et al.* (2020) in

TABLE 2

Genotypic and phenotypic correlation coefficient among various traits in a set of exotic germplasm accessions of fodder oats

| Traits | | PH | LL | LW | NOL | NOT | ADF | CP |
|---|---|---|---|---|---|---|---|---|
| LL | G | 0.629** | | | | | | |
| | P | 0.409** | | | | | | |
| LW | G | 0.748** | 0.058 | | | | | |
| | P | 0.309** | 0.208 | | | | | |
| NOL | G | 0.063 | 0.290** | 0.320** | | | | |
| | P | 0.078 | 0.215* | 0.144 | | | | |
| NOT | G | 0.390** | 0.073 | 0.449** | -0.108 | | | |
| | P | 0.340** | 0.078 | 0.231* | -0.090 | | | |
| ADF | G | 0.413** | 0.178 | 0.474** | -0.007 | 0.389** | | |
| | P | 0.331** | 0.134 | 0.255* | -0.010 | 0.362** | | |
| CP | G | 0.044 | 0.038 | -0.164 | 0.435** | -0.129 | -0.086 | |
| | P | 0.035 | 0.035 | -0.083 | 0.431** | -0.123 | -0.086 | |
| GFY | G | 0.738** | 0.590** | 0.611** | 0.012 | 0.272** | 0.217* | -0.291** |
| | P | 0.533** | 0.416** | 0.292** | 0.008 | 0.260* | 0.203 | -0.281** |

Critical value of r @ 5% =0.21 and at 1% = 0.27 *Significant at 5% and **Significant at 1% level of significance respectively.

TABLE 3

Path coefficient analysis for direct (diagonal and bold) and indirect effects on Green fodder yield (g/plot) in a set of exotic germplasm accessions for fodder oats

| Traits | PH | LL | LW | NOL | NOT | ADF | CP | Genotypic correlation with GFY |
|---|---|---|---|---|---|---|---|---|
| PH | **0.942** | -0.010 | -0.136 | 0.013 | -0.000 | -0.050 | -0.021 | 0.738** |
| LL | 0.593 | **-0.015** | -0.010 | 0.063 | -0.000 | -0.021 | -0.018 | 0.590** |
| LW | 0.705 | -0.000 | **-0.182** | 0.070 | -0.000 | -0.057 | 0.077 | 0.611** |
| NOL | 0.059 | -0.004 | -0.058 | **0.218** | 0.000 | 0.008 | -0.204 | 0.012 |
| NOT | 0.367 | -0.001 | -0.082 | -0.023 | **-0.001** | -0.047 | 0.060 | 0.272** |
| ADF | 0.389 | -0.002 | -0.086 | -0.001 | -0.007 | **-0.121** | 0.040 | 0.217* |
| CP | 0.042 | -0.000 | 0.030 | 0.095 | 0.002 | 0.010 | **-0.469** | 0.291** |

*Significant at 5% and **Significant at 1% level of significance respectively.

sorghum, Moushtaq *et al.* (2013), Poonia *et al.* (2017) in oats. It was also noted that traits like per cent crude protein content has negative correlation with green fodder yield and similar observations reported by Moushtaq *et al.* (2013). Traits such as number of leaves, crude protein, plant height, ADF, leaf length and leaf width showed positive and high significant correlation among each other. Surje and De (2014) and Kumar *et al.* (2016) also reported similar results. Some other traits such as leaf width, crude protein, number of leaves and number of tillers had negative and non- significant correlation among each other. Above results indicates that selection for higher green fodder yield should be focused on plant height, leaf length and leaf width as taller plants will bear more number of leaves and would result in higher biomass production in oats.

**Path coefficient analysis**

Correlation coefficient analysis provides knowledge about the relationship among the traits but does not tell about the extent of their relationship. So, Path coefficient analysis carried out to determine the extent of relationship among traits by taking green fodder yield as dependent variable and other traits as independent variable. At genotypic level (Table 3) highest direct effect on green fodder yield was exerted by plant height (0.942) followed by number of leaves (0.218). The results of the present study are similar to the results obtained by Kapoor (2018), Surje and De (2014), Kakad *et al.* (2017). Indirect positive effects on green fodder yield were revealed by leaf width (0.705), followed by leaf length (0.593), ADF% (0.389) and number of tillers (0.367) via plant height (0.942). So, selection criteria for improving the fodder yield will be focus on plant height, leaf width and leaf length in future breeding programme.

## CONCLUSION

Selection criteria for plant height, leaf length and leaf width will be significant for the improvement of green fodder yield in the material under study. At the same time, selection for quality traits such as crude protein and ADF will adversely affects the green fodder yield due to strong negative correlation of these traits with green fodder yield.

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