*Forage Res.,* **50**(1) : pp. 15-19 (2024) **http://forageresearch.in**

# VARIABILITY STUDIES IN OAT ACCESSION (*AVENA SATIVA* (L.)) UNDER DIFFERENT LOCATIONS

**NEHA BELSARIYA[1]*, MAYURI SAHU[2], SUJIT[3] AND ANJALI KAK[4]**

[1,2&3]Department of Genetics and Plant Breeding, COA, IGKV, Raipur-492012 (Chhattisgarh) India
[4] Division of Germplasm Conservation, National Bureau of Plant Genetic Resources
*(*e-mail: nehabelsariya@gmail.com*)

**(Received: 10 May 2024; Accepted: 15 June 2024)**

## SUMMARY

An experiment comprising 32 different genotypes of oat was conducted during *rabi* 2021 in four different environments. In each environment each genotype was sown in a two-row plot of 2.5m length in randomised block design with two replications. Observations of five randomly plants of each genotype in each replication were recorded on ten different characters *viz.,* days to 50% flowering, plant height(cm), leaf length (cm), leaf width (cm), number of tillers per plant, green fodder yield (gm), leaf dry weight per plant (gm), stem dry weight per plant (gm), leaf stem ratio, dry matter weight (gm), days to maturity and plant population. Analysis of variance revealed that significant differences existed among genotypes for all the characters in all four environments. High estimates of broad sense heritability along with high estimates of genetic advance as percent of mean was observed for green forage yield, leaf dry weight, stem dry weight, leaf stem ratio in all the three environments.

**Key words:** Oat, Variability, Heritability, Genetic advance

## INTRODUCTION

Oats (*Avena sativa* L.) 2n = 6x = 42, is a western Mediterranean cereal crop with a moderately agricultural history, since its cultivation had started. The genus Avena is large and diverse and contains both wild and cultivated species of polyploidy series. Its stem or culm is composed of a series of nodes and internodes. The nodes are solid, the elongated internodes of the mature stem are hollow in the center but during early vegetative stage of development the internodes are solid or show only a slight indication of the breakdown of pith (Wagh, 2018). Oat is regarded as most important cereal crop throughout the world and used as an important source of essential nutrients for human consumption (Boczkoswka and Tarczyk, 2013). Increased oat consumption is often enhanced due to nutritional attributes including antioxidants and high soluble fiber (Rasane *et al*., 2015). The actual health benefits of oat are attributed to its high dietary fiber content (33 per cent) as compared to other cereal grains. Due to its excellent growth habit, it is very much popular as forage. It ranks sixth in cereal production globally following wheat, maize, rice, barley and sorghum (FAO 2011). In many parts of the world oat is grown as multipurpose crop for grain, pasture, and forage crop. It is one of the best dual purpose cereal crops that fit well into the platter of human and cattle as well.

To reach this goal, the basic requirements are to have adequate information on the extent of variability, heritability, expected genetic gain and degree of genetic association among the different characters. Burton and Devane (1953) suggested that genotypic coefficient of variation (GCV) together with heritability estimates would give reliable indication about the expected improvement of a trait under consideration. The indirect selection through less complex traits with larger heritability, however results in larger genetic progress when compared to direct selection. Considerable significance has been devoted to studies involving correlation of traits in breeding programs.

## MATERIALS AND METHODS

The experiment was conducted during *rabi* season of 2021-22 with 32 diverse genotypes were grown in a randomized block design (RBD) with two replications in four different environments *viz.,* EI at Research cum instructional farm, Department of Genetics and Plant Breeding, IGKV, Raipur Chhattisgarh, E II at SK CARS, Kawardha, Chhattisgarh, E III at RMD CARS, Ambikapur, Chhattisgarh and E IV at SG CARS, Jagdalpur, Chhattisgarh. Chhattisgarh is located between 17°14′N and 24°45′N latitudes and 79°16′E and 84°15′E longitudes. Recommended agronomic practices and plant protection measures were adopted to raise the uniform crop stand. At each location, observations were recorded on five randomly selected competitive plants from each genotype from each replication on 12 different morphological characters *viz*., days to 50% flowering, plant height (cm), leaf length (cm), leaf width (cm), number of tillers per plant, green fodder yield (gm), leaf dry weight per plant (gm), stem dry weight per plant (gm), leaf stem ratio, dry matter weight (gm), days to maturity and plant population. The mean values computed from the observations for each replication from each location were used for statistical analysis. The Analysis of variance (ANOVA) was done following the method given by Fisher (1920). The phenotypic and genotypic coefficient of variability (PCV, GCV) were computed according to the method suggested by Burton (1952), heritability ($h^2$) and genetic advance as percent of mean (GA) as suggested by Allard (1960).

## RESULTS AND DISCUSSION

The results of analysis of variance for environment (E I, E II, E III and E IV) are presented in (Table 1) and revealed that significant genotypic differences existed for all the characters studied across the environments. It is evident from analysis of variance for three different environments that sufficient genetic variability exists among genotypes for all the characters studied and hence desirable improvement can be brought through selection in these different characters.

The results on phenotypic (PCV) and genotypic (GCV) coefficients of variability are presented in Table 2. It is clear that, in general, PCV estimates were higher than the corresponding GCV estimates for all the thirteen characters in all four environments which indicated that these characters were influenced by environment. High estimate of PCV than the corresponding GCV estimates for these characters in oat were also reported by Negi *et al.,* (2018), Vanjare *et al.,* (2021).

It is clear from the Table 2 that none characters exhibited high (>20 %) GCV estimates in all the four environments except Leaf dry weight per plant, leaf stem ratio and plant population. However, the PCV estimates were high (>20 %) for Leaf dry weight per plant, leaf stem ratio and plant population in all the four environments. High estimates of PCV for these

TABLE 1

Pooled Analysis of variance for thirteen yield and yield attributing traits under four different location of season rabi 2021-22

| Environment | Source | df | Mean sum of square | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DTF | PH | LL | LW | NT P | GFY | LDW | SDW | L/R ratio | DMW | DTM | PP | 1000 SW |
| Raipur | Replication | 1 | 1.27 | 42.41 | 116.64 | 0.15 | 1.05 | 0.39 | 0.42 | 39.06 | 0.0002 | 35.25 | 62.02 | 2.25 | 35.11 |
| | Genotype | 31 | 100.83** | 177.53** | 56.62** | 0.05** | 2.13** | 468.18** | 5.44 | 45.43** | 0.01** | 42.37** | 17.61** | 64.4** | 53.70** |
| | Error | 31 | 2.43 | 2.77 | 2.26 | 0.01 | 0.48 | 7.57 | 0.09 | 6.19 | 0.0007 | 12.96 | 0.983 | 6.90 | 15.36 |
| Kawardha | Replication | 1 | 15.02 | 34.96 | 97.27 | 0.0002 | 1.89 | 2.03 | 0.02 | 79.66 | 0.002 | 71.23 | 13.14 | 23.77 | 162.56 |
| | Genotype | 31 | 114.63** | 172.20** | 54.62** | 0.06** | 1.39** | 563.82** | 4.40** | 43.69** | 0.01** | 32.74** | 25.62** | 28.18** | 51.59** |
| | Error | 31 | 2.02 | 9.04 | 2.26 | 0.02 | 0.2 | 7.28 | 0.11 | 4.58 | 0.0005 | 13.11 | 2.657 | 7.83 | 6.43 |
| Ambikapur | Replication | 1 | 2.64 | 0.00 | 4.67 | 0.04 | 1.03 | 173.58 | 1.00 | 2.76 | 0.0003 | 0.00 | 1.563 | 4.00 | 1.27 |
| | Genotype | 31 | 111.02** | 161.86** | 43.81** | 0.06** | 2.11** | 471.44** | 5.83** | 47.23** | 0.01** | 44.47** | 20.68** | 72.05** | 68.37** |
| | Error | 31 | 1.29 | 6.86 | 5.01 | 0.01 | 0.96 | 3.74 | 0.10 | 7.22 | 0.0008 | 8.05 | 2.401 | 8.45 | 18.14 |
| Jagdalpur | Replication | 1 | 17.02 | 6.73 | 0.09 | 0.01 | 0.26 | 11.22 | 0.08 | 0.02 | 0.00001 | 1.03 | 28.89 | 18.06 | 6.25 |
| | Genotype | 31 | 101.11** | 156.63** | 40.78** | 0.04** | 1.78** | 532.70** | 4.63** | 62.72** | 0.02** | 47.14** | 12.26** | 22.48** | 36.98** |
| | Error | 31 | 1.56 | 7.54 | 3.73 | 0.02 | 0.28 | 10.82 | 0.10 | 5.77 | 0.0006 | 5.39 | 1.245 | 5.45 | 10.2 |

*, **: Significant at 5% and 1% probability levels, respectively

DTF: Days to 50% flowering, PH: Plant height, LL: leaf length, LW: leaf width, NT P: No. of tillers per plant, GFY: Green fodder yield per plant, LDW: Leaf dry weight per plant, SDW: stem dry weight per plant, L/R Ratio: Leaf stem ratio, DMW: Dry matter weight per plant, DTM: Days to Maturity, PP: Plant population, 1000 SW: 1000 seed weight.

TABLE 2
Genetic parameters for green fodder yield and its contributing traits in Oat (Avena sativa L.) under different environment

| Traits | Environments | Maximum | Minimum | Grand mean | CV (%) | PCV (%) | GCV (%) | $h^2$ (bs) % | GA (as % of mean) |
|---|---|---|---|---|---|---|---|---|---|
| **Days to 50% flowering** | | | | | | | | | |
| | Raipur | 104.5 | 71 | 91.11 | 1.71 | 7.89 | 7.7 | 95.3 | 15.48 |
| | Kawardha | 110.5 | 75 | 94.83 | 1.5 | 8.05 | 7.91 | 96.54 | 16.02 |
| | Ambikapur | 108 | 73.5 | 94.33 | 1.2 | 7.94 | 7.85 | 97.71 | 15.99 |
| | Jagdalpur | 106 | 72 | 92.48 | 1.35 | 7.75 | 7.63 | 96.95 | 15.47 |
| **Plant height (cm)** | | | | | | | | | |
| | Raipur | 128.9 | 89.3 | 113.7 | 1.5 | 8.4 | 8.2 | 96.9 | 16.7 |
| | Kawardha | 124.5 | 89.8 | 108.6 | 2.8 | 8.8 | 8.3 | 90.0 | 16.3 |
| | Ambikapur | 134.2 | 93.9 | 119.4 | 2.2 | 7.7 | 7.4 | 91.9 | 14.6 |
| | Jagdalpur | 131.8 | 96.7 | 116.7 | 2.4 | 7.8 | 7.4 | 90.8 | 14.5 |
| **Leaf length (cm)** | | | | | | | | | |
| | Raipur | 51.70 | 33.70 | 43.59 | 3.45 | 12.45 | 11.96 | 92.33 | 23.67 |
| | Kawardha | 54.25 | 34.70 | 46.44 | 3.24 | 11.48 | 11.02 | 92.05 | 21.77 |
| | Ambikapur | 48.40 | 26.55 | 39.82 | 5.62 | 12.41 | 11.06 | 79.49 | 20.31 |
| | Jagdalpur | 49.05 | 32.65 | 42.30 | 4.57 | 11.15 | 10.17 | 83.23 | 19.12 |
| **Leaf width (cm)** | | | | | | | | | |
| | Raipur | 2.2 | 1.6 | 2.02 | 5.65 | 8.43 | 6.26 | 55.13 | 9.58 |
| | Kawardha | 2 | 1.1 | 1.75 | 7.04 | 11.28 | 8.82 | 61.07 | 14.2 |
| | Ambikapur | 1.98 | 1.29 | 1.82 | 6.55 | 10.45 | 8.14 | 60.68 | 13.06 |
| | Jagdalpur | 2.05 | 1.3 | 1.92 | 7.33 | 9.25 | 5.64 | 37.21 | 7.09 |
| **No. of tillers per plant** | | | | | | | | | |
| | Raipur | 8.85 | 5.15 | 7.65 | 9.07 | 14.9 | 11.86 | 63.1 | 19.41 |
| | Kawardha | 8.6 | 4.85 | 7.05 | 6.27 | 12.62 | 10.95 | 75.29 | 19.58 |
| | Ambikapur | 9.22 | 5.35 | 7.73 | 12.71 | 16.05 | 9.81 | 37.36 | 12.35 |
| | Jagdalpur | 9.2 | 5.6 | 7.31 | 7.22 | 13.89 | 11.87 | 73 | 20.89 |
| **Green fodder yield per plant (gm)** | | | | | | | | | |
| | Raipur | 145.65 | 72.8 | 104.2 | 2.64 | 14.8 | 14.56 | 96.82 | 29.52 |
| | Kawardha | 141 | 70.6 | 103.26 | 2.61 | 16.36 | 16.15 | 97.45 | 32.85 |
| | Ambikapur | 148.8 | 80.8 | 108.66 | 1.78 | 14.19 | 14.07 | 98.43 | 28.76 |
| | Jagdalpur | 144.25 | 71.2 | 105.79 | 3.11 | 15.58 | 15.27 | 96.02 | 30.82 |
| **Leaf dry weight per plant (gm)** | | | | | | | | | |
| | Raipur | 10.95 | 3.55 | 6.91 | 4.44 | 24.07 | 23.66 | 96.60 | 47.91 |
| | Kawardha | 10.26 | 3.40 | 6.55 | 5.11 | 22.91 | 22.33 | 95.02 | 44.85 |
| | Ambikapur | 11.35 | 3.80 | 7.26 | 4.40 | 23.72 | 23.31 | 96.55 | 47.18 |
| | Jagdalpur | 9.75 | 3.45 | 6.18 | 5.19 | 24.90 | 24.35 | 95.66 | 49.06 |
| **Stem dry weight per plant (gm)** | | | | | | | | | |
| | Raipur | 40.35 | 19.05 | 28.64 | 8.69 | 17.74 | 15.47 | 76.01 | 27.78 |
| | Kawardha | 44.65 | 23.85 | 31.13 | 6.87 | 15.78 | 14.20 | 81.02 | 26.34 |
| | Ambikapur | 37.75 | 15.80 | 24.89 | 10.80 | 20.96 | 17.97 | 73.47 | 31.73 |
| | Jagdalpur | 38.15 | 14.30 | 23.04 | 10.43 | 25.40 | 23.16 | 83.14 | 43.50 |
| **Leaf stem ratio** | | | | | | | | | |
| | Raipur | 0.38 | 0.13 | 0.26 | 10.16 | 28.50 | 26.63 | 87.28 | 51.24 |
| | Kawardha | 0.37 | 0.11 | 0.23 | 9.23 | 31.75 | 30.38 | 91.55 | 59.88 |
| | Ambikapur | 0.45 | 0.13 | 0.31 | 8.95 | 27.94 | 26.47 | 89.74 | 51.65 |
| | Jagdalpur | 0.41 | 0.12 | 0.28 | 8.55 | 32.08 | 30.92 | 92.90 | 61.39 |
| **Dry matter weight per plant (gm)** | | | | | | | | | |
| | Raipur | 47.4 | 24.2 | 1124.8 | 0.3 | 0.5 | 0.3 | 53.2 | 0.5 |
| | Kawardha | 51.2 | 28.3 | 1209.2 | 0.3 | 0.4 | 0.3 | 42.8 | 0.3 |
| | Ambikapur | 43.0 | 21.8 | 1013.9 | 0.3 | 0.5 | 0.4 | 69.3 | 0.7 |
| | Jagdalpur | 38.5 | 20.0 | 921.1 | 0.3 | 0.6 | 0.5 | 79.5 | 0.9 |
| **Days to Maturity** | | | | | | | | | |
| | Raipur | 144.5 | 133 | 139.27 | 0.71 | 2.19 | 2.07 | 89.42 | 4.03 |
| | Kawardha | 144 | 129.5 | 137.45 | 1.19 | 2.74 | 2.47 | 81.21 | 4.58 |
| | Ambikapur | 148.5 | 132.5 | 139.72 | 1.11 | 2.43 | 2.16 | 79.19 | 3.97 |
| | Jagdalpur | 144.5 | 133 | 140.58 | 0.79 | 1.85 | 1.67 | 81.56 | 3.11 |
| **Plant population** | | | | | | | | | |
| | Raipur | 28.00 | 5.00 | 15.16 | 17.33 | 39.39 | 35.38 | 80.66 | 65.45 |
| | Kawardha | 24.00 | 9.00 | 14.52 | 19.28 | 29.23 | 21.97 | 56.51 | 34.03 |
| | Ambikapur | 35.00 | 10.50 | 23.91 | 12.16 | 26.54 | 23.59 | 79.00 | 43.19 |
| | Jagdalpur | 21.00 | 7.00 | 11.19 | 20.87 | 33.40 | 26.08 | 60.97 | 41.95 |
| **1000-seed weight (gm)** | | | | | | | | | |
| | Raipur | 47.7 | 22.5 | 37.2 | 10.54 | 15.79 | 11.77 | 55.51 | 18.06 |
| | Kawardha | 43.8 | 21.05 | 32.91 | 7.7 | 16.36 | 14.44 | 77.83 | 26.24 |
| | Ambikapur | 43.25 | 16.9 | 31.98 | 13.32 | 20.57 | 15.67 | 58.06 | 24.6 |
| | Jagdalpur | 46.95 | 26.85 | 35.28 | 9.05 | 13.77 | 10.37 | 56.75 | 16.1 |

CV: coefficient of variation, PCV: phenotypic coefficient of variation, GCV: genotypic coefficient of variation, h2 heritability (broad sense), GAM: genetic advance over mean.

three characters indicated that sufficient genetic variability exited in the experimental material and therefore, selection might bring desirable improvement in these characters. Similar kind of results for different characters were also reported by *wagh et al.,* (2018), Vanjare *et al.,* (2021).

Higher magnitude of broad sense heritability (>60 %) in all the four environments was observed for days to 50 % flowering, plant height, leaf length, green fodder yield, leaf dry weight, stem dry weight, leaf stem ratio and days to maturity. For rest of the characters the estimates of heritability for all three environments were either moderate or low. Similar kind of results for different characters were also reported by Singh *et al.,* (2011), Krishna *et al.,* (2013), Negi *et al.,* (2018), Sahu *et al.,* (2020) and Belsariya *et al.,* (2023). In all the four environments, high magnitude of genetic advance as percentage of mean (>20 %) among 13 characters studies was reported for green forage yield, leaf dry weight, stem dry weight, leaf stem ratio and plant population. which indicated that this character governed by additive gene and therefore to selection based on phenotypic performance is likely to give beneficial results in improving these characters. High heritability does not always indicate high genetic advance. Johnson *et al.,* (1955) suggested that heritability estimates coupled with genetic advance as % of mean together provide a better judgment rather than heritability alone in predicating the resultant effect of selection.

TABLE 3.2
List of prominent genotypes of oat used in the study for Multilocation testing

| GENOTYPE | GENOTYPE |
|---|---|
| EC0057332 | EC0035051 |
| EC0209494 | EC0107017 |
| EC0097537 | HFO-718 |
| EC0007814 | OL-1896 |
| EC0107524 | 1760 |
| IC0014555 | OS-6 |
| EC0097535 | UPO-212 |
| EC0209215 | EC0076710 |
| EC0029056 | EC0537798 |
| EC0102326 | EC0097522 |
| EC0060975 | EC0097519 |
| EC0009884 | EC0131307 |
| EC0246146 | EC0537815 |
| EC0097241 | EC0537819 |
| EC0097531 | EC0014016 |
| EC0097536 | EC0108486 |

Source: Procured from NBPGR (National Bureau of Plant Genetic Resources).

In the present investigation over all the environment, high heritability coupled with high genetic advance as percent of mean was found for green forage yield, leaf dry weight, stem dry weight, leaf stem ratio which indicate the predominance of additive gene action in the expression of these characters which could be utilized through selection for improvement in these characters. For number of tillers per plant, the heritability estimates were moderate to high heritability in different environments coupled with moderate to high estimates genetic advance and selection may be helpful in improving this trait because finding reveals that that the character is governed by additive gene effect but the influence of the environment is high. For rest of the characters either the estimate of heritability or of genetic advance was low to moderate and, therefore selection may not be useful in improving these traits as these characters are highly influenced by the environment. Similar results are also reported by Ahmed *et al.,* (2013), Krishna *et al.,* (2014), Premkumar *et al.,* (2017), Deep *et al.,* (2019) and Chawla *et al.,* (2023).

## CONCLUSIONS

The present investigation suggested that sufficient variability existed in experimental material for all the thirteen characters in all the four environments which offer opportunity for improvement in component traits through selection. High heritability coupled for high genetic advance was observed for green forage yield, leaf dry weight, stem dry weight, leaf stem ratio which indicated that selection can be emphasized to improve green forage yield, leaf dry weight, stem dry weight, leaf stem ratio.

## REFERENCES

Ahmed, S., A.K. Roy, and A.B. Majumdar, 2013: Correlation and path coefficient analysis for fodder and grain yield related traits in oats (*Avena sativa* L.), *Annals of Biology*, **29:** 75-78.

Allard, R.W., 1960: *Principles of plant breeding*. John Wiley Sons Inc., New York. 485.

Belsariya N., M. Sahu, Sujit, and A. Kak, 2023: Variability pattern and its distribution among germplasm accession of oat (*Avena sativa* L.), *Forage Res.,* **39(1):** pp. 0-0.

Burton, G.W., 1952: Quantitative inheritance in grasses. Proc. 6th International Grassland Cong, **1:** 227-283.

Boczkowska, M., and E. Tarczyk, 2013: Genetic diversity among polish landraces of common oat (*Avena* *sativa* L.), *Genet. Resou. Crop Evol.,* **60:** 2157-69.

Burton, G.N., and E.M. Devane, 1953: Estimating Heritability in Fall Fescue (*Festuca arundiancea* L.) from *Replicated Clonal Materials. Agronomy Journal*, **45:** 478-481.

Chawla1, R, M. Jattan, S. Kumar, D.S. Phogat, N. Kumari, P. Mahla, S. Meena and B. Rani, 2023: Characterizing variation in oat (*Avena sativa* L.) accessions for grain and fodder yield determinants, *Forage Res.,* **49(1):** pp. 64-68.

Deep A, S. Singh, M. Singh, L. Yadav, and P. Malik, 2019: Correlation and genetic divergence analysis for seed and fodder yield and its contributing character in Oat (*Avena sativa* L.), *Int. J. Pure App. Biosci.* **7(3):** 471- 477. 12.

FAO. 2011: Production statistics; Food and Agriculture Organisation, Rome. Oliver RE, Jellen EN, Ladizinsky G, Korol AB, Kilian A, Beard JL, Dumlupinar Z, Wisniewski-Morehead NH, Svedin E, Coon M, Redman RR, Maughan PJ, Obert DE, Jackson EW. New Diversity Arrays Technology (DArT) markers for tetraploid oat (*Avena magna* Murphy et Terrell) provide the first complete oat linkage map and markers linked to domestication genes from hexaploid *A. sativa* L. Theor Appl Genet. **123:**1159-71.

Fisher, R.A. 1920: A mathematical examination of the methods of determining the accuracy of an observation by the mean error, and by the mean square error. Monthly Notices of the Royal Astronomical Society. **80:** 758-770.

Johnson H.W, H.F. Robinson, R.E. Comstock, 1995: Genotypic and phenotypic correlation in soybeans and their implication in selection, *Agron J.* **47:** 477-482.

Krishna A, S Ahmed, H.C. Pandey, and D Bahukhandi, 2013: Estimates of Genetic variability, heritability, and genetic advance of oat (*Avena sativa* L.) genotypes for grain and fodder yield. *Agricultural Science Research Journals,* **3(2):** 56-61.

Krishna A, A. Ahmed, H.C. Pandey, and V. Kumar, 2014: Correlation, path analysis and diversity analysis of oat (*Avena sativa* L.), genotypes for grain and fodder yield, *J. Plant Sci. Res.,* **1:**1-9.

Negi, H., B. Prasad, and P. Lohani, 2018: Estimates of genetic variability parameters in oat germplasm for improving fodder yield, *Journal of Hill Agriculture,* **9(4):** 371-376.

Premkumar R, N. Kumari, and C.R. Anandakumar, 2017: Studies on genetic variability and character association among yield and yield attributing traits in oats (*Avena sativa* L.), *Int. J. Curr. Microbiol. App. Sci.* **6(11):** 4075-4083.

Rasane, P., A. Jha, L. Sabikhi, A. Kumar, and V.S. Unnikrishnan, 2015: Nutritional advantages of oats and opportunities for its processing as value added foods, *J. Food Sci. Tech.,* **52:** 662–75.

Sahu, M., and A. Tiwari, 2020: Genetic variability and association analysis of oat (*Avena sativa* L.) genotypes for green forage yield and other components, *Curr. J. App. Sci. & Tech.,* ***39*****(170):** 133-141.

Singh, S.B., and A.K. Singh, 2011: Genetic variability and divergence analysis in oat (*Avena sativa* L.) under refined environment of intermediate Himalayan Hills, *Indian J. Plant Genet. Resour.,* **24**: 56-61.

Vanjare, D.C., G.C. Shinde, S.D. Shinde, and V.S. Pawar, 2021: Genetic Variability, Heritability and Genetic Advance Studies for Green Forage Yield and Associated Traits in Forage Oat (*Avena sativa* L.), *Int.J.Curr.Microbiol.App.Sci.,* **10(03):** 488-493.

Wagh, V.R., A.H. Sonone and S.V. Damame, 2018: assessment of genetic variability, correlations, and path coefficient analysis in forage oat (*Avena sativa* L.), *Forage Res.,* **44 (3):** 172-175.