Genetic diversity studies in kodo millet 
(Paspalum scrobiculatum L.)

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Abstract
The present investigation was undertaken to assess genetic diversity in seventy genotypes of kodo millet. The analysis of variance revealed the presence of significant variation among the genotypes for all 13 characters. Higher genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance as per cent mean were recorded for thumb raceme length, number of productive tillers per plant, length of panicle, raceme length and grain yield per plant, indicating that simple selection could be practised for improving these traits. Seventy genotypes were grouped into seven different clusters on the basis of magnitude of $D^2$ values by Mahalanobis $D^2$ analysis. Cluster I had 51 genotypes followed by cluster II with 14 genotypes, while clusters III, IV, VI and VII were mono genotypic. The inter–cluster distance was high between clusters II and III and therefore it is suggested to use these genotypes as parents for hybridization to evolve potential segregants.

Key words: Diversity, Kodo millet, GCV, PCV, Heritability.

INTRODUCTION
Millets are a group of highly variable small-seeded grasses, widely grown around the world as grains for food and fodder. They are highly tolerant to extreme weather conditions and the nutrient contents are similar or higher than other major cereals. Kodo millet is one of the most important small millets grown in large areas of developing world especially in Africa and Asia. Kodo millet, Paspalum scrobiculatum L. is a self pollinated crop belonging to the Poaceae family, is a tetraploid (2n=4x=40) good source of minerals. Knowledge of genetic variability in respect of yield in any species is a very valuable estimation in plant breeding programme, since it helps in selection of ideal parents and or traits for selective hybridization. People have come across the importance of kodo millet and hence its demand is increasing. To fulfill the demand of kodo millet in future, extensive research is needed (Nirubana et al., 2017). Therefore, the present study is conducted to analyse the genetic variability and diversity among 70 genotypes of Kodo millet.

MATERIALS AND METHODS
The present investigation was carried out at Educational and Research Farm, Department of Agricultural Botany, College of Agriculture, Dapoli, Dist. Ratnagiri, Maharashtra during kharif, 2020-21. The material comprised of 70 genotypes of Kodo millet collected from ICAR-Indian Institute of Millets Research, Rajendranagar, Hyderabad (Table 1). The experiment was conducted in Randomized Block Design with two replications. The seed was dibbled at a 30 cm distance between row to row and 20 cm distance plant to plant. Each plot had a 2.0 m × 0.9 m area, with three rows per genotype. Each row had 10 plants thus constituting 60 plants in two replications. A. standard package of practices was carried out to maintain a good crop stand. The observations were recorded on five plants selected randomly from each genotype for thirteen quantitative characters and two qualitative characters i.e. culm branching and panicle appearance (Bowen, 2009). The average values were used for further analysis.
Table 1. Kodo millet genotypes used in the present study

| S. No. | Genotypes | S. No. | Genotypes |
|--------|-----------|--------|-----------|
| 1      | IPS 4     | 2      | IPS 5     |
| 3      | IPS 13    | 4      | IPS 68    |
| 5      | IPS 69    | 6      | IPS 91    |
| 7      | IPS 105   | 8      | IPS 147   |
| 9      | IPS 155   | 10     | IPS 158   |
| 11     | IPS 159   | 12     | IPS 172   |
| 13     | IPS 178   | 14     | IPS 207   |
| 15     | IPS 236   | 16     | IPS 240   |
| 17     | IPS 245   | 18     | IPS 254   |
| 19     | IPS 287   | 20     | IPS 319   |
| 21     | IPS 329   | 22     | IPS 344   |
| 23     | IPS 358   | 24     | IPS 368   |
| 25     | IPS 383   | 26     | IPS 388   |
| 27     | IPS 415   | 28     | IPS 429   |
| 29     | IPS 593   | 30     | IPS 606   |
| 31     | IPS 614   | 32     | IPS 622   |
| 33     | IPS 627   | 34     | IPS 628   |
| 35     | IPS 645   | 36     | IPS 648   |
| 37     | IPS 653   | 38     | IPS 654   |
| 39     | IPS 669   | 40     | IPS 670   |
| 41     | IPS 694   | 42     | IPS 699   |
| 43     | IPS 706   | 44     | IPS 709   |
| 45     | IPS 730   | 46     | IPS 741   |
| 47     | IPS 744   | 48     | IPS 764   |
| 49     | IPS 777   | 50     | IPS 782   |
| 51     | IPS 785   | 52     | IPS 793   |
| 53     | IPS 795   | 54     | IPS 803   |
| 55     | IPS 814   | 56     | IPS 828   |
| 57     | IPS 862   | 58     | IPS 870   |
| 59     | IPS 883   | 60     | IPS 891   |
| 61     | IPS 908   | 62     | IPS 919   |
| 63     | EDS 38    | 64     | ERP 49    |
| 65     | ERP 51    | 66     | ERP 55    |
| 67     | ERP 62    | 68     | ERP 77    |
| 69     | ERP 96    | 70     | ER 96     |

The analysis of variance was computed as suggested by Panse and Sukhatme, (1985). The phenotypic and genotypic coefficients of variation (PCV, GCV) were computed as per Burton and DeVane (1953). Heritability in a broad sense ($H^2$) was estimated by formulae suggested by Lush (1949) and the genetic advance was calculated in percent by the formula suggested by Johnson et al. (1955). Genetic diversity was estimated by Mahalanobis (1936) $D^2$ statistic technique as described by Rao (1952). The statistical package used for analysis was GENALEX. Protein and calcium content was estimated as per the standard procedure and expressed as per cent.

RESULTS AND DISCUSSION
Analysis of variance revealed significant differences among the genotypes for all the 13 quantitative characters indicating the presence of considerable genetic variation in the experimental material (Table 2). Based on qualitative characters, the 70 genotypes were classified into three distinct classes. Two genotypes showed high culm branching, 14 genotypes showed medium culm branching and 54 genotypes had low culm branching. While, 41 genotypes had open type panicles, 18 had semi-compact type panicles and 11 had compact type panicles (Table 3).
Table 2. Analysis of variance for different characters studied in Kodo millet genotypes

| S. No. | Characters                              | Mean sum of squares |
|--------|----------------------------------------|---------------------|
|        | Replication (1)                        | Treatment (69)      | Error (69) |
| 1.     | Days to 1st flowering                  | 0.03                | 40.31*     | 4.54      |
| 2.     | Days to maturity                       | 5.80                | 40.22*     | 8.53      |
| 3.     | Number of productive tillers per plant | 0.01                | 4.94*      | 0.20      |
| 4.     | Plant height                           | 0.15                | 190.19*    | 6.35      |
| 5.     | Length of panicle                      | 0.00                | 4.76*      | 0.12      |
| 6.     | Raceme length                          | 0.01                | 1.66*      | 0.14      |
| 7.     | Raceme number                          | 0.03                | 0.08*      | 0.02      |
| 8.     | Thumb raceme length                    | 0.01                | 2.02*      | 0.10      |
| 9.     | Protein content                        | 0.01                | 1.00*      | 0.20      |
| 10.    | Calcium content                        | 0.00                | 0.05*      | 0.00      |
| 11.    | Grain yield per plant                  | 0.04                | 4.35*      | 0.52      |
| 12.    | Straw yield per plant                  | 0.00                | 6.27*      | 1.10      |
| 13.    | Harvest index                          | 1.24                | 19.86*     | 3.10      |

*Significant at 5% level. Figures in parenthesis denotes degrees of freedom

A maximum range of variation was observed in plant height (35.10 to 73.40 cm) followed by days to first flowering (61 to 79 days) and days to maturity (85 to 104 days) (Table 4). Sao et al. (2017) reported similar results for plant height.

The phenotypic coefficient of variability was greater than the corresponding genotypic coefficient of variability. The genotypic coefficient of variation helps in assessing the genetic reliability of the different characters and enables to compare the magnitude of variation. The genotypes were highly variable for characters thumb raceme length (37.5%), the number of productive tillers per plant (27.7%), length of panicle (23.37%), grain yield per plant (23.10%), straw yield per plant (21.48%) and raceme length (21.40%) as indicated by the estimates of PCV (>20%). (Table 4). These results are in agreement with Brunda et al. (2014) for grain yield per plant, Nirubana et al. (2017) for the number of productive tillers per plant and Sao et al. (2017) for the length of panicle.

Among the traits, the highest value of GCV was registered for thumb raceme length (35.61%), number of productive tillers per plant (26.58%), length of panicle (22.79%) and grain yield per plant (20.47%) suggesting that these characters are under the influence of genetic control (Table 4). These results are in accordance with Keerthana et al. (2019).

In the present study, a high estimate of heritability in a broad sense was observed for the characters viz., length of panicle (95%), plant height (93%), number of productive tillers per plant (92%), thumb raceme length (90%), raceme length (84%), calcium content (81%), days to first flowering (80%), grain yield per plant (78%), harvest index (73%), straw yield per plant (70%), protein content (66%) and days to maturity (65%), indicating that these characters may serve as effective selection parameters during the breeding programme for the improvement of kodo millet (Table 4). Sao et al. (2017) observed similar results.

The estimate of genetic advance as per cent of mean ranged from 6.95 (days to maturity) to 69.66 per cent (thumb raceme length). Thumb raceme length (69.66%), the number of productive tillers per plant (52.55%), length of panicle (45.8%), grain yield per plant (37.36%), raceme length (37.04%), plant height (36.73) and straw yield per plant (31.01%), showed higher GAM, indicated that top priority should be given for these characters while formulating selection strategies (Table 4). High GAM was recorded for number of productive tillers per plant by Keerthana et al. (2019), for plant height by Nirubana et al. (2017) and for days to maturity by Savankumar et al. (2018). High heritability coupled with high genetic advance was noticed in plant height (93%, 19.1), length of panicle (95%, 3.06), the number of productive tillers per plant (92%, 3.04), thumb raceme length (90%, 1.92) and days to first flowering (80%, 7.78) (Table 4). It revealed the presence of lesser environmental influence and prevalence of additive gene action in their expression. Similar results were recorded by Sao et al. (2017).

The seventy genotypes were grouped into seven clusters, which indicated a wide range of variation among
| S.No. | Genotype | Culm Branching | Panicle appearance | S.No. | Genotype | Culm Branching | Panicle appearance |
|-------|----------|----------------|-------------------|-------|----------|----------------|-------------------|
| 1     | IPS-4    | Medium         | Open              | 36    | IPS-648  | Low            | Open              |
| 2     | IPS-5    | Medium         | Open              | 37    | IPS-653  | Low            | Open              |
| 3     | IPS-13   | Medium         | Semi-compact      | 38    | IPS-654  | Low            | Open              |
| 4     | IPS-68   | Low            | Compact           | 39    | IPS-669  | Low            | Semi-compact      |
| 5     | IPS-69   | Low            | Compact           | 40    | IPS-670  | Low            | Open              |
| 6     | IPS-91   | Low            | Open              | 41    | IPS-694  | Low            | Semi-compact      |
| 7     | IPS-105  | Low            | Open              | 42    | IPS-699  | Low            | Semi-compact      |
| 8     | IPS-147  | Low            | Open              | 43    | IPS-706  | Low            | Open              |
| 9     | IPS-155  | Low            | Open              | 44    | IPS-709  | Low            | Open              |
| 10    | IPS-158  | Low            | Semi-compact      | 45    | IPS-730  | Low            | Compact           |
| 11    | IPS-159  | Low            | Open              | 46    | IPS-741  | Low            | Open              |
| 12    | IPS-172  | Low            | Semi-compact      | 47    | IPS-744  | High           | Semi-compact      |
| 13    | IPS-178  | Low            | Semi-compact      | 48    | IPS-764  | Low            | Open              |
| 14    | IPS-207  | Low            | Open              | 49    | IPS-777  | Low            | Compact           |
| 15    | IPS-236  | Low            | Semi-compact      | 50    | IPS-782  | Low            | Open              |
| 16    | IPS-240  | Medium         | Open              | 51    | IPS-785  | Low            | Compact           |
| 17    | IPS-245  | Low            | Open              | 52    | IPS-793  | Medium         | Open              |
| 18    | IPS-254  | Low            | Compact           | 53    | IPS-795  | Low            | Compact           |
| 19    | IPS-287  | Medium         | Open              | 54    | IPS-803  | Low            | Open              |
| 20    | IPS-319  | Low            | Semi-compact      | 55    | IPS-814  | Medium         | Open              |
| 21    | IPS-329  | Low            | Compact           | 56    | IPS-828  | Low            | Open              |
| 22    | IPS-344  | Low            | Compact           | 57    | IPS-862  | Low            | Open              |
| 23    | IPS-358  | Low            | Compact           | 58    | IPS-870  | Low            | Compact           |
| 24    | IPS-368  | Low            | Open              | 59    | IPS-883  | Low            | Open              |
| 25    | IPS-383  | Low            | Open              | 60    | IPS-891  | Low            | Open              |
| 26    | IPS-388  | Low            | Open              | 61    | IPS-908  | Low            | Semi-compact      |
| 27    | IPS-415  | Low            | Open              | 62    | IPS-919  | Low            | Open              |
| 28    | IPS-429  | Low            | Open              | 63    | EDS-38   | Low            | Open              |
| 29    | IPS-593  | Low            | Semi-compact      | 64    | ERP-49   | Medium         | Semi-compact      |
| 30    | IPS-606  | Medium         | Semi-compact      | 65    | ERP-51   | Medium         | Semi-compact      |
| 31    | IPS-614  | Low            | Semi-compact      | 66    | ERP-55   | Medium         | Open              |
| 32    | IPS-622  | Low            | Open              | 67    | ERP-62   | Medium         | Open              |
| 33    | IPS-627  | Low            | Open              | 68    | ERP-77   | Medium         | Semi-compact      |
| 34    | IPS-628  | Low            | Open              | 69    | ERP-96   | High           | Open              |
| 35    | IPS-645  | Low            | Semi-compact      | 70    | ER-96    | Medium         | Open              |
Table 4. Estimates of genetic parameters for various characters of Kodo millet genotypes

| S. No. | Characters                                | Mean Range | PCV (%) | GCV (%) | H²bs (%) | GA (%) | GAM (%) |
|--------|------------------------------------------|------------|---------|---------|----------|--------|---------|
|        |                                          | Min.       | Max.    |         |          |        |         |
| 1.     | Days to 1st flowering                     | 69         | 61      | 79      | 6.85     | 6.11   | 80      | 7.78    | 11.25   |
| 2.     | Days to maturity                          | 95         | 85      | 104     | 5.19     | 4.18   | 65      | 6.61    | 6.95    |
| 3.     | Number of productive tillers per plant    | 95         | 2.7     | 10.1    | 27.70    | 26.58  | 92      | 3.04    | 52.55   |
| 4.     | Plant height (cm)                         | 52         | 35.1    | 73.4    | 19.06    | 18.44  | 93      | 19.10   | 36.73   |
| 5.     | Length of panicle (cm)                    | 6.69       | 4.3     | 11.6    | 23.37    | 22.79  | 95      | 3.06    | 45.80   |
| 6.     | Raceme length (cm)                        | 4.44       | 2.8     | 6.9     | 21.40    | 19.61  | 84      | 1.65    | 37.04   |
| 7.     | Raceme number                             | 1.88       | 1.3     | 2.2     | 11.76    | 8.89   | 57      | 0.26    | 13.84   |
| 8.     | Thumb raceme length (cm)                  | 2.75       | 1.1     | 6       | 37.50    | 35.61  | 90      | 1.92    | 69.66   |
| 9.     | Protein content (%)                       | 7.75       | 6.48    | 8.75    | 10.00    | 8.14   | 66      | 1.06    | 13.65   |
| 10.    | Calcium content (%)                       | 3.15       | 2.9     | 3.55    | 5.17     | 4.67   | 81      | 0.27    | 8.68    |
| 11.    | Grain yield per plant (g)                 | 6.76       | 4.65    | 11.3    | 23.10    | 20.47  | 78      | 2.53    | 37.36   |
| 12.    | Straw yield per plant (g)                 | 8.94       | 5.9     | 14.05   | 21.48    | 17.98  | 70      | 2.77    | 31.01   |
| 13.    | Harvest index (%)                         | 43.01      | 35.17   | 48.44   | 7.88     | 6.73   | 73      | 5.09    | 11.84   |

Table 5. Grouping of Kodo millet genotypes into different clusters by Tocher method

| Cluster | Number of genotypes | Name of the genotypes |
|---------|---------------------|-----------------------|
| I       | 51                  | IPS-415, IPS-670, IPS-709, IPS-622, IPS-785, IPS-628, IPS-158, IPS-795, IPS-814, IPS-358, IPS-645, IPS-344, IPS-730, IPS-648, IPS-68, IPS-782, IPS-155, IPS-803, IPS-69, IPS-614, IPS-245, IPS-777, IPS-919, IPS-828, IPS-429, IPS-669, IPS-862, IPS-908, IPS-764, IPS-627, IPS-699, IPS-793, IPS-207, IPS-105, IPS-883, IPS-159, IPS-653, IPS-172, IPS-319, IPS-741, IPS-654, IPS-13, IPS-147, IPS-254, IPS-240, IPS-329, IPS-388, IPS-178, IPS-706, IPS-383. |
| II      | 14                  | ERP-51, IPS-287, ERP-77, ER-96, IPS-593, ERP-55, ERP-62, EDS-38, ERP-96, IPS-891, IPS-5, ERP-49, IPS-4, IPS-744. |
| III     | 1                   | IPS-236 |
| IV      | 1                   | IPS-606 |
| V       | 1                   | IPS-91  |
| VI      | 1                   | IPS-694 |
| VII     | 1                   | IPS-870 |

the genotypes studied. Cluster I was the largest which consisted of 51 genotypes, followed by clusters II with 14 genotypes. The clusters III, IV, V, VI and VII were monogenotypic (Table 5, Fig. 1). More solitary clusters indicate that only a few individuals of the entire germplasm are diverse from each other.

The high intra-cluster distance indicated the presence of a high degree of variability within the cluster and thus offers scope for improvement by various selection methods. The highest intra cluster distance was observed for cluster II (D=8.60) indicating the highest variability followed by cluster I (D=7.75). Cluster III, IV, V, VI and VII showed no intra cluster distance being solitary (Table 6). The maximum inter cluster distance was observed between clusters II and III (D=19.46) (Table 6). The genotypes grouped in these genetically diverse clusters could be used in a hybridization programme for further crop improvement on Kodo millet. Genotypes included in cluster II had good mean values for days to first flowering, days to maturity (here we are considering maximum days), number of productive tillers per plant, plant height, length of panicle, raceme length, raceme number, thumb raceme length, protein content, grain yield per plant, straw yield per plant and harvest index. The cluster III comprised of one
Fig. 1. Clustering by Tocher Method (Dendrogram)
Table 6. Average intra and inter cluster values in 7 clusters \( (D) = (\sqrt{D^2}) \) in Kodo millet genotypes

| Cluster | I | II | III | IV | V | VI | VII |
|---------|---|----|-----|----|---|----|-----|
| I       | 7.75 | 13.16 | 10.60 | 10.55 | 9.71 | 10.03 | 12.79 |
| II      | 8.60 | 19.46 | 10.86 | 15.21 | 17.10 | 11.47 |
| III     | 0.00 | 13.62 | 13.76 | 8.01 | 17.51 |
| IV      | 0.00 | 16.23 | 9.17 | 4.2 | 5.43 |
| V       | 0.00 | 14.09 | 15.05 |
| VI      | 0.00 | 15.02 |
| VII     | 0.00 | 12.01 |

Table 7. Cluster mean performance and contribution towards divergence of 13 characters in 70 genotypes of Kodo millet

| Character                              | Clusters | Population mean | Per cent contribution |
|----------------------------------------|----------|----------------|-----------------------|
| Days to 1st flowering                  | I 68.18  | 72.66 72.1 74.2 60.8 75.1 65.1 | 69.73 3.44 |
| Days to maturity                       | II 94.35 | 98.36 97.6 100.7 84.8 101.2 89.1 | 95.16 1.10 |
| Number of productive tillers per plant | III 5.41 | 7.42 4.4 | 9 2.7 4.9 4.2 | 5.43 5 |
| Plant height (cm)                      | IV 50.68 | 60.11 35.1 37.8 63.3 41.6 36.1 | 46.38 3 |
| Length of panicle (cm)                 | V 6.03 | 9.14 4.3 | 8 5.5 5.6 9.1 | 6.81 5 |
| Raceme length (cm)                     | VI 4.05 | 5.89 3.3 | 4.9 4.2 4.1 | 4.53 6 |
| Raceme number                          | VII 1.87 | 1.91 1.9 | 1.9 2.1 1.6 2 | 1.90 5 |
| Thumb raceme length (cm)               | I 2.37 | 4.22 1.4 | 2.9 1.8 1.8 | 2.71 12.01 |
| Protein content (%)                    | II 7.79 | 7.69 7.18 | 8.4 7.35 6.48 7.88 | 7.54 2.53 |
| Calcium content (%)                    | III 3.14 | 3.14 3 3.23 3 3.53 3.38 | 3.20 7.41 |
| Grain yield per plant (g)              | IV 6.3 | 8.68 5.25 | 9.05 5.4 5.4 | 6.51 22.65 |
| Straw yield per plant (g)              | V 8.49 | 10.7 8.2 | 10.95 7.1 9.95 6.8 | 8.88 12.43 |
| Harvest index (%)                      | VI 42.64 | 44.92 39.12 | 45.25 43.16 35.17 44.7 | 42.14 14.43 |

A genotype which had better mean value for the characters days to first flowering and days to maturity (Table 7). Among the 13 characters studied the character grain yield per plant (22.65%) contributed the highest for divergence followed by harvest index (14.43%), straw yield per plant (12.43%) and thumb raceme length (12.01%). However, the character number of productive tillers per plant (5%), length of panicle (5%), raceme number (5%), days to first flowering (3.44%) and plant height (3%) recorded the lowest contribution (Table 7). Thippeswamy et al. (2018) found similar results for plant height, Jyoti et al. (2020) for the number of productive tillers per plant.

From the present investigation, it is evident that a wide range of variability is present for different traits coupled with high heritability and high genetic advance as percentage of the mean for important yield traits like thumb raceme length, the number of productive tillers per plant, length of panicle and raceme length; hence selections based on these traits could improve productivity in kodo millet. While, clusters II and III were most diverse to each other, hence genotypes present in these clusters are suggested to provide a broad-spectrum variability in the evolution of segregating generation.

REFERENCES

Brunda, S.M., Kamatar, M.Y., Naveen Kumar, K.L and Hundekar, R. 2014. Study of genetic variability, heritability and genetic advance in foxtail millet in both rainy and post rainy season. *Journal of Agriculture and Veterinary Science, 7*(11): 34-37. [Cross Ref]

Bowen. 2009. Document analysis as a qualitative research method. *Qualitative researchjournal, 9*(2):27-40. [Cross Ref]

Burton, G. W. and De Vane, E. H. 1953. Estimating heritability in tall Fescue (*Festuca arundinacea*) from replicated clonal material. *Agronomy Journal, 45* (2): 478- 481. [Cross Ref]
Johnson, H. W., Robinson, H. F. and Comstock, R. F. 1955. Estimation of genetic environmental variability in soybean. *Agronomy Journal, 47*(1): 314-318. [Cross Ref]

Jyoti Thakur, Vikky Kumar and Kanwar R. R. 2020. Genetic divergence studies in Kodo millet (*Paspalum scrobiculatum* L.). *Journal of Pharmacognosy and Phytochemistry, 9*(6): 1373-1377.

Keerthana, K., Chitra, S., Subramanian, A., Nithila, S. and Elangovan, M. 2019. Studies on genetic variability in finger millet (*Eleusine coracana* (L.) Gaertn] genotypes under sodic conditions. *Electronic Journal of Plant Breeding, 10* (2): 566-569. [Cross Ref]

Lush, J. C., 1949. Heritability of quantitative characters in farm animals. *Proceeding of 8th Congress hereditas, 28*(3):356-375. [Cross Ref]

Mahalanobis, P. C., 1936. On the Generalized Distance in Statistics. *Proceedings of National Institute of Science, India, 2* (2): 49-55.

Nirubana, V., Ganeshamurthy, K., Ravikesavan, R. and Chideshwari, T. 2017. Genetic variability studies for yield and yield components in kodo millet (*Paspalum scrobiculatum* L.). *Electronic Journal of Plant Breeding, 8*(2): 704-707. [Cross Ref]

Panse, V. G. and Sukhatme, P. V. 1985. Statistical methods for Agricultural Workers. ICAR, New Delhi.

Rao, C.R. 1952. Advanced statistical methods in biometrical research. John Wiley and Sons Inc., New York.

Sao, A., Preeti Singh, Prafull Kumar and Adikant Pradhan. 2017. Estimates of genetic parameters for yield and contributing traits in kodo millet (*Paspalum scrobiculatum* L.). *Research Journal of Agricultural Sciences, 8*(1): 120-122.

Savankumar, N., Patel, Harshal, E., Patil, Harshalkumar, M., Modi and Joydeep Singh. Th. 2018. Genetic variability study in little millet (*Panicum miliare* L.) genotypes in relation to yield and quality traits. *International Journal of Current Microbiology and Applied Science, 7*(6): 2712-2725. [Cross Ref]

Thippeswamy, V., Sajjanar, G.M. and Prabhakar. 2018. Genetic diversity analysis for yield and yield components in foxtail millet [*Setaria italica* (L.) Beauv.]. *International Journal of Plant Sciences, 13*(1): 82-89. [Cross Ref]