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# Variation in Fruit, Seed and Germination Traits in *Sterculia urens* Roxb.

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***Abstract*:** *Sterculia urens* Roxb., commonly known as Gum Karaya or Indian-tragacanth, is one of India's commercial non-timber forest genetic resources. Many tribal communities depend upon various NTFPs, including *Sterculia* Gum, for their routine life and livelihood security. The present study recorded variation in fruit, seed and germination traits among selected accessions from the Vansda forest of South Gujarat. The result showed that there was a significant variation among 14 accessions for fruit length (29.30-43.29 mm), fruit thickness (14.60-19.70 mm) and fruit weight (1.05-2.56 g), seed length (8.57-11.56 mm), seed thickness (5.33-6.91 mm) and single seed weight (0.12-0.29 g). The significant variation was recorded for seed germination, which ranged from 53 to 100 percent. Six out of fourteen accessions produced > 90% seed germination. Seed length (86%) and seed weight (81%) recorded maximum heritability values. The overall genetic gain among fruit and seed traits was less; however, seed weight (38.50%) and germination (30.86%) recorded comparatively higher gain than other traits. It is revealed that seed lots collected from the Vansda forest exhibited variability in fruit & seed biometry and germination percentage. Hence, there is a scope to select and improve the species.

***Keywords*:** *Sterculia urens,* Gum Karaya, Seed variability, Germination, Heritability

*Sterculia urens* Roxb. (Gum Karaya, Family: Malvaceae-Sterculioideae) is one of the commercial important NTFP tree species distributed in the tropical deciduous forests of dry rocky hill lands. Globally, this species is distributed in India, Sri Lanka and Malaysia; however, also grown in Australia, Pakistan, Panama, Philippines, Indonesia, Senegal, Sudan and Vietnam (Rao 2015, Gautami and Bhat 1992). In India, the species of *Sterculia* are found in the tropical Himalayas, Western and Central India, and the Eastern and Western Ghats. In Gujarat, this species is found throughout deciduous and scrub forests of Panchmahals, Dangs, Khatana, Barda Wildlife Sanctuary, Girnar (Junagadh), Ramapara Wildlife Sanctuary, Vyara and Chhotauadepur (Anon 2008). Tribal communities/ forest dwellers use to collect gums and resins from standing trees, including *Sterculia urens*, in the natural forests. Gums extracted from this species are called Karaya gum (or Indian-tragacanth). The pure form of gum is used in foodstuffs as emulsifiers/stabilizers, as thickeners in cosmetics and medications, and as an adhesive for dentures (Coppen 1995, Orwa et al 2009). Due to its natural source and various end uses, the industrial demand is increasing day by day in the international market. It is reported that the compound annual growth rate (CAGR) of global market for gum karaya is about 5.4% from 2016 to 2021; however, for coming 10 years, the Indian market for gum karaya is expected to grow upto 3.7% CAGR (https://www.futuremarketinsights.com/ reports/karaya-gum-market).

Domestication is an important step toward bringing such commercial plants from wild into cultivated condition for its sustainable utilization of gums and its value-added products to meet the industrial demand; meanwhile, it also helps in conservation of species and its natural habitat. Understanding variability for fruit/seed attributes and other economic traits is one of the parts of domestication; however, such information on this species is scanty (Bhuva 2016). Therefore, a study was undertaken to document the variability in fruit, seed and germination among fourteen accessions of *S. urens*.

## MATERIAL AND METHODS

To understand the tree to tree variation within a population of *S. urens* for fruit, seed and germination traits, 14 good bearing accessions were selected in the tropical dry deciduous forest of the Vansda forest (Latitude of 20° 45' N and Longitude of 73° 28' E), South Gujarat, India. Laboratory and nursery trials were conducted in the College of Forestry, Navsari Agricultural University, Navsari. Bio-metric parameters of these 14 trees are given in Table 1. Fruit maturity occurs from April to May. Individual tree-wise fruits were collected, labelled and packed separately. Fruit traits such as length, thickness, weight, seeds per fruit, seed length, seed thickness, single seed weight and fruit/seed weight were measured as per standard procedure (Bhuva 2016). Total

sixty seeds of three samples containing 20 seeds each were used for seed trait assessment. The seed germination trial was conducted in the forest nursery using the germination tray filled with sterile sand. These trays were arranged randomly following completely randomized design by maintaining uniformity growing conditions under shade-net areas. Pre-sowing treatment of soaking seeds in normal water for 12 hrs. was commonly given to all the 14 seed lots, separately. The number of seeds germinated for each day was counted up to 21 days from the date of sowing. The emergence of plumule above the sand was taken to count germination. Data were subjected to statistical analysis following Panse and Sukhatme (1967) with statistical software.

## RESULTS AND DISCUSSION

The seed samples collected from fourteen accessions of *Sterculia urens* from the Vansda forest showed greater variation for fruit, seed and germination traits. Number of fruits per inflorescence varied from 3.22 to 5.56 with overall mean of 4.42 among nine individuals (Fig. 1). Trees such as VNP-03, VNP-01 and VNP-05 recorded more than 5 fruits per inflorescence. Table 2 and 3 presenting variability within individuals as well as between trees/accessions for fruit and seed traits. There was significant variation among different individuals for fruit length (29.30 to 43.29 mm), fruit thickness (14.60 to 19.70 mm) and fruit weight (1.05 to 2.56 g) (Table 2). The number of seeds per fruit ranged between 3.40 (VNP-05) and 4.77 (VNP-03; Fig. 1). Similarly, all the seed traits such as seed length (8.57 to 11.56 mm), seed thickness (5.33 to 6.91 mm) and single seed weight (0.12-0.29 g) also varied significantly among individuals of *Sterculia urens* ($P < 0.05$; Table 3). Seeds collected from VNP-05>VNP-06>VNP-03>VNP-07>VNP-04>VNP-10 showed bigger and bolder seeds than other accessions. Seed germination significantly varied from 53 to 100 per cent with overall mean of 81.43 per cent (Fig. 2). Accessions such as VNP-02>VNP-06>VNP-10>VNP-11>VNP-12>VNP-14 recorded more than 90 per cent germination within 9 days from sowing date.

The seed length associated positively with seed weight (r=0.769); while, seed thickness also correlated significantly with seed weight (r=0.843) (Table 4). However, germination

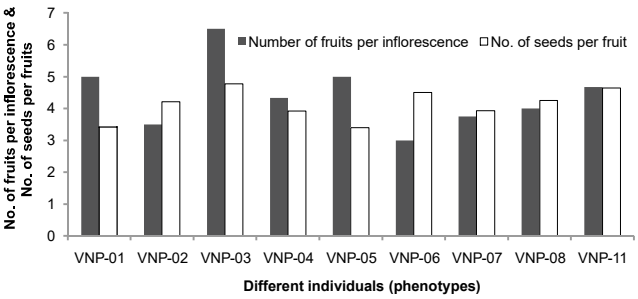


**Fig. 1.** Variation among different accessions for fruit traits of *S. urens*

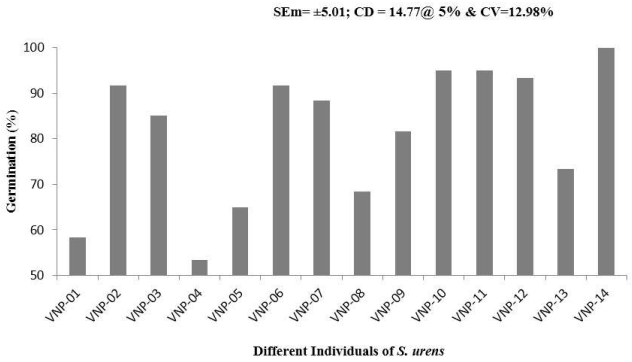


**Fig. 2.** Variation in seed germination among different accessions of *S. urens*

**Table 1.** Details of biometric information of 14 selected accessions of *S. urens*

| Accession code | Tree height (m) | Girth at breast height (GBH) (cm) | Clear bole height (m) | Crown diameter (m) |
|---|---|---|---|---|
| VNP-01 | 11.20 | 131.00 | 3.10 | 8.35 |
| VNP-02 | 6.30 | 39.00 | 4.00 | 3.30 |
| VNP-03 | 9.70 | 46.00 | 8.30 | 4.55 |
| VNP-04 | 12.80 | 95.00 | 10.30 | 8.75 |
| VNP-05 | 14.50 | 159.00 | 9.50 | 8.05 |
| VNP-06 | 14.00 | 109.00 | 9.00 | 9.00 |
| VNP-07 | 16.00 | 122.00 | 11.00 | 9.60 |
| VNP-08 | 5.80 | 56.00 | 1.80 | 3.30 |
| VNP-09 | 10.80 | 50.00 | 7.00 | 5.50 |
| VNP-10 | 10.80 | 69.00 | 6.90 | 3.80 |
| VNP-11 | 10.50 | 62.00 | 7.80 | 3.85 |
| VNP-12 | 15.20 | 129.00 | 11.30 | 7.75 |
| VNP-13 | 17.20 | 137.00 | 13.10 | 7.40 |
| VNP-14 | 8.00 | 76.00 | 6.00 | 4.75 |

does not show significant correlation with seed length, seed thickness and seed weight. Genetic parameters are also worked out for seed traits and germination . The phenotypic co-efficient of variation (PCV) showed a great difference among studied parameters and they varied from 7.09 (seed thickness) to 22.86 per cent (seed weight), whereas for

**Table 2.** Variation in fruit and seed traits among different accessions of *S. urens* in Vansda tropical forest

| Accession code | Fruit length (mm) | | | Fruit thickness (mm) | | | Fruit weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Minimum | Maximum | Mean | Minimum | Maximum | Mean | Minimum | Maximum | Mean |
| VNP-01 | 28.7 | 49.9 | 38.11 | 13.5 | 24.8 | 18.17 | 1.2 | 2.7 | 1.87 |
| VNP-02 | 23.5 | 41.1 | 35.34 | 12.6 | 18.9 | 16.30 | 0.8 | 2.5 | 1.98 |
| VNP-03 | 35.2 | 48.3 | 41.84 | 15.8 | 21.9 | 18.53 | 2.2 | 3.1 | 2.56 |
| VNP-04 | 28.4 | 45.9 | 39.67 | 12.4 | 19.8 | 17.53 | 1.1 | 3.1 | 2.24 |
| VNP-05 | 26.2 | 46.4 | 37.16 | 13.4 | 20.2 | 16.26 | 0.8 | 2.8 | 1.84 |
| VNP-06 | 20.2 | 36.7 | 29.30 | 17.5 | 20.3 | 18.68 | 1.7 | 3.1 | 2.31 |
| VNP-07 | 35.0 | 49.5 | 43.29 | 15.1 | 24.0 | 19.53 | 1.8 | 3.2 | 2.48 |
| VNP-08 | 34.0 | 37.6 | 36.66 | 13.2 | 15.4 | 14.60 | 0.9 | 1.3 | 1.05 |
| VNP-09 | - | - | - | - | - | - | - | - | - |
| VNP-10 | - | - | - | - | - | - | - | - | - |
| VNP-11 | 24.6 | 42.2 | 30.79 | 16.2 | 23.7 | 19.70 | 1.4 | 3.3 | 2.13 |
| VNP-12 | - | - | - | - | - | - | - | - | - |
| VNP-13 | - | - | - | - | - | - | - | - | - |
| VNP-14 | - | - | - | - | - | - | - | - | - |
| Overall values | 20.2 | 49.9 | 36.91 | 12.4 | 24.8 | 17.70 | 0.8 | 3.3 | 2.05 |
| SEm (±) | | | 2.6 | | | 0.77 | | | 0.18 |
| CD @ 5% | | | 7.71 | | | 2.29 | | | 0.53 |

**Note:** Data is not given in five trees due to insufficient collection

**Table 3.** Variation in fruit and seed traits among different accessions of *S. urens* in Vansda tropical forest

| Accession code | Seed length (mm) | | | Seed thickness (mm) | | | Seed weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Minimum | Maximum | Mean | Minimum | Maximum | Mean | Minimum | Maximum | Mean |
| VNP-01 | 7.92 | 10.44 | 9.58 | 5.13 | 7.03 | 6.05 | 0.10 | 0.29 | 0.19 |
| VNP-02 | 8.42 | 10.13 | 9.35 | 5.51 | 6.77 | 6.32 | 0.18 | 0.29 | 0.24 |
| VNP-03 | 9.37 | 11.83 | 10.81 | 6.03 | 7.01 | 6.57 | 0.22 | 0.33 | 0.29 |
| VNP-04 | 6.07 | 11.58 | 10.52 | 4.06 | 7.51 | 6.91 | 0.03 | 0.34 | 0.28 |
| VNP-05 | 9.77 | 12.85 | 11.56 | 4.85 | 6.94 | 6.15 | 0.19 | 0.36 | 0.29 |
| VNP-06 | 9.79 | 12.08 | 11.01 | 5.97 | 7.35 | 6.73 | 0.16 | 0.35 | 0.29 |
| VNP-07 | 8.72 | 11.89 | 10.66 | 5.58 | 7.20 | 6.47 | 0.07 | 0.33 | 0.27 |
| VNP-08 | 7.71 | 10.41 | 9.26 | 4.82 | 5.86 | 5.33 | 0.07 | 0.17 | 0.12 |
| VNP-09 | 8.39 | 11.26 | 9.82 | 5.62 | 7.10 | 6.39 | 0.12 | 0.28 | 0.23 |
| VNP-10 | 8.37 | 12.47 | 10.49 | 5.53 | 7.66 | 6.46 | 0.02 | 0.40 | 0.29 |
| VNP-11 | 8.62 | 12.33 | 10.05 | 4.42 | 7.24 | 6.35 | 0.09 | 0.31 | 0.24 |
| VNP-12 | 7.61 | 9.71 | 8.57 | 5.64 | 7.31 | 6.53 | 0.03 | 0.29 | 0.22 |
| VNP-13 | 7.72 | 10.65 | 9.41 | 4.85 | 6.36 | 5.81 | 0.06 | 0.25 | 0.18 |
| VNP-14 | 8.58 | 11.11 | 9.70 | 5.22 | 7.43 | 5.98 | 0.15 | 0.30 | 0.21 |
| Overall values | 6.07 | 12.85 | 10.06 | 4.06 | 7.66 | 6.29 | 0.02 | 0.4 | 0.24 |
| SEm (±) | | | 0.13 | | | 0.08 | | | 0.01 |
| CD @5% | | | 0.37 | | | 0.23 | | | 0.03 |

**Table 4.** Correlation between seed traits and germination in *S. urens*

| Parameters | Seed length (mm) | Seed thickness (mm) | Seed weight (g) |
|---|---|---|---|
| Seed thickness | 0.417 | - | |
| Seed weight | 0.769* | 0.843** | - |
| Germination | -0.126 | 0.180 | 0.203 |

**Note:** *Significant at 5% P; ** Significant at 0.1% P

**Table 5.** Estimation of genetic parameters for seed traits and germination in *S. urens*

| Parameters | PCV (%) | GCV (%) | ECV (%) | $H^2_{b.s}$ | GA | GG (%) |
|---|---|---|---|---|---|---|
| Seed length (mm) | 8.71 | 8.09 | 3.22 | 86.0% | 1.56 | 15.49 |
| Seed thickness (mm) | 7.09 | 6.22 | 3.37 | 77.0% | 0.70 | 11.26 |
| Seed weight (g) | 22.86 | 20.67 | 9.76 | 81.0% | 11.26 | 38.50 |
| Germination (%) | 20.41 | 17.48 | 10.52 | 73.0% | 25.13 | 30.86 |

PCV= Phenotypic co-efficient of variation; GCV= Genotypic co-efficient of variation; ECV= Environmental co-efficient of variation; $H^2_{b.s}$ = Broad sense heritability; GA= Genetic advance; GG= Genetic gain

genotypic co-efficient of variation (GCV), values ranged from 6.22 (seed thickness) to 20.67 per cent (seed weight). Environmental co-efficient of variation (ECV) values ranged from 3.22 (seed length) to 10.52 per cent (germination). All the parameters such as seed length, seed weight, seed thickness and germination showed highest (> 73%) heritability values (Table 5). Germination per cent showed the highest genetic advance of 25.13 and genetic gain of 30.86% than rest of the parameters, except seed weight, which has 38.50% genetic gain.

Selected accessions of *Sterculia urens* from Vansda forest showed greater variability for fruit, seed and germination traits. Thus, there is a scope and potential for selection and improvement of this species. Even seed traits and germination recorded higher heritability values; hence, such parameters can be considered while selection of superior trees in *S. urens*. Similar kind of observation was also recorded among different forest tree species *viz., Dysoxylum binectariferum* (Gunaga et al 2015), *Mammea suriga* (Gunaga and Vasudeva 2009), *Pongamia pinnata* (Raut et al 2010), *Garcinia talbotii* (Bansude et al 2013), *Sterculia urens* (Bhuva et al 2019), *Madhuca longifolia* (Hegde et al 2018) and other forest species. Generating such baseline data/information provide a quick guide for further selection and improvement of forest tree species and its conservation management.

## CONCLUSION

Study shows that fruit traits, seed traits and germination per cent varied among accessions of *Sterculia urens*. Fruits collected from some of the accessions recorded bolder seeds and yielded higher germination. It is indicated that there is further scope for superior tree selection in order to raise good quality planting materials for raising plantations.

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## AUTHORS CONTRIBUTION

Dr. Gunaga designed the experiment and analyzed the data, Dr. Thakur and Dr. M.J. Dobriyal helped in laboratory/nursery experiments, Dr. D. Nayak helped in revising Manuscript and Dr. H.T. Hegde involved in the field studies.

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