Kong. Res. J. 3(1) : 17-21, 2016 ISSN 2349-2694
Kongunadu Arts and Science College, Coimbatore.

DOI:10.26524/krj119

VARIATION IN SEED CHARACTERS OF *TERMINALIA CHEBULA* RETZ. FROM THE SOUTHERN WESTERN GHATS OF TAMIL NADU

Sahaya Anthony Xavier, G.
Department of Botany, St.Xavier's College (Autonomous), Palayamkottai – 627002.
E.mail: saxsxc@gmail.com

ABSTRACT

Seed is an important aspect of a plant's life history. The successful regeneration of a plant in its habitat and the ability of the plant to disperse across ecosystems depend upon the seed. The number of seeds produced and the size of the seed are factors which affect the survival of a plant. The size of the seed determines the amount of reserve food available to the developing seedlings. In stressful environments, larger seeds may have a higher establishment rate, as they may provide more reserve food for the seedlings. From the *Terminalia chebula* populations in the Southern Western Ghats of Tamil Nadu, 100 seeds each were collected from twelve populations. The seed weight, seed length and seed width were noted individually. The seed characters were noted and compared between the populations. The mean values were also calculated and compared. The inter-population variation was studied with respect to the seed characters of *Terminalia chebula.*

Keywords: *Terminalia chebula,* Southern Western Ghats, seeds.

1. INTRODUCTION

Seed size is an important aspect of the reproductive biology of a plant. It is traditionally considered that seed mass within a species is a remarkably constant characteristic (Harper *et al*., 1970; Silvertown, 1981). Schaal (1980) has shown that there is considerable variation in the seed mass between the individuals of a species or the seed mass of an individual plant can vary greatly (Schaal, 1980). It has also been recognized that seed size is correlated with habitat (Salisbury, 1942). Seed size affects the seedling biomass. Usually the seedlings from larger seeds are larger than those from small seeds, especially in the early stages of growth (Schaal, 1980).

Evolution has led to variation in the seed weight between or within plant species and populations. The variation in seed size and weight are a means to produce a large number of seeds which can ensure the fitness of the plant populations. A greater allocation of the resources from the mother plant also ensures a greater chance of establishment of the resulting seedling (Zhang, 1998).

There is however, a *quid pro quo* in that the massive production of seeds and allocation of resources to individual seeds is dependent on the resources available with the maternal plant. Thus the compromise between the two different strategies results in the variation in the seed weights even within a species. Various biological and environmental factors play a crucial role in determining the seed weight. Thus seed weight is dependent on the genetic constitution of the maternal plant and the environmental and evolutionary processes operating in the environment (Zhang, 1998).

Plant species in closed or dry habitats produce larger seeds than those in open or moisture-rich habitats (Salisbury, 1942; Herbert, 1972). The seed weight also varies with the height, growth, form and mode of dispersal (Zhang, 1998). Therefore the study of the relationship between seed characters and other traits in natural populations is important (Sivakumar *et al*., 2002).

This study investigated the variation in seed characters in natural populations of *Terminalia chebula* of the Southern Western Ghats in Tamil Nadu. Therefore the seed length, seed width and seed mass (seed weight) of the above species was investigated.

2. MATERIALS AND METHODS

2.1. Plant material

Terminalia chebula Retz. is a tropical tree, 15-20m high, which has yellow-white flowers. The fruit is a dry drupe. It is widely distributed in the greater part of India and Burma in mixed deciduous forests of comparatively dry types. It grows well in laterite, clayey and sandy soils. In peninsular India, it is found in mixed deciduous forests to dry deciduous forests and extends up to an elevation of 3000'. It survives well with the temperature between minimum 30° - 60° F. and 100° - 180° F and rainfall from 30" to 130". It is fairly hardy against frost as well as drought. It withstands fire well and shows good recovery from burning. The fruits, known as myrobalans, contain 3.5% chebulic acid, 37% fatty oil, 27-39% tannin and ellagic acid. The drug is highly astringent (Keys, 1976). The fruits are used for their astringent, anti-diarrhoeal and haemostatic properties.

2.2. Seed collection and data analysis

Seeds of *Terminalia chebula* were collected randomly from natural populations and labeled. The seeds were dried in shade in the lab. One hundred seeds were taken randomly from each population to represent the population. Two collections were made at Chanan Parai and Veerapuli forests from two different populations. The seed length and width were measured using a Vernier calliper and the seed weight was measured using an electronic balance (SHIAMDZU Model BL- 6205). The data was tabulated and analyzed.

3. RESULTS AND DISCUSSION

The results of the study are given in Table 1-4 and Fig. 1-3.

3.1. Seed length

The maximum seed length among all the populations was observed to be 3.98 cm (S1) and the minimum seed length was 1.27 cm (S10). The average seed length was found to be maximum at
3.21 am in Chanan Parai I population (S1) and the average seed length was minimum in Kadukkatheri population (S9) (2.73). The mean seed lengths of the populations varied from 2.73 cm to 3.21 cm although individual seeds showed a much higher variation. However as a population the mean seed weight does not show much variation.

3.2. Seed width

The maximum average seed width was 1.94 cm in Chanan Parai I population (S1) and the minimum average seed width was 1.48 cm represented by two populations (Courtallam (S5) and Kadukkatheri, Courtallam (S9). The maximum seed width was observed in two populations (2.94 cm width at S6 and S10). The minimum seed width was observed in Mylar with seed width of 1.00 cm. The mean seed width too shows a variation of 1.48cm to 1.94 cm. The range of variation too is not very high for the seed width. Therefore the mean seed width too does not show much variation.

3.3.Seed weight

The average maximum seed weight was 3.66g at Chanan Parai II (S2) and the minimum average seed weight was 2.91g at Kadukkatheri (S9). The minimum seed weight was 1.12 g at Courtallam (S5). The maximum seed weight was 6.62 g at Chanan Parai II (S2). The mean seed weight varied from 3.15g to 3.66 g although individual seeds did show quite a large variation. When considered as a group however, the variation between the groups is not significant.

There is variation in the seed sample collected from the given area. However, the results of the ANOVA show that the variation in the seed length, seed width and seed weight are not statistically significant. This could be because the seeds have been collected over a small geographical area.

The difference in seed size may have important ecological implications. The variation in seed mass within a species may affect the seed germination (Weis, 1982) and the germination rate (Zhang and Maun, 1990). Large seeds may have more reserve food which could enable them to have a greater percent germination than smaller seeds (Hendrix, 1984). On the other hand, smaller seeds may germinate more quickly than larger seeds. They may be better able to exploit the given conditions in an environment and may thus have a competitive edge over larger seeds (Howell, 1981). Seedlings from smaller seeds, particularly of fast-growing species, would be able to cope with mild drought by morphogenetic and physiological plastic response in a better way than those from large seeds. However, seedlings from large seeds had greater survival than those from smaller seeds under intense water stress. (Ekta and Singh, 2004).

For a plant, decreased seed weight may be a disadvantage as small seeds are often associated with lower germination percentage and smaller seedlings would lead to decreased chances of seed germination and seedling establishment (Stanton, 1984; Krannitz *et al.*, 1991). However, Stamp (1990) found that with increase in the size of the seed, there is a decrease in the seed germination rate. Hendrix (1984) reported that the increase or decrease in rate of germination with increase in seed size was dependent on the environmental conditions.

Several studies have documented the variation in seed weight both within and between plant populations (Hawke and Maun, 1988; Michaels *et al*., 1998, Zhang and Hamill, 1996; Cordazzo, 2002). Populations with different seed weights are expected to have evolved under different selection pressures (Westoby *et al*., 1990; 1992). Moreover, seed traits do not evolve in isolation but are shown to be correlated with other plant traits such as plant height and growth form (Mazer, 1989; Leishman *et al*; 1995). Variability studies are the prerequisite for genetic improvement of any tree species under various agro climatic conditions, (Sharma *et al.,* 1994). In case of *Grewia optiva,* the seed length and the 100 seed weight were found to be the best predictors of germination (Tyagi *et al.,* 1999).

Table 1. Seed characters in *Terminalia chebula* seeds.

Characters	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
Avg. seed length (cm)	3.21± 0.77	3.00± 0.90	2.98± 0.72	2.96± 0.54	2.90± 0.87	3.01± 0.6	3.04± 0.67	2.92± 1.03	2.73± 0.4	2.88± 1.61	2.94± 0.91	2.93± 0.81
Range for seed length	2.49 - 3.98	2.12 - 3.90	2.34 - 3.70	2.42 - 3.43	2.14- 3.77	2.41 - 3.56	2.37 - 3.67	2.12 - 3.95	2.34 - 3.13	1.27 - 2.65	2.14 - 3.85	2.12 – 0.3.67
Avg. seed breadth (cm)	1.94± 0.96	1.64± 0.54	1.57± 0.45	1.69± 0.64	1.48± 0.42	1.64± 1.3	1.57± 0.3	1.65± 0.48	1.48± 0.36	1.59± 3.35	1.55± 0.77	1.56± 0.56
Range for seed breadth	1.35 - 2.90	1.10 - 2.10	1.22 - 2.02	1.12 - 2.33	1.06 - 1.75	1.16 - 2.94	1.26 - 1.87	1.17 - 2.10	1.12 - 1.73	1.90 - 2.94	1.31 - 2.32	1.00 - 1.95
Avg. seed weight (g)	3.25± 1.66	3.66± 2.96	3.35± 1.91	3.15± 2.24	3.15± 1.27	3.46± 1.93	3.47± 1.80	3.29± 1.53	2.91± 1.68	3.28± 1.66	3.21± 3.24	3.33± 1.95
Range for seed weight	1.94 - 4.91	1.36 - 6.62	2.15 - 5.26	1.41 - 5.39	1.12 - 4.42	1.53 - 4.97	1.67 - 4.65	1.76 - 4.77	1.23 - 4.59	1.90 - 4.94	1.82 - 6.45	1.38 - 4.87

S1- Chanan Parai I, Karayar; S2 - Chanan Parai II, Karayar; S3 - Talaianai, Manimuthar; S4 - Below Manjolai; S5 - Courtallam; S6 - Old Courtallam; S7 - Veerapuli I; S8 - Veerapuli II; S9 - Kadukka theri, Courtallam; S10 - Foothills of Kadukka theri, Courtallam; S11 – Servalar; S12 – Mylar.

Table 2. Results of ANOVA for seed length.

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	14.39304	11	1.308458	7.22926	4.98E-12	1.796696
Within Groups	215.0218	1188	0.180995			
Total	229.4148	1199				

Table 3. Results of ANOVA for seed width.

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	16.15565	11	1.468696	18.45258	2.18E-34	1.796696
Within Groups	94.55643	1188	0.079593			
Total	110.7121	1199				

Table 4. Results of ANOVA for seed weight.

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	39.715	11	3.610454	3.370128	0.000132	1.796696
Within Groups	1272.717	1188	1.071311			
Total	1312.432	1199				

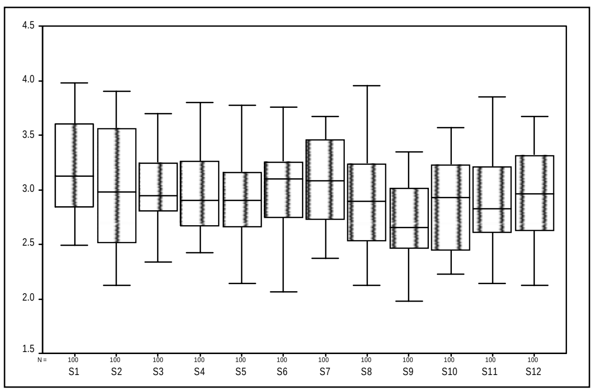

Fig.1. Boxplot of mean seed length in *Terminalia chebula* from the different populations

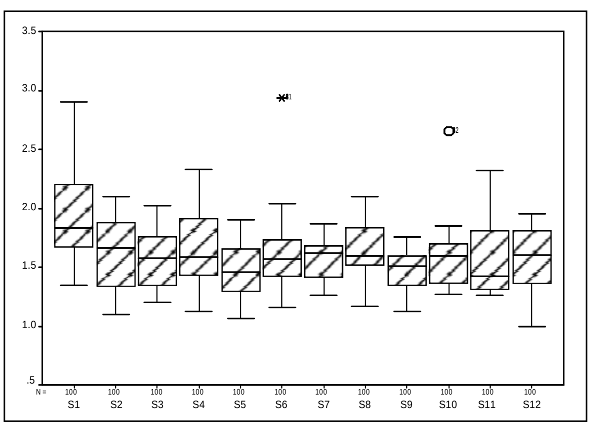

Fig. 2. Box plot for mean seed width in *Terminalia chebula* from the different populations

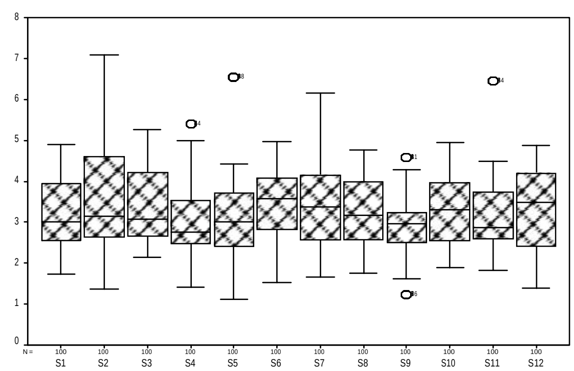

Fig. 3. Box plot of mean seed weight in *Terminalia chebula* from the different populations

4. CONCLUSION

Apart from the variations in the seed characteristics such as seed size, seed length, seed breadth and seed weight a number of other factors too play a crucial role in the establishment of a seed. These include ecological factors such as seed dispersal, seed dormancy and viability, seed predation and the ability of a seed to uptake water. The requirements of a seed may also vary from site to site (Winn, 1985). Thus the variation in seed size is of great ecological significance in the establishment and maintenance of plant populations. The seed also plays an important role in the perpetuation of populations in harsh environments which in turn are important to determine the evolutionary success of a species.

Further studies should be conducted on a wider scale to understand the variation in seed characteristics of *Terminalia chebula.*

ACKNOWLEDGEMENTS

The author would like to thank the University Grants Commission for grant of a minor project which made this study possible. The author would also like to thank the Principal, St. Xavier's College (Autonomous), Palayamkottai – 627002 for providing the laboratory facilities.

REFERENCES

Cordazzo, C.V., (2002). Effect of seed mass on germination and growth in three dominant species in Southern Brazilian coastal dunes. *Brazilian J. Biol.* **62**(3):427-35.

Ekta Khurana and J.S. Singh, (2004). Germination and seedling growth of five tree species from tropical dry forest in relation to water stress: impact of seed size. *J. Trop. Ecol*. **20**:385-396.

Harper, J.L., P.H. Lovell and K.G. Moore, (1970). The shapes and sizes of seeds. *Ann. Rev. Ecol. Syst.* **1**: 327-356.

Hawke, M.A. and M.A. Maun, (1988). Some aspects of nitrogen, phosphorus and potassium nutrition of three colonizing beach species. *Can. J. Bot.* **6**: 1490–1496.

Hendrix, D., (1984). Variation in seed weight and its effects on germination in *Pastinaca sativa* L. (Umbelliferae). *Am. J. Bot*. **71(**6):795-802.

Herbert G. Baker, (1972). Seed weight in relation to environmental conditions in California. *Ecol.* **53:**997–1010.

Howell, N., (1981). The effect of seed size and relative emergence time on fitness in a natural population of *Impatiens capensis* Meerb. (Balsaminaceae). *Amer. Midl. Nat*. **105**: 312-320.

Keys, J.D., (1976). *Chinese Herbs - Their Botany, Chemistry and Pharmacodynamics.* Rutland, Charles E. Tuttle Co., 338 p. ISBN No.0-8048-1667-0.

Krannitz, P.G., L.W. Aarssen and J.M. Dow, (1991). The effect of genetically based differences in seed size on seedling survival in *Arabidopsis thaliana* (Brassicaceae). *Amer. J. Bot.* **78**: 446 – 450.

Leishman, M.R., M. Westoby and E. Jurado, (1995). Correlates of seed size variation: a comparison among five temperate floras. *J. Ecol.* **83**: 517–530.

Mazer, S.J., (1989). Ecological, taxonomic, and life history correlates of seed mass among Indiana dune angiosperms. *Ecol. Mon*. **59**: 153–175.

Salisbury, E.J., (1942). *The reproductive capacity of plants.* Bell and Sons, London.

Schaal, B.A., (1980). Reproductive capacity and seed size in *Lupinus texensis*. *Am. J. Bot.* **67**: 703-709.

Sharma, N. K., U. Burman, J.C. Tewari, M.D. Bohra and L.N. Hersh, (1994). Variability studies in pod and seed characteristics of *Prosopis juliflora* (S.W.) DC. *Ind. J. For*. **17**(2): 161–165.

Silvertown, J., (1981). Seed size, life span, and germination date as co adapted features of plant life history. *Am. Naturalist.* **118**: 860-864.

Sivakumar, V., K. T. Parthiban, B. Gurudev Singh, V.S. Gnanambal, R. Anandalakshmi and S. Geetha, (2002). Variability in drupe characters and their relationship on seed germination in Teak (*Tectona grandis* L.f.) *Silvae Genetica.* **51**:5–6.

Stamp, N.E., (1990). Production and effect of seed size in a grassland annual (*Erodium brachycarpum,* Geraniaceae). *Am. J. Bot.* **77:** 874 – 882.

Stanton, M.L., (1984). Seed variation in wild radish: effect of seed size on components of seedling and adult fitness. *Ecol.* **65:**1105 -1102.

Tyagi, P.C., M.C. Agarwal and Nirmal Kumar, (1999). Provenance variation in seed parameters and germination of *Grewia optiva* Drummond. *Ind. For.* **125**(5): 517–521.

Weis, Y.M., (1982). The effect of propagule size on germination and seedling growth in *Mirablis hirsute*. *Can. J. Bot*. **60**: 1868 – 1874.

Westoby, M., B. Rice and J. Howell, (1990). Seed size and plant growth form as factors in dispersal spectra. *Ecol*. **71**: 1307–1315.

Westoby, M., E. Jurado and M. Leishman, (1992). Comparative evolutionary ecology of seed size. *Trends Evol. Ecol*. **7**: 368–372.

Winn, A.A., (1985). The effect of seed size and microsite on seedling emergence in four field populations of *Prunella vulgaris. J. Ecol.* **73:** 831–840.

Zhang, 1998. Variation and allometry of seed weight in *Aeschynomene Americana. Annals Bot*. **82**:843–847.

Zhang, J. and A.S. Hamill, (1996). Responses of *Abutilon theophrasti* to agricultural management systems. *Weed Search* **36**: 471–481.

Zhang, J. and M.A. Maun, (1990). Sand burial effects on seed germination, seedling emergence and establishment of *Panicum virgatum. Holarct. Ecol*. **13**: 56–61.