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Study on Variation of Quantitative Characteristics of Seeds and Oil Content in *Pongamia pinnata* L. Pieree (Honge) an Important Bio-Diesel Tree

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Abstract

The preliminary study was taken up to understand the variation on growth and reproductive parameters for *Pongamia pinnata* in different rainfall areas in Hasssan district of Karnataka. The study was carried out in three contrasting locations represented by 10 random trees from each locations. The results revealed significant variation among the rainfall habitats. The girth was found to be highest in low rainfall (0.93 m) and least in high rainfall area (0.60 m). The results were contradictory for height parameter, where maximum height was found in high rainfall (7.5 m) and was least in low rainfall habitat (5.6 m) .The reproductive parameters such as number of buds, flowers and pods were maximum in low rainfall habitat (55.6, 34.4 and 8.0) and was least in low rainfall habitat. Though the pod parameters (length, width and thickness) were significantly superior in high rainfall habitat (5.82 cm, 2.83 cm and 1.31 cm), but the results showed reverse trend for seed parameters. Where low rainfall habitat recorded maximum (2.35 cm, 2.05 cm and 0.95 cm) compare to medium and high rainfall areas. The seed oil content was maximum for low rainfall (24.5 %) and was least in high rainfall habitat (22.5 %). However, the results did not show significant variation between the locations in each of these rainfall habitats. Similarly, tree-to-tree variations in each of the three sources studied were found to be significant for all the parameters. These findings have significant relevance for identifying better source when there is need for large scale seed collection for getting good seed oil content.

Keywords : *Pongamia pinnata,* quantitative characteristics, oil content, bio-diesel

Population growth and increase in living standards are placing greater stress upon the environmental issues, like never before in the history of human civilization. It is now widely accepted that climate change is the most serious environmental issue affecting human lives (Nair *et al.,* 2010). Enormous efforts have been taken and continue to be made around the world and one such initiative is use alternative source for diesel. *Pongamia* is one such species that falls into this category (Arote and Yeole, 2010)

Pongamia pinnata (L.) Pierre (synonyms *Derrisindica* Lam., Bennet, *Pongamia glabra* Vent. and *Cytisus pinnaus* L.) tree belonging to family Fabaceae, subfamily Papilonaceae, popularly known as 'Karanj' or 'Karanja' in Hindi is a potential source of biodiesel (Mukta and Sreevalli, 2010; Bala *et al*., 2011). The tree is adaptable to wide agronomic climatic conditions. Besides the oil-yielding capacity, its multipurpose benefits as a provider of green manure (Bala *et al*., 2011) and medicine and its role in agro forestry make it a potential candidate for large-scale plantation on marginal lands. It can also play a role in rural economy by generating huge manpower employment both during various stages of its cultivation as well as during downstream processing. In recent days it is gaining worldwide attention because, most of the physical and chemical properties of seed oil are similar to those of diesel, though the 'Conrdson carbon residue' is higher in the case of honge (Bala *et al*., 2011).

Despite increasing research efforts on various aspects, they have more or less managed to maintain a mysterious aura. They still encompass many secrets in their biology and much more information is required for their silviculture and utilization. In order to fill up some of the information gaps especially relating to quantitative characters on the growth, seed and oil content, present study was taken up to understand the biology of seeds and oil content in honge.

Material and Methods

Preliminary survey was taken up in Karnataka and information related to distribution of the species was collected from primary field visits, forest records

and also from farmers. Based on the distribution pattern of the species, Hassan district was selected for the present study, as the area ranged from high rainfall habitat to low rainfall areas and more importantly due to logical facilities available in the area to carry out the study. Within Hassan, the sites were selected based on rainfall range such as high, medium and low. The area like Alur and Sakaleshpur falls under high rainfall, Hassan and Chennrayapatna under medium rainfall, Arasikere and Holenarasipura falls under low rainfall habitats. Within these locations 10 trees were selected randomly and marked with paint for further study. The growth parameters such as girth (m) and height (m) parameter were recorded along with geographical co-ordinates (Latitude and Longitude) of each trees. Further, visits were carried out to same trees in each of these locations and collected observations on number of buds, flowers and pods. Later, matured pods were collected from each tree separately. The maturity of the pods were confirmed, when the pods turn to brownish yellow from green colour and ripened pods from identified trees were collected during the month of April to June from the study site. The collected pods were brought to laboratory and 50 representative pods were considered from each tree to record observations of length, width and thickness of both pods and seeds by using digital caliper.

The remaining matured pods were used to remove seeds manually for extraction of oil. The seeds were cleaned and dried at 50°C for 48 h. Dried seeds were weighed and ground. The powdered seeds (sufficient for three extractions to be taken from each sample, each extraction being 100 g of powdered material) were packed in polythene bags and stored at 4°C until further analysis. Hot water extraction was also used for extraction of the oil where 100-g powdered seed was immersed in n-hexane, agitated gently in a conical flask for 24 h. The residue was allowed to settle and supernatant was decanted, distilled at 65°C to remove the solvent completely. The final volume of the oil was measured (%v/w) and also the final weight of the solid material left was noted (Kesari *et al*., 2008). The data obtained from all the characters were subjected to statistical analysis by following standard methods.

Results and Discussion

The data comprise morphological and reproductive traits measured on 10 trees, and each of the 10 trees is a different genotype. There were three rainfall zones and 2 locations in each zone. The results on growth parameters showed the girth (m) was highest in case of low rainfall conditions (0.93 m) which was significantly (p-0.05) different from medium (0.7) and high rainfall conditions (0.56) (Fig. 1). On the other side, the height was maximum in high rainfall habitat (7.5 m), followed by medium (6.9 m) and least was in low rainfall areas (5.6 m) (Fig. 2). As far as reproductive characters are considered, the number of buds, flowers, pods per inflorescence were maximum in low rainfall conditions (55.6, 34.5, 8.0) which was significantly different from medium (52.5, 29.8, 6.0) and was least in high rainfall conditions (48.8, 26.7, 5.0) (Table I).

The results on pod characters showed clear trend in each of these locations, where pods from high rainfall

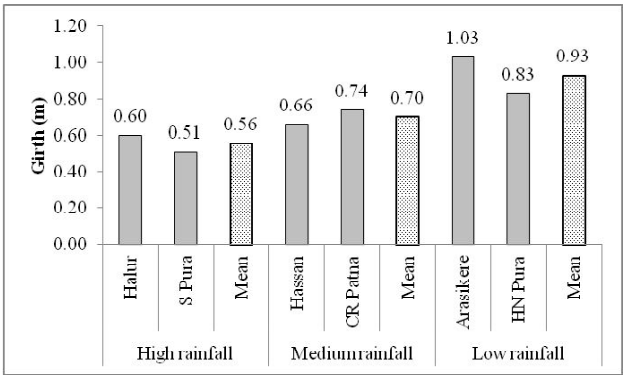

Fig. 1: Variation in girth of different rainfall habitat in *Pongamia pinnata* in Hassan, Karnataka

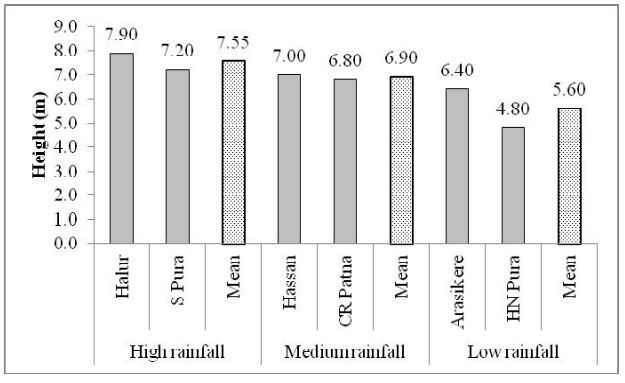

Fig. 2: Variation in girth of different rainfall habitat in *Pongamia pinnata* in Hassan, Karnataka

TABLE I

Variation in reproductive characters in different rainfall habitat in Pongamia pinnata *in Hassan, Karnataka*

Rainfall area	Reproductive Character			
	Study Locations	No. of buds/ inflorescence	No. of flowers/ inflorescence	No. of pods/ inflorescence
High rainfall	Alur	49.80	27.60	4.70
	Sakaleshpur	47.80	25.70	5.30
	Mean	48.8	26.7	5
Medium rainfall	Hassan	53.20	30.80	6.60
	Chennarayapatna	51.80	28.70	5.40
	Mean	52.5	29.8	6
Low rainfall	Arasikere	53.60	35.00	7.60
	Holenarasipura	57.50	34.00	8.30
	Mean	55.6	34.5	8
LSD for zone @ 5%	-	3.2	2.56	0.78
LSD for location @ 5%	-	NS	NS	NS

zone recorded maximum length (5.82 cm), width (2.83 cm) and thickness (1.31 cm) which was significantly different from medium rainfall conditions (4.63, 2.55, 1.27) and least pod traits were found in low rainfall conditions (4.42 cm, 2.04 cm, 1.03 cm) (Table II). The data on seed characters showed contrary trend, where the characters such as seed length, width and thickness was found to be maximum for low rainfall conditions (2.35 cm, 2.05 cm, 0.95 cm) and least characters were recorded in high rainfall habitats (2.02 cm, 1.64 cm, 0.80) (Table III). The results on seed oil content showed maximum oil content (%v/w) was in low rainfall (24.5 %) which was significantly different from medium (23.0%) and least oil content was found in high rainfall conditions (22.5%) (Fig. 3).

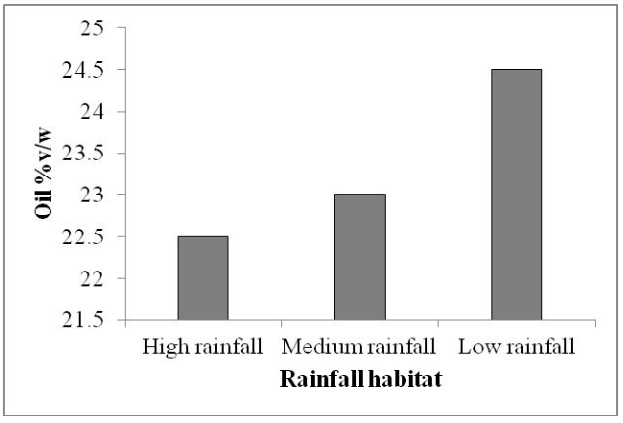

Fig. 3: Variation in seed oil content of different rainfall habitat in *Pongamia pinnata* in Hassan, Karnataka

The results indicated that, the differences in the morphometric characters could be due to variation in microclimate and local environmental conditions in the range of distribution of this species (Gera *et al.,* 2014). Due to particular set of local environmental conditions, the genetic constitution of the species for the particular traits must have changed resulting in geographically distinct clines (Kesari *et al*., 2008).

The occurrence of the species over a wide geographic range encompassing a great diversity of edapho-climatic conditions of its habitat is expected to be reflected in the genetic constitution of its diverse populations (Gera *et al.,* 2014). As a result, racial variation among the populations of diverse origin did show association with locality factors such as latitude, longitude. Altitude, precipitation etc (Shekar *et al.,* 2012).

TABLE II

Variation in pod characters in different rainfall habitat in Pongamia pinnata *in Hassan, Karnataka*

Rainfall area	Pod Characters			
	Study Locations	Length (cm)	Width (cm)	Thickness
High rainfall	Alur	5.43	2.76	1.34
	Sakaleshpur	6.21	2.89	1.28
	Mean	5.82	2.83	1.31
Medium rainfall	Hassan	4.15	2.75	1.36
	Chennarayapatna	5.10	2.35	1.18
	Mean	4.63	2.55	1.27
Low rainfall	Arasikere	4.71	1.90	1.10
	Holenarasipura	4.12	2.18	0.96
	Mean	4.42	2.04	1.03
LSD for zone @ 5%		0.15	0.43	0.2
LSD for location @ 5%		NS	NS	NS

TABLE III

Variation in seed characters in different rainfall habitat in Pongamia pinnata *in Hassan, Karnataka*

Rainfall area	Seed Characters			
	Study Locations	LAngth (cm)	Width (cm)	Thickness
High rainfall	Alur	1.98	1.57	0.75
	Sakaleshpur	2.05	1.71	0.85
	Mean	2.02	1.64	0.8
Medium rainfall	Hassan	2.32	1.98	0.93
	Chennarayapatna	1.86	1.78	0.84
	Mean	2.09	1.88	0.89
Low rainfall	Arasikere	2.53	1.85	0.91
	Holenarasipura	2.16	2.25	0.98
	Mean	2.35	2.05	0.95
LSD for zone @ 5%		0.25	0.16	0.05
LSD for location @ 5%		NS	NS	NS

It is clear from the present investigation that, in case of pongamia different seed sources as well as individual trees within each seed source influenced these characters. The extent of variation was found to be higher among the trees within each seed source than between the groups of trees growing in a locality. The significant variation could be due to average annual rainfall of the seed sources appears to have direct influence on growth, pod, seed and seed oil content, as the average annual rainfall at Arasikere and Holenarasipura is much lower as compared to that of Hassan and Chennarayapatna (medium rainfall) and Alur and Sakaleshpur (high rainfall). Higher tree-to-tree variation observed for morphometric traits could be due to genetic dissimilarity among the trees as the orthodox seeds of the species might get dispersed within a narrow range due to lack of dormancy. Similar line of significant pattern was observed in seed and pod characteristics of *Pongamia* but the extent of collections were large from contrasting locations (Rao *et al.,* 2011; Divakara *et al.,* 2010; Raut *et al.,* 2011). Whatever might be the cause for variation and tree-to-tree variation within a population for seed germination, its importance needs to be considered while taking up seed collection either for bulk planting or for research programme.

Based on the variation studies, it can be concluded that the performance with respect to the growth performance, seed characters and seed oil content was higher in low rainfall habitats compare to high rainfall areas. The study has significant relevance to provides scientific base line information in identifying the sites for large scale collection of seeds to get better performance both in terms of seed morphometric as well as seed oil content.

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