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Crude and Ecological Densities of Certain Variants of the Medicinal Shrub, *Gaultheria fragrantissima* Wallich in Shola Forests of Nilgiris, the Western Ghats

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ABSTRACT The crude and ecological densities of four leaf type variants of the medicinal plant, *Gaultheria fragrantissima* such as ovate, lanceolate, elliptic-lanceolate and oblanceolate leaf type variants were determined in four major shola forests of Nilgiris, the Western Ghats such as Ebbenadu shola, Honnathalai shola, Kodappamand shola and Kothagiri terrace shola for a period of one year from January 2004 to December 2004. The study revealed that the ecological densities of all the four variants of *G. fragrantissima* were higher than that of the respective crude densities at all times of sampling. The annual mean crude density determined for the whole habitat was varying between 0.31/m^2 (oblanceolate leaf type variant in Kothagiri terrace) and 0.84/m^2 (ovate leaf type variant in Ebbenadu shola). The mean annual ecological density of the four variants was varying between 1.33m^2 (elliptic lanceolate leaf type variant in Kodappamand) and 4.22/m^2 (ovate leaf type variant in Ebbenadu shola). The present study revealed that Ebbenadu shola margins have suitable microclimate for the growth and perpetuation of the study species, *G. fragrantissima* in Nilgiris.

INTRODUCTION

Gaultheria fragrantissima (Family, Ericaceae) is a medicinal shrub distributed from Nepal to Bhutan at altitudes from 1,800m to 2,500m and also in Burma and Ceylon and Khasia hills, the Nilgiri hills, Palni hills and hills of Travancore of Western Ghats at the altitudes 1,500m above msl (Anonymous 1956). In Nilgiris, it prefers to grow mainly in the margins of shola forests and however, very few individuals of this species are found in the interior sholas also (Aiyar 1932; Puri et al. 1989; Paulsamy et al. 2008).

The oil extracted from its leaves is being sold in the markets of Nilgiris in the name of 'Indian Winter Green Oil' which contains methyl salicylate as the chief constituent used for the treatment of rheumatism, arthritis, sciatica, neuralgia etc. The oil is also used in the preparation of pain balms and ointments and is also used as a flavouring agent in toothpastes and in perfume preparation (Hooker 1882; Chopra 1932; Polunin and Stainton 1984). On the basis of leaf shapes, four ecological variants such as ovate, lanceolate, elliptic-lanceolate and oblanceolate leaf type variants have been identified in the population of *G. fragrantissima* in Nilgiris (Paulsamy et al. 2006). However, no early reports are available on the ecological variants of this species with reference to leaf shape or any other character. The quantitative ecological attribute, density is one of the useful parameters to determine the suitable habitat in a natural ecosystem to any species. The study on two patterns of this character such as crude and ecological densities is most essential to understand the preference of micro-sites within the community (Daubenmire 1959). In view of this fact, the present study was aimed at to know the microhabitat preference of the medicinal shrub, *G. fragrantissima* in the sholas of Nilgiris, the Western Ghats.

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MATERIALS AND METHODS

Determination of crude and ecological densities of the study species, *G. fragrantissima* was carried out for a period of one year from January, 2004 to December, 2004 at monthly interval in the margins and interior parts of four major sholas on Nilgiris, *viz.*, Ebbenadu, Honnathalai, Kodappamand and Kothagiri terrace which are situated at the altitudes 2100, 2150, 2360 and 2320m above MSL (Mean Sea Level) respectively. The minimum quadrat size was fixed as 1x1m by following species-area curve method, and each time, 100 quadrats were laid by even spaced

method and the samplings were made from the margins to interior sholas. The number of individuals of all the four ecological variants of *G. fragrantissima* in each quadrat was recorded. From the observations, both the attributes, crude and ecological densities were calculated by using the following formula of Curtis and McIntosh (1950).

Crude/ecological density = Number of individuals of the species in all quadrats / Total number of quadrats studied.

To obtain crude and ecological densities of the four ecological variants of *G. fragrantissima*, samplings were respectively made in whole sholas (both at interior and margins of sholas) and at the actual area of their occurrence (at shola margins).

RESULTS AND DISCUSSION

The crude density is the individuals per unit total space and ecological density is the individuals per unit of habitat space (i.e.) available area that can actually be colonised by the population (Whittaker 1970). The monthly changes in crude and ecological densities of all the four variants in the studied sholas are presented in tables 1-4. For all the leaf variants in all the study sholas, the ecological density was greater than the respective crude density. It is due to the abundant accumulation of high number of individuals of all the four ecological variants of *G. fragrantissima* in the shola margins, a preferable micro-site in sholas for the study species (Paulsamy et al. 2006). Rajvanshi et al. (1987) reported that apart from microclimatic variations at soil level, the duration and intensity of light in interior sholas and duration of shade provided by the free canopy and angle of light at shola margins exert influences not only on species composition but also on the quantitative ecological characters of the constituent species. It has been observed that both densities of all the four variants of the study species were increased and attained peak during rainy season in all sholas. It is a common fact that in tropical and subtropical regions, the factor, soil wetness increases the seed germination rate and hence the density of individuals during rainy season for all constituent species in a natural community (Misra 1946). The annual mean crude density of ovate leaf type variant was higher in Ebbenadu shola (0.84 individuals/m^2) followed by Kodappamand (0.69 individuals/m^2), Kothagiri terrace (0.56 individuals/m^2) and Honnathalai (0.33 individuals/m^2) sholas. It indicates that the Ebbenadu shola margins are having suitable microclimate for the better growth of the ovate leaf type variant of *G. fragrantissima*. Vijayakumar and Paulsamy (2008) has already reported the suitability of Ebbenadu

Table 1: Crude density of ovate and lanceolate leaf type variants of *Gaultheria fragrantissima* during the study period in the sholas of Nilgiris.

Year and month	*Crude density (individuals/m^2)*							
	Shola							
	Ebbenadu	*Honna-thalai*	*Kodappa-mand*	*Kothagiri terrace*	*Ebbenadu*	*Honna-thalai*	*Kodappa-mand*	*Kothagiri terrace*
	Ovate leaf variant				*Lanceolate leaf variant*			
2004 January	0.71	0.22	0.68	0.51	0.59	0.70	0.51	0.59
February	0.58	0.18	0.53	0.42	0.42	0.58	0.39	0.41
March	0.46	0.12	0.42	0.31	0.38	0.43	0.21	0.28
April	0.41	0.09	0.39	0.20	0.21	0.36	0.18	0.19
May	0.69	0.16	0.38	0.31	0.26	0.34	0.24	0.28
June	0.76	0.28	0.69	0.49	0.38	0.62	0.38	0.47
July	0.84	0.38	0.72	0.61	0.49	0.81	0.49	0.68
August	0.96	0.47	0.84	0.69	0.67	0.89	0.68	0.81
September	1.21	0.58	0.99	0.81	0.79	0.98	0.81	0.96
October	1.27	0.63	0.96	0.84	0.96	1.19	0.98	1.02
November	1.16	0.54	0.92	0.89	0.87	1.06	1.01	0.84
December	1.08	0.31	0.81	0.68	0.68	0.82	0.86	0.71
Annual mean crude density(individuals/m^2)	0.84^{a}	0.33^{b}	0.69^{c}	0.56^{bc}	0.55^{a}	0.73^{b}	0.56^{a}	0.51^{a}

Annual mean crude densities followed by different letter(s) are significant to each other according to DMRT at 5% level.

shola margin for the high yield of oil content of ovate leaf variant of *G. fragrantissima*. Similar trend of result has been observed for ecological density of this variant with higher values than that of crude density .

The crude density of lanceolate leaf type variant was not varied significantly across the sholas studied (Table 1). The highest annual mean crude density for this variant has been observed in Honnathalai shola (0.73 individuals /m^2) followed by Kodappamand (0.56 individuals /m^2), Ebbenadu (0.55 individuals /m^2) and Kothagiri terrace (0.51 individuals /m^2) (Table 1). For annual mean ecological density also the Honnathalai shola recorded higher value (3.65 individuals / m^2) followed by Kothagiri terrace (3.01 individuals /m^2), Kodappamand (2.80 individuals /m^2) and Ebbenadu (2.79 individuals /m^2) (Table 2). From

Table 2: Ecological density of ovate and lanceolate leaf type variants of *Gaultheria fragrantissima* during the study period in the sholas of Nilgiris.

Year and month	*Ecological density (individuals/m^2)*							
	Shola							
	Ebbenadu	*Honna-thalai*	*Kodappa-mand*	*Kothagiri terrace*	*Ebbenadu*	*Honna-thalai*	*Kodappa-mand*	*Kothagiri terrace*
	Ovate leaf variant				*Lanceolate leaf variant*			
2004January	3.55	1.10	3.40	2.55	2.95	3.50	2.55	2.95
February	2.90	0.90	2.65	2.10	2.10	2.90	1.95	2.05
March	2.30	0.60	2.10	1.55	1.90	2.15	1.05	1.40
April	2.05	0.45	1.95	1.00	1.05	1.80	0.90	0.95
May	3.45	0.80	1.90	1.55	1.30	1.70	1.20	1.40
June	3.80	1.40	3.15	2.45	1.90	3.10	1.90	2.35
July	4.20	1.90	1.10	3.05	2.45	4.05	2.45	3.40
August	4.80	2.35	4.20	3.45	3.35	4.45	3.40	4.05
September	6.05	2.90	4.95	4.05	3.95	4.90	4.05	4.80
October	6.35	3.15	4.86	4.20	4.80	5.95	4.90	5.10
November	5.80	2.70	4.60	4.45	4.35	5.30	5.05	4.20
December	5.40	1.55	4.05	3.40	3.40	4.10	4.30	3.55
Annual mean crude density(individuals/m^2)	4.22[a]	1.65[b]	3.24[a]	2.81[b]	2.79[a]	3.65[a]	2.80[a]	3.01[a]

Annual mean crude densities followed by different letter are significant to each other according to DMRT at 5% level.

Table 3: Crude density of elliptic-lanceolate and oblanceolate leaf type variants of *Gaultheria fragrantissima* during the study period in the sholas of Nilgiris.

Year and month	*Crude density (individuals/m^2)*							
	Shola							
	Ebbenadu	*Honna-thalai*	*Kodappa-mand*	*Kothagiri terrace*	*Ebbenadu*	*Honna-thalai*	*Kodappa-mand*	*Kothagiri terrace*
	Elliptic-lanceolate leaf variant				*Oblanceolate leaf variant*			
2004January	0.42	0.34	0.26	0.49	0.52	0.41	0.36	0.37
February	0.28	0.22	0.18	0.31	0.46	0.36	0.31	0.22
March	0.24	0.19	0.13	0.19	0.31	0.24	0.26	0.16
April	0.16	0.13	0.10	0.12	0.22	0.18	0.21	0.10
May	0.13	0.23	0.07	0.16	0.18	0.16	0.19	0.13
June	0.26	0.38	0.16	0.27	0.28	0.25	0.23	0.18
July	0.37	0.57	0.27	0.43	0.46	0.38	0.37	0.22
August	0.61	0.66	0.33	0.67	0.68	0.46	0.42	0.34
September	0.77	0.72	0.41	0.76	0.82	0.52	0.57	0.42
October	0.84	0.81	0.57	0.92	1.17	0.67	0.66	0.53
November	0.93	0.63	0.43	0.8	0.96	0.71	0.51	0.61
December	0.68	0.51	0.29	0.63	0.72	0.59	0.42	0.48
Annual mean crude density(individuals/m^2)	0.47[a]	0.44[a]	0.26[b]	0.47[a]	0.56[a]	0.41[ab]	0.37[b]	0.31[b]

Annual mean crude densities followed by different letter are significant to each other according to DMRT at 5% level.

Table 4: Ecological density of elliptic-lanceolate and oblanceolate leaf type variants of *Gaultheria fragrantissima* during the study period in the sholas of Nilgiris.

Year and month	*Ecological density (individuals/m²)*							
	Shola							
	Ebbenadu	*Honna-thalai*	*Kodappa-mand*	*Kothagiri terrace*	*Ebbenadu*	*Honna-thalai*	*Kodappa-mand*	*Kothagiri terrace*
	Elliptic-lanceolate leaf variant				*Oblanceolate leaf variant*			
2004 January	2.10	1.70	1.30	2.45	2.60	2.05	1.80	1.85
February	1.40	1.10	0.90	1.55	2.30	1.80	1.55	1.10
March	1.20	0.95	0.65	0.95	1.55	1.20	1.30	0.80
April	0.80	0.65	0.50	0.60	1.10	0.90	1.05	0.50
May	0.65	1.15	0.35	0.80	0.90	0.80	0.95	0.65
June	1.30	1.90	0.80	1.35	1.40	1.25	1.15	0.90
July	1.85	2.85	1.35	2.15	2.30	1.90	1.85	1.10
August	3.05	3.30	1.65	3.35	3.40	2.30	2.10	1.70
September	3.85	3.60	2.05	3.80	4.10	2.60	2.85	2.10
October	4.20	4.05	2.85	4.60	5.85	3.35	3.30	2.65
November	4.65	3.15	2.15	4.00	4.80	3.55	2.55	3.05
December	3.40	2.55	1.45	3.15	3.60	2.95	2.10	2.40
Annual mean crude density(individuals/m²)	2.37[a]	2.24[a]	1.33[ab]	2.39[a]	2.82[a]	2.05[ab]	1.87[ab]	1.56[bc]

Annual mean crude densities followed by different letter are significant to each other according to DMRT at 5% level.

the density value it has been understood that the margins of Honnathalai shola are more suitable for the growth and establishment of this variant in the Nilgiris.

For the elliptic-lanceolate leaf type variant of *G. fragrantissima*, the crude and ecological densities showed considerable variation over the months of sampling in each shola during the study period (Tables 3 and 4). Among the four sholas studied, the Ebbenadu and Kothagiri terrace exhibited higher annual mean crude density (0.47 individuals /m² each) followed by Honnathalai (0.44 individuals /m²) and Kodappamand (0.26 individuals /m²). Similarly, the annual mean ecological density was also higher in Kothagiri terrace (2.39 individuals/m²) and Ebbenadu (2.37 individuals/m²) followed by Honnathalai (2.24 individuals/m²) and Kodappamand (1.33 individuals /m²). The response of elliptic-lanceolate leaf type variant in terms of both densities secured to shola micorsites indicates that Kothagiri terrace and Ebbanadu are most fit for its growth and reproduction.

The monthly variations in the crude and ecological densities of oblanceolate leaf type variant of *G. fragrantissima* in all the four studied sholas are given in tables 2 and 4. The annual mean crude density between the study sholas for this variant was not significantly varied. On the other hand, the ecological density was significantly greater (2.82 individuals/m²) in Ebbenadu shola followed by Honnathalai (2.05 individuals /m²), Kodappamand shola (1.87 individuals /m²) and Kothagiri terrace shola (1.56 individuals/m²) (Table 4). It shows the presence of suitable factors in the margins of Ebbenadu shola for the oblanceolate leaf type variant of *G. fragrantissima.*

CONCLUSION

On basis of density analysis for the species, *G. fragrantissima* in four studied sholas, it is determined that the shola margins are the most suitable habitats for the growth and perpetuation of all variants of this species. In addition, it is known that the Ebbenadu shola margins are fitter than any other sholas studied. Therefore, it is suggested for cultivation of all variants of *G. fragrantissima* in shola margins of similar local climate of Ebbenadu shola in Nilgiris to obtain better growth of this species.

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