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Germination and reproductive capacity of the medicinal shrub, *Gaultheria fragrantissima* Wallich in Nilgiris, the Western Ghats, India.

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Abstract

Germination and reproductive capacities of the four ecological variants of the medicinal shrub, *Gaultheria fragrantissima* in four sholas of Nilgiris including Ebbenadu, Honnathalai, Kodappamand and Kothagiri terrace were studied. The seed output was higher (21168-47628), and varied between variants and sholas. The germination percentage and survivability rate were considerably lower in all the four variants and varied much across the sholas. The reproductive and aggressive capacities of all the four variants were appreciable and varied considerably between the variants and sholas. The allocation of biomass to reproductive parts (seeds) and reproductive efficiency were also found to be lower in all the four ecological variants.

Keywords: *Gaultheria fragrantissima*, germination percentage, biomass allocation, Nilgiris, sholas

INTRODUCTION

The medicinal shrub, *Gaultheria fragrantissima* Wallich belonging to the family Ericaceae, is distributed from Nepal to Bhutan at altitudes from 1,800 m to 2,500 m in Himalayas and in the high hills of Nilgris, South India and Eastern Himalayas at an altitude of 1,500 m above msl (Anonymous, 1956). In the Nilgiris, it grows at the margins of the shola forests. The 'winter green oil', extracted from the leaves, has many medicinal importances due to the presence of an active principle, methyl salicylate. The oil is used in the preparation of pain balms and perfumes (Polunin and Stainton, 1984). On basis of variation in the shape of the leaf, four ecological variations *viz.*, ovate, lanceolate, elliptic-lanceolate and oblanceolate are identified in the populations of *Gaultheria fragrantissima* in the Nilgiris (Paulsamy *et al*., 2006). The present paper deals with the degree of variation in the germination characters and biomass allocation to reproductive parts of the four ecological variants of the species, *Gaultheria fragrantissima* in Nilgiris, South India.

MATERIALS AND METHODS

The variants of *Gaultheria fragrantissima* that are found in four sholas of the Nilgiri Biosphere Reserve, namely, Ebbenadu, Honnathalai, Kodappamand and Kothagiri terrace were used for the present study. The reproductive efficiency (RE), seed output (SO), reproductive capacity (RC) and aggressive capacity (AC) of the four variants of the species, *G. fragrantissima* were calculated as per the methods described by Reddy and Aruna (1997):

$$RE = \frac{\text{Crude dry weight of reproductive parts}}{\text{Crude dry weight of vegetative parts}}$$

SO = Average number of fruit bearing bodies per plant X average number of seeds per fruit

For the calculation of seed output, 20 individuals from each variant were selected and observed during the fruiting period. The plants were marked for identification and protected from disturbances. Mean number of berries (fruit) per raceme was calculated on the basis of 30 racemes taken randomly from the bulk collected. Reproductive capacity of *G. fragrantissima* of the berry was calculated out of 20 berries. Three replicates were maintained for each variant.

RC = SO x (per cent seed germination / 100)

AC = RC x (per cent survival of seedlings / 100)

The germination percentage of 50 randomly selected seeds for each variant was determined by allowing them to germinate separately over the moist blotting paper medium in Petri dishes under the conditions prevailed in the study area. The number of seeds germinated in each variant after 10 days of sowing was counted. Three replicates were maintained for each species.

To determine the percentage survival of seedlings, one nursery bed with the size of 0.5 x 1.0m for each variant was prepared in the study shola. Seeds were sown at the rate of 1000 per plot per variant during the subsequent month of seed maturation. Three replicates were maintained for each variant. Total numbers of seedlings were determined variant-wise by adding the number of seedlings produced during the subsequent 5 days sampling intervals to the seedling present at the first count. Number of saplings present five weeks after sowing were counted and the per cent survival of seedlings was calculated as under:

$$\text{Per cent survival of seedlings} = \frac{\text{Number of saplings present}}{\text{Number of seedlings produced}} \times 100$$

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Table1. Germination and reproductive capacities of the four ecological variants of *Gaultheria fragrantissima* in the sholas of Nilgiris.

Character	Shola															
	Ebbenadu				Honnathalai				Kodappamand				Kothagiri terrace			
	OVA	LAN	ELA	OLA	OVA	LAN	ELA	OLA	OVA	LAN	ELA	OLA	OVA	LAN	ELA	OLA
Seed output/ plant (No)	38528^{a}	24057^{b}	24738^{b}	30753^{c}	35328^{a}	47628^{b}	28737^{c}	32148^{d}	28552^{a}	21168^{b}	31104^{c}	31122^{c}	28512^{a}	34928^{b}	40068^{c}	34314^{b}
Germination (%)	19^{a}±2.0	13^{a}±1.2	12^{a}±1.0	17^{a}±1.1	11^{a}±0.8	17^{a}±1.2	13^{a}±0.9	16^{a}±1.2	17^{a}±1.4	10^{a}±0.9	11^{a}±0.9	12^{a}±1.1	10^{a}±1.0	16^{a}±1.3	11^{a}±0.8	12^{a}±1.2
Survival of seedlings (%)	30.55^{a}	9.70^{b}	14.84^{c}	28.77^{a}	11.57^{a}	27.77^{b}	15.60^{c}	24.33^{b}	27.09^{a}	17.50^{b}	10.52^{c}	18.38^{b}	14.72^{a}	26.39^{b}	17.39^{c}	19.42^{c}
Reproductive capacity (RC)	7320^{a}	3127^{b}	2968^{b}	5228^{c}	3886^{a}	8096^{b}	3735^{a}	5143^{c}	4853^{a}	2116^{b}	3421^{c}	3734^{c}	2851^{a}	5588^{b}	4407^{c}	4117^{c}
Aggressive capacity (AC)	2236^{a}	303^{b}	440^{b}	1504^{c}	449^{a}	2248^{b}	582^{a}	1251^{c}	1314^{a}	370^{b}	359^{b}	686^{c}	419^{a}	1474^{b}	766^{c}	799^{c}

OVA- Ovate; LAN- Lanceolate; ELA- Elliptic-lanceolate; OLA- Oblanceolate.

The shola – wise means in horizontal rows followed by different letter(s) are significantly different to each other at 5% level according to DMRT.

Table 2. Allocation of biomass to various plant parts (g/plant) and reproductive efficiency (RE) of the four variants of *Gaultheria fragrantissima*. Values are $\overline{X} \pm 1$ S.D.

Plant parts	Variant			
	Ovate	Lanceolate	Elliptic-lanceolate	Oblanceolate
Stem	2155±208.4 (41.68)	3296±219.6 (47.05)	3127±218.7 (46.18)	2981±216.8 (46.59)
Leaf	1195±102.3 (23.11)	1590±134.0 (22.69)	1540±103.4 (22.74)	1445±121.4 (22.57)
Seed	730±48.6 (14.12)	690±53.2 (9.85)	715±58.7 (10.55)	645±56.4 (10.08)
Root	1090±99.7 (21.08)	1430±126.3 (20.41)	1390±112.3 (20.53)	1330±112.3 (20.78)
Total	5170	7006	6772	6401
Reproductive efficiency (RE)	16.44^{a}	10.92^{b}	11.80^{b}	11.21^{b}

The figures in parentheses are the percent biomass contribution.

For the attribute, RE, the values followed by same letter are not significantly different from to each other at 5% level according to DMRT

Biomass allocation patterns for the four variants of *G. fragrantissima* were studied during the subsequent month of seed maturation based on Harper and Ogden (1970).

RESULTS AND DISCUSSION

The seed output, seedling survivability and the characters of reproductive potential such as germination percentage, reproductive capacity and aggressive capacity for the four variants of the species, *G. fragrantissima* in the four sholas of Nilgiris are given in Table 1. The fruit type of the species is berry. The seed output for the four variants varied across the sholas studied. The higher (47628 seeds/plant) and lower (21168 seeds/plant) seed output were produced by the variant lanceolate leaf type in Honnathalai and Kodappamand sholas respectively. Matthew (1999) also reported that more number of around 350 berries per plant and around 75 seeds per berry were produced by the species. The seedling survivability rate was low (<30.55 %) in all the four variants and varied across the sholas studied. This is possible due to the less plasticity of the species according to changes in microclimatic conditions (Reddy and Aruna, 1997).

The germination percentage of seeds of all the four variants was very low (11-19% only) and not varied significantly ($p < 0.05$) across the sholas studied. This may be due to the excess soil wetness during the month of seed dispersal (September and October), which may degrade the minute seeds. It has been reported that the germination rate of the plant species was decreased in the soils of high wetness which deteriorate the embryo/endosperm or both (Saxena and Ramakrishnan, 1982; Ram and Ramakrishnan, 1988; Harsh *et al.*, 2004). The reproductive and aggressive capacities of all the four variants were appreciable and generally varied significantly ($p < 0.05$) between the variants and across the sholas. The single variant lanceolate leaf type achieved the maximum (8096) and minimum (2116) reproductive capacities in different sholas, Honnathalai and Kodappamand respectively. Similarly, the same variant had obtained maximum and minimum aggressive capacities also in Honnathalai (2248) and Ebbenadu shola (303). This, perhaps might be due to the variation in microclimatic conditions of the sholas (Ant, 2004).

Allocation of biomass to various plant parts by the four ecological variants of the species is given in Table 2. For all the four variants, it ranged between 9.85% and 14.12% in lanceolate leaf type variant and in ovate leaf type variant, respectively with regard to reproductive parts. It is further observed that the allocation of dry matter to the reproductive parts by all the four variants was more or less same. The reproductive efficiency was low (10.92-16.44) for all the four variants. Grime (1979) explained that the species growing in shade conditions generally allocate more organic matter to the non-reproductive parts. It was found that *G. fragrantissima* normally grew in the partially shade environment of the shola forests, which could be the possible reason for the allocation of more organic matter to the non-reproductive part.

It is obvious from the study that all the reproductive attributes except seed output are lower for the species, *G. fragrantissima,* irrespective of the variants. The less population size of this species available in Nilgiri sholas may be improved through increasing the germination percentage. The population of the species could be increased by increasing the rate of germination either through seed scarification or through proper clonal treatment or through suitable *in vitro* regeneration strategies. It is suggested that commercial cultivation of the species in degraded sholas of Nilgiris by adopting the strategies of most successful regeneration of the plant has to be carried out so as to meet its increasing demand.

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