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RESEARCH NOTE

Seed source variation for albinism in Cinnamon (*Cinnamomum zeylanicum* Blume.)

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Albinism is the lack of synthesis of chlorophyll pigments in cotyledons or leaves or any green parts of the plant body. Such a rare occurrence of albino seedlings was recorded for the first time in *Cinnamomum zeylanicum* Blume. Occurrence of such albino seedlings was found to be 0.89 per cent. In fact, large seed source variation for albinism was recorded, where populations nearer to a larger meta-population showed no albinism; however, fragmented populations showed highest albinism.

Key words: Albinism, Cinnamon, Heterozygosity, Meta-population

Cinnamon (*Cinnamomum zeylanicum* Blume: Family: Lauraceae.), popularly known as "Ceylon Cinnamon" or "True Cinnamon", is the oldest spice known to man. Cinnamon is a moderately sized, bushy, evergreen tree grows upto 18 m tall and it forms lower branches with pale brown thin bark, which is strongly aromatic. Native Cinnamon sources of Sri Lanka were introduced in to India by British during the 18th century. Essential oils are commercially extracted from bark and leaves of cinnamon plants. Bark oil is used in expensive perfumes, flavouring, liquors and pharmaceutical preparations, whereas leaf oil is used in the manufacture of cheaper types of perfumes used in soap, tooth paste, hair oil, *etc.*. The Western Ghats of India is considered as the centre of origin of Cinnamon and being a cross pollinated crop, high variability for growth, quality and oil content has been reported (Krishnamoorthy *et al.,* 1991).

Albinism is lack of synthesis of chlorophyll pigments in cotyledons or leaves or any green parts of the plant body. This is one of the examples for lethal mutation, where entire albino plant or their part would die after few days of seed germination. Chlorophyll content is a key to the survival and development of green plants after germination. During seed germination, embryonic eoplasts differentiate into different plastid types including chloroplasts. However, it is often noted that seedlings show lack of chlorophyll. It is a well-known fact that chlorophyll deficiency results from genetic mutation (Ruppel *et al.,* 2011). The mutants show various levels of chlorophyll deficiency prompting their naming as chlorino, albino, xantha, variegata, viridis *etc.* However, all these levels are commonly reported as albinism. In true sense, albinism is the complete lack of chlorophyll in plants. Occurrence of albinism in plant population results from natural selfing, reduced population sizes and inbreeding within population or by mutation. This suggests that loss of genetic heterozygosity of a species within a population and hence an important parameter in population genetics (Vasudeva, 2005)

Albinism is normally lethal for the plants as photosynthesis is hampered. Depending on the level of chlorophyll deficiency, the duration of survival after regeneration varies. However, in a rare occurrence, the redwood (*Sequoia sempervirens*) albinos were shown to parasitize their parent tree by root grafting to survive and even reach a height of over 20 m (Davis and Holderman, 1980). In ornamental plants, it is considered a novelty and efforts are made to preserve these plants. But most reports include a note on the number of days to which albino seedlings survive making it clear that they ultimately die a premature death.

Forest trees too exhibit albinism. Scientific reports of albinism and chlorophyll deficiency in forest species date back to 1940s (Gunaga *et al.,* 2006). Occurrence of albino seedlings has been reported in many tree species. For instance, Gunaga *et al.* (2018) in *Caesalpinia bonduc* (with 0.83% frequency); Gunaga and Vasudeva (2011) in *Dysoxylum malabaricum*; Kala and Dubey (2012) in *Putranjiva roxburghii* (with 8.5% frequency) and Beniwal and Chauhan (2012) in *Pongamia pinnata* (3.5%) have reported albinism. However, such report is scanty in *Cinnamomum zeylanicum*; perhaps, for the first time, we report seed source variation for albinism in a progeny trial of Cinnamon.

The current experiment was conducted during 2018 to 2020 at the College of Forestry, Sirsi, Karnataka. Mature and completely ripen fruits were collected from randomly selected 90 open pollinated trees from five seed sources *viz.,* Hangal, Sirsi, Yellapura, Sagara and Siddapur representing three forest types of Karnataka state (Table 1) to evaluate the progenies of Cinnamon during 2017-18. Immediately after the collection, fruits were kept in plastic bags for 5 days to soften and to facilitate depulping, and later they were washed under tap water. De-pulped seeds were shade-dried for 24 h and then soaked in water for 24 h and used for sowing. Seeds were sown in rows on sand bed adopting Completely Randomized Design (CRD) with three replications. A large sample size of 500-750 seeds per seed source was used in the experiment.

In the present study, total 20 albino seedlings of *Cinnamomum zeylanicum* were recorded from 2300 germinated seeds and frequency of albinism was around 0.87 % (Plate 1). Perhaps, this is the first report of the natural frequency of albino seedlings in Cinnamon. Albinism is one of the important natural events that have been reported in several forest tree species as an indicator of lack of adequate cross pollination. Occurrence of albino seedlings has been reported in *Sapindus trifoliatus* with extreme low frequency of 0.000125 per cent by Gunaga *et al.* (2006). Very high frequencies of albinism have been reported in several species. For instance, Kala and Dubey (2012) reported 8.5 % albino seedlings in *Putranjiva roxburghii*; Venkatesh and Sharma (1974) recorded 21.19 %

Table 1. Seed source variation for albinism in *Cinnamomum zeylanicum*

Seed Source	District, nearest Forest Type, Population size (n)	Latitude	Longitude	Altitude (m above msl)	No. of progenies evaluated	Per cent of progenies with albinism	Frequency of albino seedlings (Per cent)*
Hangal	Haveri - Scrub Forest (n= 200)	N 14°44'14.9"	E 75°07'56.6"	584 m	25	12.0	1.13
Sagara	Shimoga - Semi Evergreen Forest (n= 450)	N 14°10'21.9"	E 75°05'57.1"	624 m	15	6.67	0.33
Sirsi	Uttara Kannada -Semi-evergreen Forest (n= 200)	N 14°48'09.2"	E 74°44'32.9"	486 m	15	6.67	0.40
Yellapur	Uttara Kannada - Evergreen Forest (n= 450)	N 14°45'10.9"	E 74°50'53.9"	474 m	25	0.00	0.00
Siddapura	Uttara Kannada - Evergreen Forest (n= 100)	N 14°20'14.8"	E 74°52'35.6"	584 m	10	0.00	0.00

*computed as per cent of the number of seedlings of all progenies in that seed source

chlorophyll deficient and 0.18 % albino seedlings from a lot of 1800 seeds of *Eucalyptus* species. Beniwal and Chauhan (2012) reported as high as 66 per cent albinism in progeny of one of the candidate plus trees of *Pongamia pinnata* studied with overall frequency of 3.5 per cent. Mirgal *et al.* (2016) observed a very high frequency (4.88 %) of albino seedlings in progenies of *Antiaris toxicaria* grown in mist chamber at Dapoli, Maharashtra. Poor pollination and/or isolation of natural populations as a result of fragmentation lead to mating among sibs and hence high levels of homozygosity in the ensuing progeny. As a consequence, recessive lethal alleles are expressed resulting in higher frequency of albino seedlings.

It was shown in our study that the initial growth of albino seedlings was good and comparable to that of normal seedlings; however, after 15-20 days, albino seedlings showed slow growth than normal seedlings. After 60 days of sowing, the albino seedlings showed almost three times lesser plant height than the normal seedlings (3.2 cm vs. 9.1 cm). None of the albino seedlings survived beyond 60 days of sowing.

Interestingly in our study, albino seedlings recorded only in three seed sources *viz.,* Hangal, Sirsi and Sagara; however, no albino seedlings were observed among half-sib families of Siddapura and Yellapura sources (Table 1). Highest frequency of albinism (1.13% albino seedlings from 12.0 % progenies) was observed in Hangal seed source situated nearer to scrub forests, which is not an ideal habitat for the Cinnamon. Since there are no other natural populations of Cinnamon around this seed source, as a result of fragmentation, this source may be experiencing severe inbreeding. Two populations *viz*., Sirsi and Sagara situated nearer to semi-evergreen forest types (where natural cinnamon is scanty) showed an intermediary frequency of albinos (0.33 % and 0.40 % albino seedlings from 6.67 % progenies each from Sirsi and Sagar). Interestingly, no albinism was observed among two seed sources situated nearer to the ever-green forests (Yellapur and Siddapur), which is an ideal habitat for a cinnamon trees. This may suggest that presence of larger meta-population of cinnamon trees is necessary for effective cross pollination and to maintain a higher heterzygosity among offspring. Rao *et al.* (1999) have also noted an interesting observation that only seeds collected from a specific locality showed albinism (0.0004 %) in *Artocarpus integrifolia*. Similar observations have been reported by Squillace and Kraus (1963) in *Tabernaemontana alternifolia* and Gunaga *et al.* (2018) reported 0.83 per cent albino seedlings in *Caesalpinia bonduc*. Out of 1326 seedlings, 11 albino seedlings were recorded from a seedling lot. It appears that it is essential to report the population parameters from where seeds are collected and progenies must be maintained by provenances while analyzing the frequency of albinism. This study, apart from reporting seed source variation for albinism in *Cinnamomum zeylanicum* for the first time, it points that sib-mating due to the lack of sufficient natural population as a plausible reason for higher albinism among some seed sources.

Plate 1. Occurrence of albinism in *Cinnamomum zeylanicum* (Cinnamon) seedlings

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