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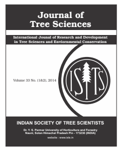

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Albino Wildling of *Tabernaemontana alternifolia* L. and a Review of Albinism in Forest Plants in India

V. K.Patil*, M. D. Patil and S. S.Narkhede

College of Forestry, DBSKKV, Dapoli, District Ratangiri, Maharashtra – 415712 (India)

* Corresponding author: vinarachna@gmail.com

ABSTRACT

A rare occurrence of albino seedling in natural regeneration of *Tabernaemontana alternifolia* is reported here. This albinic individual was characterized by exceptionally long survival compared to early reports in other species. In the context, we present a review of reports of albino seedlings in forest plants from India and found that reports came mostly from nursery stocks and rarely from natural regenerations. Collating various observations, it is hoped, this review will spur researchers into taking up planned studies of albinism rather than reporting just observations.

Key words:

albinism, chlorophyll deficiency, forest plants, in situ; mutation, selfing

INTRODUCTION

Chlorophyll content is key to the survival and development of green plants after germination. During seed germination, embryonic eoplasts differentiate into different plastid types including chloroplasts (Whatley 1978). 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). But other factors like light, temperature, media composition and culture conditions also influence the frequencies of albinos in regeneration (Kumari et al. 2009). 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.

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 are able 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 plants too exhibit albinism. Scientific reports of albinism and chlorophyll deficiency in forest species date from 1940s (Squillace and Kraus 1963). In Indian context, they have started appearing from early 1970s. Here a rare occurrence of albinism in natural regeneration of *Tabernaemontana alternifolia* L. (Apocynaceae) is reported.

While searching the literature, it was noticed that there has been an increasing trend in reporting of albinos in forest plants in recent years. So, it was considered appropriate to review the available literature on albinism in forest plants at least from India. The same is presented here.

OBSERVATIONS

T. alternifolia is a small deciduous tree of understory (Kanade et al. 2008). The species is endemic to India and can be found in different degraded forests in Western Ghats (Bhattarai et al. 2012). It is an important medicinal plant and is reported to be active against lymphocytic leukemia, diarrhea, syphilis, various forms of cancer and also found to be rich in metals (Chandrachood et al. 2009).

On February 16, 2013, an albino seedling of *T. alternifolia* was noticed in the forest adjoining Gothos village in Kudaltaluka of Sindhudurg district of Maharashtra. The seedling was in a four-leaf stage. Only very few traces of green colour were visible on the leaves of this one foot tall seedling (Fig. 1). The leaves had attained normal size at this stage and were looking healthy except for some bites by some insect.This forest had several well grown individuals of *T. alternifolia* and ample regeneration of this species. In fact, growing within 10 centimeters of this albino seedling was another normal seedling. But this normal seedling had grown nearly three times the height of the albino seedling and was in a two branch stage with 16 leaves.

Literature on albinism in forest plants in India was surveyed and compiled as Table 1. It shows a list of forest plants in which albinism has been reported so far from India. It also provides information on the habit of the species and whether the albino was observed in situ or ex situ. It was found that albinism has been reported so far in 54 forest species including 5 bamboo species, 3 climber species, 4 shrubs and 42 tree species. This includes few personal communications also. They are indicated in the table.

DISCUSSION

After literature survey, it was concluded that this is the first report of an albino seedling in *T. alternifolia*. Authors had intended to monitor the growth and survival of this albino seedling. But during their next visit to the forest, it was found that there was a forest fire and unfortunately the albino seedling was lost to it.

The closeness of two seedlings (albino and normal) and status of regeneration in the forest helped to speculate that both these seedlings germinated in the monsoon of 2012. As a corollary the albino seedling was at least 5 to 8 months old. It means this albino seedling had survived for a considerably longer period than most nursery grown albino seedlings which do not survive beyond 30-40 days (Dhillon et al. 2009; Jose et al. 2009). There could be several reasons behind this longer survival of albino: larger seed, root grafting, absence of harsh weather. This observation establishes that albino plants can survive for a long time in wild. The development, however, remains stunted.

Most common place to observe albino seedlings of forest plants is a nursery. A glance at Table 1 shows that there are numerous reports of albino seedlings in nursery stocks in comparison to fewer reports from natural regenerations in the wild. Albinic wildlings of only 6 species have been reported so far.

It is emphasized by several workers that albino mutants can be used as markers to estimate natural selfing. Estimation of natural selfing in forest plants is very important because it gives an idea about the ability of a population to retain its vigor (Squillace and Kraus 1963). It is well established that albino seedlings are homozygous recessive individuals resulting from a 1-factor segregation ratio of 3:1 (Indira and Koshy 1986; Patterson et al. 2000). However, very few efforts have been made to make use of this application as only few studies have reported estimation of natural selfing (Venkatesh and Sharma 1973; Kumar et al. 1995). Such studies demand extensive experimental set up to grow separate progenies of a large number of open crossed and selfed individuals. Nonetheless

Table 1: Review of reports on albinism in forest plants in India.

S. No.	Species	Habit	Albinism reported *In situ*/ *Ex situ*	Reference
1	*Acacia nilotica*	Tree	*Ex situ*	Nagesh and Kardam (2002)
2	*Aegle marmelos*	Tree	Ex situ	Anandalakshmi et al. (2005)
3	*Alangium lamarckii*	Tree	Ex situ	Ahirwar (2015)
4	*Antiaris toxicaria*	Tree	Ex situ	Amit Mirgal, College of Forestry, Dapoli (Pers. Comm.)
5	*Artocarpus hirsuta*	Tree	Ex situ	Abdul Kader et al. (1999)
6	*Artocarpus integrifolia*	Tree	Ex situ	Raoet al. (1999)
7	*Azadirachta indica*	Tree	Ex situ	Kulkarni and Srimathi (1987); Abdul Kader and Seethalaxmi (2000); Reddy et al. (2001); Dhillon et al. (2009)
8	*Bambusabambos*	Bamboo	Ex situ, In situ	Kumar et al. (1995); Rane et al. (2013)
9	*Bambusaarundinacea*	Bamboo	Ex situ	Indira and Koshy (1986)
10	*Bixa orellana*	Shrub	Ex situ	Kumaran et al. (2010)
11	*Bombax ceiba*	Tree	Ex situ	Venkatesh and Emmannuel (1976)
12	*Bombax insignis*	Tree	Ex situ	Venkatesh and Emmannuel (1976)
13	*Caesalpinia bonduc*	Shrub	Ex Situ	Mokat et al. (2012)
14	*Cupressus lusitanica*	Tree	Ex Situ	Karoshi and Geremew (2006)
15	*Dalbergia sissoo*	Tree	Ex Situ	Kumar et al. (1977) ; Verma and Saxena 2011
16	*Dendrocalamus giganteus*	Bamboo	Ex Situ	Dhiman and Sharma (1997)
17	*Dendrocalamus strictus*	Bamboo	Ex Situ	Kumar et al. (1993) ; Verma (2007); Rane et al. (2010)

18	*Dipterocarpus retusus*	Tree	Ex Situ	Thakur et al. (2003)
19	*Dysoxylum malabaricum*	Tree	In Situ	Gunaga and Vasudeva (2011)
20	*Erythropalum scandens*	Climber	Ex Situ	Jose et al. (2007)
21	*Eucalyptus citriodora*	Tree	Ex Situ	Nagesh et al. (2007)
22	*Eucalyptus tereticornis*	Tree	Ex Situ	Venkatesh and Sharma (1974)
23	*Garcinia indica*	Tree	Ex Situ	Rajesh Gunaga, College of Forestry, Navsari, Navsari (Pres. Comm.)
24	*Garcinia talbotti*	Tree	Ex Situ	Rajesh Gunaga, College of Forestry, Navsari, Navsari (Pres. Comm.)
25	*Gloriosa superba*	Climber	Ex Situ	Gogate et al. (2011)
26	*Gluta travancorica*	Tree	Ex Situ	Jose and Pandurangan(2011)
27	*Gmelina arborea*	Tree	Ex	Venkatesh et al. (1978) ; Karoshi et al. (2001)
28	*Humboldtia vahliana*	Tree	Ex Situ	Jose et al. (2009)
29	*Jasminummalabaricum*	Climber	In Situ	Satish Vanage, College of Forestry, Dapoli (Pers. Comm.)
30	*Madhuca bourdillonii*	Tree	Ex situ	Abdul Kader and Chac ko (2001)
31	*Madhuca latifolia*	Tree	Ex situ	Divakara and Kumar (2008)
32	*Mangifera indica*	Tree	In situ	Jeeva and Kiruba (2012)
33	*Melia dubia*	Tree	In situ	Hiremath et al. (2014)
34	*Melocanna baccifera*	Bamboo	Ex situ	Dakshindas (1995)
35	*Munduleasericea*	Tree	Ex situ	Nagesh et al. (2001b)
36	*Olea dioica*	Tree	In situ	Shareef and Rajkumar (2012)
37	Pinus roxburghii	Tree	Ex situ	Venkatesh and Thapaliyal (1977)
38	Pinus wallichiana	Tree	Ex situ	Ginwal et al. (2004)
39	Pongamia pinnata	Tree	Ex situ	Mohanty et al.(2005) ; Kumaran et al. (2007); Rajamohan and Sasikumar (2008); ; Dhillon et al. (2009); ; Beniwal and Chauhan (2012)
40	*Pterocarpus santalinus*	Tree	Ex situ	Vakshasya 1981
41	*Putranjiva roxburghii*	Tree	Ex situ	Kala and Dubey (2012)
42	*Salvadora oleoides*	Tree	Ex situ	Mertia and Kunhamu (2000)
43	*Samaniasaman*	Tree	Ex situ	Nagesh et al. (2001a)

44	*Sapindus emarginatus*	Tree	Ex situ	Anandalaxmi et al. (2013)
45	*Sapindus trifoliatus*	Tree	Ex situ	Gunaga et al. (2006)
46	*Saraca asoca*	Tree	Ex situ	Mokat et al. (2011); Gunaga et al. (2013)
47	*Simarouba glauca*	Tree	Ex situ	Rathakrishnan et al. (2003)
48	*Simmondsia chinensis*	Shrub	Ex situ	Dhillon et al. (2009)
49	*Swietenia mahogany*	Tree	Ex situ	Durai (2012)
50	*Syzygium mundagom*	Tree	Ex situ	Jose et al. (2009)
51	*Tabernaemontana alternifolia*	Tree	In situ	Present report
52	*Tamarindus indica*	Tree	Ex situ	Jaisankar et al., 2011
53	*Tectona grandis*	Tree	Ex situ	Bagchi et al., 1983
54	*Zizyphus rugosa*	Shrub	In situ	Samir Raut , College of Forestry, Dapoli (Pers. Comm.)

Photo 1: Albino wildling of Tabernaemontanaalternifolia from Gothos, Maharashtra

assisted selfing, as performed by Patterson et al. (2000) in *Eucalyptus globulus*, can be carried out to understand and monitor out crossing rates for practical purposes especially in seed orchards. In even less rigorous attempts, inferences could be drawn on the pollination biology of species just by recording useful observations about population (e.g. Indira 1988 in *Bambusa arundinacea*).

In nurseries very high frequencies of albinism are reported in some species. Venkatesh and Sharma (1974) recorded 0.18 % albino and 21.19% chlorophyll deficient seedlings in a lot of 1800 seeds. Kala and Dubey (2012) reported 8.5% albino seedlings in *Putranjiva roxburghii*. Beniwal and Chauhan (2012) reported as high as 66% albinism in progeny of one Candidate Plus Tree (CPT) of *Pongamia pinnata* with overall 3.5%. But, higher frequencies of albinos in nursery stocks imply very high mutation rates which Squillace and Kraus (1963) dismissed and proposed that a mechanism of natural selection like heterozygote preference must be operating in species showing higher frequencies of albinos. But such a mechanism can be established if comparable frequencies of albinos are recorded in such species in wild and in nursery both. Conversely, Kumari et al. (2009) have highlighted that environmental factors, too, govern the frequency of albinism. These could be working in nursery scenario at elevated frequencies.

Rao et al. (1999) noted an interesting observation that seeds collected from a particular locality showed albinism in resultant seedlings of *Artocarpus integrifolia*. Similar observations were made by Squillace and Kraus (1963). Thus, locality factors apart from environmental factors might also be having a role in occurrence and maintenance of albino mutations. The locality factors, in turn, must be associated physical factors or population genetic parameters. It would be interesting to experimentally discern the causal factors leading to albinism in such species.

Interspecific hybridization is a natural way of evolving novel genotypes that facilitates invasion and range expansion in plant species (Neuffer et al. 1999). However, it is accompanied by lethal genetic consequences. One of these has been albinism and it has been found to be very frequent (Kumari et al. 2011).

Another interesting observation is progressive development of pigmentation in albino seedlings. Amit Mirgal (pers. comm.) observed a very high frequency of albino seedlings in progenies of *Antiaris toxicaria* grown in mist chamber at Dapoli, Maharashtra. He recorded that the complete albinos progressively developed into variegated forms. His observations are ongoing and it is to be seen whetheran albino seedling turns into chlorino. This, perhaps, is the evidence that chlorophyll deficiency in seedlings is not always genetically or environmentally plastic.

Thus, several opportunities for tracing and monitoring albinism in forest plants are available. There is a need to take up dedicated studies on occurrence of albino seedlings in both natural as well as artificial regenerations. It is essential to report the population parameters from where seeds are collected and progenies must be maintained by provenances. In addition, there was a complete lack of reports of use of macro-propagation and micro-propagation techniques in generating, maintaining and monitoring albinism in forest plants. This could be a critical application for recovery of threatened species.

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REFERENCES

Abdul Kader S and Chacko KC 2001 Occurrence of mono- and poly-embryonic albino seedlings in *Madhucabourdillonii* (Gamble) Raizada. *Indian Forester* **127 (8)**: 941-943.

Abdul Kader S and Seethalakshmi KK 2000 A note on albino seedlings in *Azadirachtaindica* A. Juss.*Journal of Non-Timber Forest Products* **7** (3&4):242-243.

Abdul Kader S, Bindu KR and Chacko KC 1999 Occurrence of mono and polyembryonic albino seedlings in *Artocarpus hirsute* Hk.f. *Indian Forester* **125(11)**:1167-1168.

Ahirwar JR 2015 Occurrence of albino seedlings in *Alangium lamarckii*. *Indian Forester* **141(1)**:116-117.

Anandalakshmi R, Gurudev Singh B, Parimalam R, Warrier RR and Sivakumar V 2005 Occurrence of albino seedlings in *Aeglemarmelos* Correa. *Indian Forester* **131(7)**: 964-966.

Anandalakshmi R, Suja S, Vamadevan T, Rathnam KS, Suresh Kumar K 2013 Germination behaviour and occurrence of albino seedlings in *Sapindus emarginatus*

Vahl. *Indian Forester* **139(6)**:543-546.

Bagchi S, Emmanuel CJSK and Boisson C 1983 Germination studies in *Tectona grandis* L. *My Forest* **19(4)**: 209-213.

Beniwal RS and Chauhan R 2012 Occurrence of albino seedlings in *Pongamiapinnata* (L.) Pierre. *Indian Forester* **138 (1)**:102-104.

Bhattarai U, Tetali P and Kelso S 2012 Contributions of vulnerable hydrogeomorphic habitats to endemic plant diversity on the Kas Plateau, Western Ghats. *Springer Plus* **1(25)**: 9.

Chandrachood PS, Torane RC, Bhave AA, Deshpande NR, and Kashalkar RV 2009 Identification of Metals Found in the Leaves of *Tabernaemontana alternifolia*. *International Journal of Chem Tech Research* **1(4)**: 996-999.

Dakshindas SD 1995 Albino seedlings of *Melocanna baccifera* or *M. bambusoides. Indian Forester* **121(8)**: 768-769.

Davis DF and Holderman DF 1980 *The White Redwoods: Ghosts of the Forest*, Naturegraph Publishers, Happy Camp, CA, USA.45 pp.

Dhillon RS, HoodaMS, Sushil, Indu and Pundeer JS 2009 Albino mutants in *Azadirachta indica* (Neem), *Pongamia pinnata* (Karanj) and *Simmondsia chinensis* (Jojoba). *Indian Forester***135(9)**:1287-1290.

Dhiman RC and Sharma VK 1997 Occurrence of albino and other chlorophyll deficient seedlings in *Dendrocalanus giganteus*. *Indian Forester* **123** :435.

Divakara BN and Kumar R 2008.Albinism in *Madhuca latifolia* Macb. *Journal of Non-Timber Forest Products* **15(2)**:117-118.

Durai MV 2012 Occurrence of albino seedlings in *Swietenia mahagoni* (L.) Jacq. *Indian Forester* **138(5)**:486-487.

Ginwal HS, Sharma VK, Jadon VS, Rawat PS and Mandal AK 2004 Occurrence of albino seedlings in blue pine (*Pinus wallichiana*) and their genetic significance. *Annals of Forestry* **12(2)**: 290-292.

Gogate PP, RaneAD, Boat RI, Patil MD, Sonavane PY, Patil YB, Gunaga RP and Bhave SG 2011. Chlorophyll Deficient seedlings in *Gloriosa superba* L. *Life sciences Leaflets* **21**: 964-965.

Gunaga RP, Kiran Kumar AK and Vasudeva R 2006. Albino seedlings in *Sapindus trifoliatus* L. *Journal of Non-Timber Forest Products***13(1)**: 63-65.

Gunaga RP and Vasudeva R 2011 Albino wildlings in *Dysoxylum malabaricum* Bedd., a critically endangered tree species of Western Ghats. *Journal of Non-Timber Forest Products* **18(4)**:337-340.

Gunaga RP, Wanage SS, Mirgal AB, Rane AD, Narkhede SS and Bhave SG 2013.A note on albinism in *Saraca asoca* (Roxb) De Wild. *Indian Forester***139(5)**:471-472.

Hiremath S, Girija TN and Raghunath K 2014 A note on albinism in *Melia dubia* Cav. *Indian Forester* **140(9)**:937-938.

Indira EP 1988. Albino gene carriers and mating system in *Bambusa arundinacea* (Retz.)Willd. *Silvaegenetica*. **37(5/6)**: 249-250.

Indira EP and Koshy MP 1986 A report of monohybrid ratio for albino expression in *Bambusa arundinacea*. *Current Science* **55(19)**: 993-994.

Jaisankar I, DamodaranV, Singh D R, and Sudha R 2011. Albinism in *Tamarindus indica* L. *Indian Forester* **137(2)**:261-263.

Jeeva S and KirubaS 2012 First report of albino seedlings in *Mangifera indica* Linn. *Indian Forester* **138(9)**:860-861.

Jose PA and Pandurangan AG 2011 Occurrence of albino seedlings and its genetic significance in *Gluta travancorica* Bedd. *Indian Journal of Forestry* **34(3)**:377-378.

Jose PA, Mohanan N, and Hussain A 2009 Albino seedlings and its genetic significance in *Humboldtia vahliana* Wight. And *Syzigium mundagom* (Bourd.) Chithra – two endemic trees of southern Western Ghats. *Indian Forester* **135(1)**:137-139.

Jose PA, Pandurangan AG and Rajkumar G 2007 A note on occurrence of albino seedlings in *Erythropalum scandens* Blume. *Journal of Non-Timber Forest Products***14(2)**:125-126.

Kala S and Dubey SK 2012. Albinism in *Putranjiva roxburghii*. *Indian Forester***138 (6)**:571-572.

Kanade R, Tadwalkar M, Kushalappa C and Patwardhan A 2008 Vegetation composition and woody species diversity at Chandoli National Park, northern Western Ghats, India. *Current Science* **95(5)**:637-646.

Karoshi VR and Geremew B 2006 Mutant albino in *Cupressus lusitanica*. *Indian Forester***132**:1221-1222.

Karoshi VR, Hegde GV and Hiremath SM 2001 Albino seedlings in *Gmelinaarborea*Roxb. *Indian Forester***127**:477-479.

Kulkarni HD and Srimathi RA 1987 An albino-type natural chlorophyll mutant in Azadirachtaindica A. Juss. *Silvae Genetica* **36(1)**:44-45.

Kumar A, Bhatnagar HP and Venkatesh CS 1977. Twin seedlings in Shisham (*Dalbergia sissoo*). *Indian Forester***103**: 770.

Kumar A, Sharma VK and Beniwal BS 1993. Albino seedling in *Dendrocalamus strictus* Nees. *Indian Forester* **119(6)**:507-509.

Kumar A, Sharma V K and Dhiman R C 1995 Natural selfing in *Bambusabambos* (L.) Voss, Besch. (syn. *Bambusa arundinacea* (Retz.) Willd as estimated from albino frequencies. *Indian Forester***121(2)**:156-158.

Kumaran K, JaisankarI, NesamaniK and Paramathma M 2007 Albinism in *Pongamia pinnata* (L.) Pierre. *Indian Forester* **133(5)**:709-710.

Kumaran K, Kala S and GovindaRao M 2010 Albinism in *Bixa orellana* (L.). *Indian Forester***136(3)**:397-399.

Kumari M, Clarke HJ, Small I and Siddique KHM 2009 Albinism in plants: A major bottleneck in wide hybridization, androgenesis and doubled haploid culture. *Critical Reviews in Plant Sciences* **28(6)**:393-409.

Mertia RS and Kunhamu TK 2000 Occurrence of albino seedling in *Salvadora oleoides* Decne. *Indian Forester* **126(12)**:1349-1350.

Mohanty M, BholaN and Mohanty S 2005 Albino seedlings in *Pongamia pinnata* (L.) Pierre. *Indian Forester* **131(1)**:127-128.

Mokat DN, Desai JS and Bhave SG 2011 Albino mutants and polyembryony in *Saraca asoca* (Roxb.) de Wilde. *Journal of Non-Timber Forest Products* **18(1)**:67-70.

Mokat DN, Topare RR, Thorave PR, Bhuwad GD, Narkhede SS, and Bhave S G 2012. Albino mutants in *Caesalpinia bonduc* (L.)Roxb. - A New Report. *MFP News* **22(3)**:18-20.

Nagesh K and Kardam TS 2002 Occurrence of albino seedlings in *Acacia nilotica* (Linn.)Willd. Mimosaceae. *Indian Forester* **128(9)**:1043-1044.

Nagesh K, Goud GK, Pruthvi Raj M and Rao PS 2001 Occurrence of albino seedlings in *Samania saman* (Jacq.) Merrill. (Mimosaceae). *Indian Forester* **127(6)**:727-728.

Nagesh K, Ramesh M, Kumar V and Bhanja MR 2007. Occurrence of albino and tricotyledonous seedlings in *Eucalyptus citriodora* Hook. (Myrtaceae). *Indian Forester***133(2)**:279-281.

Nagesh K, Reddy S, ChandramouliS and Rao P S 2001 Albinism in *Mundulea sericea* (willd.) Chevel.(Papilionaceae). *Indian Forester* **127(4)**:480-482.

Neuffer B, Auge H, Mesch H, Amare llU, and Brandl R 1999 Spread of violets in polluted pine forests: morphological and molecular evidence for the ecological importance of interspecific hybridization. *Molecular Ecology* **8**:365–377.

Patterson B, Wolbang CM, Vaillancourt RE and Potts BM 2000 Inheritance of two chlorophyll mutants in *Eucalyptus globulus*. *SilvaeGenetica* **49(6)**:290-292.

Rajamohan H and Sasikumar S 2008 Sporadic occurrence of albino seedlings in kanji (*Pongamia pinnata* L.). *Indian Forester* **134(2)**:279-280.

Rane AD, Gunaga RP, Joshi SN, Jambhale AS and Bhave SG 2010 Chlorophyll deficient seedlings in *Dendrocalamus strictus* Roxb. Nees. *Journal of Non-Timber Forest Products* **17(1)**:39-40.

Rane AD, Kartik ML, Chandramouli S, Patil MB and Viswanath S 2013An albinic regenerant of *Bambusa bambos* in moist deciduous forest of Central Western Ghats. *Journal of Non-Timber Forest Products* **20(1)**:73-75.

Rao PS, Murti SSN and Venkaiah K 1999 Albinism in *Artocarpus integrifolia* Linn. F. - a case study. *Indian Forester* **125(11)**:1095-1098.

Reddy S, Nagesh K, and Raj MP 2001Occurrence of albino seedling in *Azadirachta indica* A. Juss.(Meliaceae). *Journal of Non Timber Forest Products* **8(3/4)**: 229-230.

Rathakrishnan P, Rajendran P and Divakara BN 2003Albinism in *Simmarouba glauca* Linn. *Indian Forester* **129(9)**:1167-1169.

Ruppel NJ, Logsdon CA, Whippo CW, Inoue K and Hangarter RP 2011 A mutation in Arabidopsis seedling plastid development affects plastid differentiation in embryo-derived tissues during seedling growth. *Plant Physiology* **155**:342-353.

Shareef SM and Rajkumar G 2012 Occurrence of multiple albino seedlings in *Oleadioica*Roxb.in two habitats. *Indian Journal of Forestry* **35(1)**:123-124.

Squillace AE and Kraus JF 1963. The degree of natural selfing in Slash Pine as estimated from albino frequencies. *Silvae Genetica* **12(2)**:46-50.

Thakur A, Sharma P, Das S and Singh AN 2003 Albino seedling in *Dipterocarpus retusus*: a new record. *Indian Forester* **129(4)**:541-542.

Vakshasya RK 1981Mutant albino in Red sanders. *Silvae Genetica* **30**:163.

Venkatesh CS and Emmanuel CJSK 1976 Spontaneous chlorophyll mutation in *Bombax* L. *Silvae Genetica* **25**:137-139.

Venkatesh CS and Thapaliyal RC 1977 Natural chlorophyll mutants in a Himalayan pine. *Silvae Genetica* **26**:142.

Venkatesh CS and Sharma VK 1973 Natural selfing in planted Eucalyptus and its estimation. *Journal of Plantation Crops* **1**:23-25.

Venkatesh CS and Sharma VK 1974 Some unusual seedlings of Eucalyptus: their genetic significance and value in breeding. *SilvaeGenetica* **23**:120-124.

Venkatesh CS, Arya RS and Thapaliyal RC 1978An albina-type natural chlorophyll mutant in *Gmelina arborea* Roxb.*SilvaeGenetica* **27(1)**:40-41.

Verma SK 2007Albino seedlings in *Dendrocalamus strictus* Nees. *Indian Forester* **133(1)**:133-134.

Verma SK and Saxena AK 2011Albino seedlings in *Dalbergia sissoo* Roxb. *Indian Forester* **137(4)**:525-527.

Whatley JM 1978 A suggested cycle of plastid developmental interrelationships. *New Phytologist* **80**: 489–502.