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Sal Seedling Production and Field Performance of Forest Nursery of Bhasma, Odisha

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***Abstract*: The rapid establishment of seedlings in forest regeneration or afforestation sites after planting is a prerequisite for successful reforestation. The relationship between the quality of the seedling material and their growth and survival after out planting has been recognized for decades. Despite the existence of a substantial amount of information on how to produce high-quality seedlings, there is still a need to develop practices that can be used in nurseries and at planting sites to be able to produce well-growing forest stands in ever-changing environments. Seedling survival after out planting is a complex process which can be affected by many nursery and silvicultural practices. Seedling quality can be assessed by measuring several morphological, physiological, performance attributes, and the latter integrating the morphological with physiological attributes. However, the limiting factors on the out-planting site determine the most desirable morphological and physiological seedling attributes for improving the chances for increased growth and survival after the out planting. This research paper provides the information about the plant species with seedlings available in the nursery with special focus on sal seedlings. Thus, the comparison of growing pattern of sal seedlings during initial period, after three months and after six months also analyzed.**

***Keywords*: Sal, seedlings, forest regeneration, nursery plants, growth.**

1. Introduction

The quality and germinability of seeds greatly influence the success of producing healthy and well-growing seedlings. Germinability and seedling health can be enhanced through different production methods. Global change and development of technology provide new challenges and opportunities for influencing processes along the seedling production chain. According to the projections made by Intergovernmental Panel on Climate Change [1], the global temperature will increase throughout the century. The world's forests play a key role as a carbon sink [2], and therefore, their responses to climate change may amplify or dampen atmospheric change at a regional and continental scale. During the last few years, the increased severity and frequency of summer heat waves and associated droughts have raised concerns about how climate change will interfere with forest regeneration processes. Fluctuation in the availability of genetically improved seed material has increased interest in developing the technology for the production of somatic embryos. Nursery production has traditionally focused on producing seedlings efficiently and economically. Nowadays, there is a growing interest in reducing the environmental impacts of seedling production. Sphagnum peat moss is widely used as a growth media in forest tree nurseries[3-6]. However, due to its very long regeneration time, peat is no longer considered to be a renewable resource. Furthermore, peat extraction damages peatland ecosystems and reduces its capacity to act as a carbon sink. Most seedlings are planted manually in the regeneration sites. Economic pressure and labour shortages are pushing forest owners to manage their forests more intensively to increase wood production and profitability. Mechanized tree planting has been developed in Fennoscandia as an alternative to manual planting. It has been shown to be time efficient and to lead to high-quality regeneration when compared to manual planting.

2. Materials and Methods

The seeds were collected from Bhalugarh reserve forest (RF), Bhalugarh beat, Jamtalia section, Sundargarh, Odisha. Then the seeds were sun dried. After processing and germination of sal seedlings, the plants are transferred to the Bhasma regions nurseries (N 21°57' 23.32 E 84°03'23.58'', N 21°57' 22.69'' E 84° 03'21.85'', N 21°57'21.83'' E 84°03' 19.49'', N 21° 57' 25.62'' E 84°03' 19.93'') bed for better growth. The soils in the forest nurseries are sandy loam. The climate in the study regions is sharply continental with low winter and high summer temperatures. The sowing of seeds was carried out according to the technologies adopted in each forestry institution, agrotechnical care was carried out for seedlings and young plants. Two indicators were chosen i.e. the average air temperature for the growing season (from May to October) and the amount of precipitation for the same period. Weather data were taken from the information site. For polypot seedlings and R.T seedlings seed were collected from Jamtalia R.F. Seed taken for experiment for polypot is 400 nos/1kg. For R.T seedlings 400 nos/1kg. Condition of seeds was Seeds with wings (Samara). Procedure of collection of seeds Floor of the mother sal tree was cleaned properly with Broom. Then seed branches of the tree was shaken to fall the matured sal seeds.

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Put of the fallen seeds 800 nos. good matured big size seeds were collected taken for germination. During preparation of potting mixture, Potting mixture of Polypot is Soil,Sand, C.D.M in (1:1:1) proportion. Potting mixture of R.T is Soil,Sand, C.D.M in (1:1:1) proportion. Insecticide used in potting mixture is forate 10G @ 2gms. Per polypot as well as R.T potting mixture. Filling of potting mixture is prepared by potting mixture filled in polypots of size 9” x 5” and hycopot of size 150 C.C with tray having 24 cups. After filling the hycopot as well as polypots watering done to settle the potting mixture properly and kept for 12 hrs. After plucking the wings of the seeds the seeds were dibbled in hycopots as well as polypots on the same day of collection of the seeds. Then watering done twice daily till the establishment of the seedlings. Polypot seedlings seed germination started from 5th day on wards and ended in 20th day after seed dibbling. The germination percentage found to be 86% (344 nos. found germinated out of 400 nos. dibbled). Hycopot seedlings with seed germination started from 6th day on wards and ended in 20th day after seed dibbling. The germination percent found to be 75% (300 nos. found germinated out of 400 nos. dibbled)

Fig. 1. Map of India showing Bhasma Forest nursery of Odisha.

3. Results and Discussion

It is well known that the setting of fruits and seeds is greatly influenced by weather conditions during this period. The absence of wind and precipitation during flowering reduces the range of dispersal of pollen, as a result of which under-pollination of Scots pinecones occurs. Also, weather conditions determine the size of the yield, and affect the quality of the seeds.

Table 1
Measurements in Nursery stage of polypot seedlings and hycopot seedlings

Interval	Polypot Seedlings		Hycopot seedlings.	
	Avg. Ht.	Avg.Collar girth	Avg. Ht.	Avg. Collar girth
30 days.(July-2017)	5.1	0.13	4.1	0.12
60days (Aug-2017)	9.84	0.20	10.2	0.19
90 days.(Sep-2017)	12.34	0.31	13.6	0.21
120 days (Oct.-2017)	14.5	0.42	15.1	0.32
150days. (Nov-2017)	18.5	0.57	17.6	0.36
180 days.(Dec-2017)	22.4	0.72	17.9	0.38
210 days.(Jan-2018)	26.8	0.80	18.3	0.42
240 days.(Feb-2018)	30.4	1.10	19.1	0.49
270 days.(Mar-2018)	34.2	1.18	20.4	0.51
300 days.(Apr-2018)	36.1	1.30	21.6	0.68
330 days.(May-2018)	40.12	1.50	22.8	0.72
360 days.(June-2018)	42.27	1.53	24.3	0.75

During pre-planting Operations, the total selected area of 0.8 Ha. Taken for cutting, weeding, of unwanted forest growth and weeds and burned to ashes. Ploughing done twice to break the cluds and loose and mix the top soil.The site has been divided in to two parts one for polypot seedling plantation (North site) and another for Root trainer seedlings plantation (South site). Alignment and stacking done for pitting in 4mtr. x 4 mtr. spacing. Dug out 250 nos. pits of size (45cm)3 for polypot seedling plantation and 250 nos. of pits of size (45cm)3 for R.T seedling plantation. Pitting operation carried out during 1st April 2018 to 5th April 2018. Kept for weathering up to July 1st week. Results of planting Operation of 1st Year (2018-19) shows that before planting each pits were scooped to looses the soil and 500 gm of vermicompost applied to each pits as basal dose and 6gms of insecticide. During 1st weeding numbers of casualties found in pollypot plantation and R.T. The found casualties have been replaced with available pollypot and R.T seedlings. Additional dose of 50gm. of N.P.K to each plant to boost the growth of the plant after weeding at radius of 0.5 mtr. around the each platnts. Workers also applied 50gms. of N.P.K to each plant. Measurement of seedlings during plantation is depicted in Table 2. Watering done to each plant for December 2018 to March -2019 in 15 days interval. Then April-2019 to June-2019, watering done in once in a week, four times in a month.

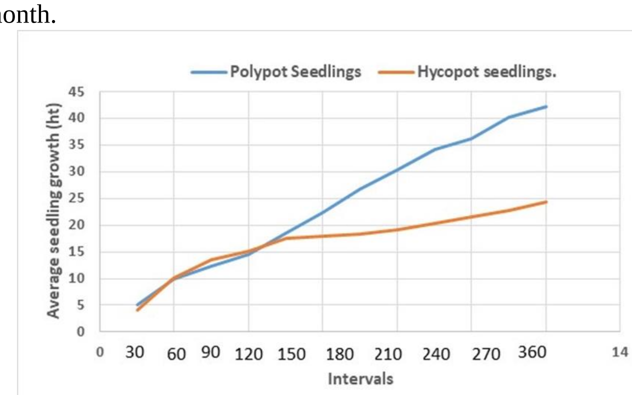

Fig. 2. Graph showing average growth of polypot and hycopot seedlings.

Table 2
Measurement of polypot seedlings and hycopot seedlings at quarterly interval

Interval	Polypot Seedlings			Hycopot seedlings.		
	Avg. Ht.	Avg. Collar girth	Suv. %	Avg. Ht.	Avg. Collar girth	Suv. %
September-2018	45.61	1.96	100	27.95	1.10	100
December - 2018	51.25	2.19	100	33.8	1.34	100
March-2019	55.28	2.66	100	40.9	1.39	100

During 2nd year operation (2019-20), soil work with removal of weed and give green manure with NPK fertilizer. Also sprayed chlorpyriphos solution to protect the plants from insects.

Table 3
Measurement of polypot seedlings and hycopot seedlings during 2nd year of seedlings

Interval	**Polypot Seedlings**			**Hycopot seedlings.**		
	Avg. Ht. in C.M	**Avg. Collar girth in C.M**	**Suv%**	**Avg. Ht. in C.M**	**Avg. Collar girth in C.M**	**Suv%**
June-2019	110.55	4.56	97	81.88	2.45	98
September-2019	120.39	5.04	96	90.57	3.68	95
December - 2019	128.3 cm.	5.52	96	88.8	4.13	95
March-2020	137.7	6.14	96	96.39	4.25	94.8

During 3rd year operation (2020-21), from 1st July 2020 to 8th July 2020 deep soil work with remove weeding and applied NPK 50gm to each plants.

Table 4
Measurement of polypot seedling and hycopot seedlings during 3rd year 2020-21

Interval	**Polypot Seedlings**			**Hycopot seedlings.**		
	Avg. Ht.	**Avg. Collar girth**	**Suv%**	**Avg. Ht.**	**Avg. Collar girth**	**Suv%**
June-2020	140.47	6.18	96	96.85	5.16	90.2
September-2020	142.6	6.21	96	97.12	5.89	90.2
December - 2020	144.3	6.25	96	97.36	6.30	89.6
March-2021	165	12.94	94	107.1	7.84	86.4

Same process followed during 4th year Operation (2021-22). The results of growth shows more in polypot seedlings (Table 5).

Table 5
Measurement of seedling polypot and hycopot during 4th year 2021-22

Interval	**Polypot Seedlings**			**Hycopot seedlings.**		
	Avg. Ht.	**Avg. Collar girth**	**Suv%**	**Avg. Ht.**	**Avg Collar girth**	**Suv%**
June-2021	177.75	14.38	94	133.12	7.66	86.4
September-2021	194.40	15.88	94	133.54	7.66	86.4

Fig. 3. Seedlings showing growths of hypocot and polypot seedlings in 30days (a,e), 60days (b,f), 180 days (c,g) and 360days (d,h) respectively

4. Conclusion

Optimal soil and climatic conditions play an important role in the cultivation of tree planting material. The geographical limits of the distribution of plant species are usually more susceptible to climate change, since environmental conditions are often at the limit of tolerance for such species [5]. This ecological marginality can lead to lower relative fertility and lower density of the local population [6], which can lead to reduced resilience in unfavourable climatic conditions. Heat supply depends on the amount of light energy, and the rhythm of seedling development depends on the length of the daylight hours. Each geographical origin has a critical photoperiod due to the sensitivity of conifers to the length of the daytime [7]. With early sowing of pine and spruce seeds in containers at the onset of the critical day length, the apical bud is laid at the end of July and the seedlings reach standard sizes by the end of the first year of life [8-10]. For sal species, an increase in a long light period allows one to accelerate and increase in the growth of seedlings and their resistance to unfavorable environmental factors [11]. The thermal regime increases the photosynthesis of young plants in order to obtain a large number of seedlings and stable seedlings. The average daily temperatures should be from 14 to 25°C, and for the intensive growth of the root system, an even higher temperature is needed, totaling to about 240°C. Although warming can promote seedling establishment in trees [14-16], seedlings are susceptible to drying out during the growing season, and this effect can increase with increasing temperature. For this reason, an increase in precipitation can promote seedling rooting much more than the warming effect, or even stimulate a warming response [17-18], but the interaction and the effects between the temperature and precipitation remains unclear. If some unfavorable soil features can be corrected or improved through the use of agricultural technology, then light and heat cannot be controlled. In especially unfavorable conditions, the only solution in this situation is to grow planting material in a closed ground with a stable microclimate. Therefore, it has been suggested that changes in other environmental factors may alter the response of tree seedlings to warming, precipitation [19-20] and the composition of existing vegetation in which tree seedlings need to adapt [21-22].

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Table 6
Floristic account of Bhasma nursery during 2022

Name of the species	**Habit**	**Family**	**Local Name**
Costus speciosus (Koenig) Sm.	H	Zingiberaceae	Gaigobora
Curculigo orchioides Gaertn.	H	Amaryllidaceae	Talamuli
Curcuma angustifolia Roxb.	H	Zingiberaceae	Chelandi
Cyanthillium cinereum (L.) H. Rob. (*Vernonia cinerea* (L.) Less.)	H	Asteraceae	Badipokosungha
Cynodon dactylon (L.) Pers.	H	Poaceae	Duba
Dactyloctenium aegyptium (L.) P. Beauv.	H	Poaceae	Kakudia ghasa
Desmodium heterophyllum (Willd.) DC.	H	Fabaceae	Kuradiagacha
Desmodium triflorum (L.) DC.	H	Fabaceae	Kuradhia
Desmodium velutinum (Willd.) DC.	H	Fabaceae	-
Elephantopus scaber L.	H	Asteraceae	Totachera
*Fimbristylis ferruginea (*L.) Vahl	H	Poaceae	-
Fimbristylis schoenoides (Retz.) Vahl	H	Poaceae	-
Geodorum laxiflorum Griff.	H	Orchidaceae	-
Globba racemosa Sm.	H	Zingiberaceae	Bana- Haladi
Gloriosa superba L.	H	Liliaceae	Agni-Sikha
Habenaria panigrahiana S. Misra	H	Orchidaceae	-
Habenaria roxburghii Nicolson	H	Orchidaceae	-
Hemidesmus indicus (L.) R. Br.	H	Asclepiadaceae	Sugandhi
Hybanthus enneaspermus (L.) F. Muell.	H	Violaceae	Madanamasta
Imperata cylindrica (L.) Raeusch.	H	Poaceae	Dabuchana
Jasminum arborescens Roxb.	H	Oleaceae	Banamalli
Laportea interrupta (L.) Chew	H	Urticaceae	Bichuati
Launaea acaulis (Roxb.) Babc. ex Kerr	H	Asteraceae	-
Phyllanthus fraternus G. L. Webster	H	Euphorbiaceae	Badiamla
Phyllanthus virgatus G. Forst.	H	Euphorbiaceae	-
Pogonatherum crinitum (Thunb.) Kunth	H	Poaceae	-
Rauvolfia serpentina (L.) Benth. ex Kurz	H	Apocynaceae	Sarpagandha
Rhynchospora colorata (L.) H. Pfeiff. (*Cyperus kyllingia* Endl.)	H	Cyperaceae	-
Senna tora (L.) Roxb. (*Cassia tora* L.)	H	Caesalpiniaceae	Chakunda
Sida acuta Burm.f.	H	Malvaceae	Suna khadika
Sida cordata (Burm.f.) Borssum	H	Malvaceae	Bisakhapuri
Sida cordifolia L.	H	Malvaceae	-
Spermacoce articularis L.f.	H	Rubiaceae	Sologonthia
Tridax procumbens L.	H	Asteraceae	Bisalyakarani
Triumfetta pentandra A. Rich.	H	Tiliaceae	Bachua
Urena lobata L.	H	Malvaceae	Bilo - Kopasia
Vanda tessellata (Roxb.) Hook. ex G. Don	H	Orchidaceae	Rasna
Viscum articulatum Burm.f.	H	Loranthaceae	Madanga
Zornia gibbosa Span	H	Fabaceae	Chenakuradhia
Phoenix acaulis Buch.-Ham. ex Roxb.	S	Arecaceae	Banakhajuri
Tephrosia purpurea (L.) Pers. var. *purpurea*	S	Fabaceae	Bana kolothia
Woodfordia fruticosa (L.) Kurz	S	Lythraceae	Dhatuki
Ziziphus oenoplia (L.) Mill.	S	Rhamnaceae	Konteikoli
Trees			
Aegle marmelos (L.) Correa	T	Rutaceae	Bel
Alangium salvifolium (L.f.) Wangerin	T	Alangiaceae	Ankulo
Albizia lebbeck (L.) Benth.	T	Mimosaceae	Sirisi
Anogeissus latifolia (Roxb. ex DC.) Wall. ex Guill. & Perr.	T	Combretaceae	Dhau
Antidesma acidum Retz.	T	Euphorbiaceae	Nun-nunia
Aporusa octandra (Buch.-Ham. ex D. Don) Vickery	T	Euphorbiaceae	Masania
Bauhinia purpurea L.	T	Caesalpiniaceae	Barada
Bauhinia variegata L.	T	Caesalpiniaceae	Kanchana
Bombax ceiba L.	T	Bombacaceae	Bura
Bridelia retusa (L.) A. Juss.	T	Euphorbiaceae	Kasi
Buchanania cochinchinensis (Lour.) M.R. Almeide (*Buchanania lanzan* Spreng.)	T	Anacardiaceae	Chara
Carallia brachiata (Lour.) Merr.	T	Rhizophoriaceae	Manja
Careya arborea Roxb.	T	Lecythidaceae	Kumbhi

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Floristic account of Bhasma nursery during 2022

Caryota urens L.	T	Arecaceae	Salapa
Cassia fistula L.	T	Caesalpiniaceae	Sunari
Chloroxylon swietenia DC	T	Rutaceae	Bheru
Cipadessa baccifera (Roth) Miq	T	Meliaceae	Pitamari
Cleistanthus collinus (Roxb.) Benth. ex Hook. f.	T	Euphorbiaceae	Karada
Dalbergia lanceolaria subsp. paniculata (Roxb.) Thoth. (Dalbergia paniculata Roxb.)	T	Fabaceae	Dhobi
Dalbergia latifolia Roxb.	T	Fabaceae	Pahadi sissu
Dendrocalamus strictus (Roxb.) Nees	T	Poaceae	Salia baunsa
Desmodium oojeinensis (Roxb.) H. Ohashi	T	Fabaceae	Bandhana
Dillenia pentagyna Roxb.	T	Dilleniaceae	Rai
Diospyros melanoxylon Roxb.	T	Ebenaceae	Kendu
Diospyros montana Roxb.	T	Ebenaceae	Jandamari
Euphorbia nivulia Buch.-Ham.	T	Euphorbiaceae	-
Ficus arnottiana (Miq.) Miq.	T	Moraceae	Jida
Ficus benghalensis L.	T	Moraceae	Baraghacha
Ficus exasperata Vahl	T	Moraceae	Karita sano
Ficus microcarpa L.f.	T	Moraceae	Jida
Firmiana simplex (L.) W. Wight (Sterculia urens Roxb.)	T	Sterculiaceae	Genduli/Kodala
Gardenia latifolia Aiton	T	Rubiaceae	Bamunia/Jhuntia
Garuga pinnata Roxb.	T	Burseraceae	Sarupatri
Glochidion zeylanicum (Gaertn.) A. Juss.	T	Euphorbiaceae	Kalachua
Gmeliana arborea Roxb.	T	Verbenaceae	Gambhari
Grewia tiliifolia Vahl	T	Tiliaceae	Dhamana
Haldinia cordifolia (Roxb.) Ridsd.	T	Rubiaceae	Halanda
Holarrhena pubescens (Buch.-Ham.) Wall.ex G. Don	T	Apocynaceae	Keruana
Holoptelia integrifolia (Roxb.) Planch.	T	Ulmaceae	Dharanja
Lagerstroemia parviflora Roxb.	T	Lythraceae	Sidha
Lannea coromandelica (Houtt.) Merr.	T	Anacardiaceae	Mahi
Madhuca longifolia (Koenig) Macbr. var. latifolia (Roxb.) A. Chev (Madhuca indica J.F. Gmel.)	T	Sapotaceae	Mahula
Mallotus philippensis (Lam.) Muell.- Arg.	T	Euphorbiaceae	Sindurigundi
Mangifera indica L.	T	Anacardiaceae	Amba
Morinda pubescens Sm.	T	Rubiaceae	Achu
Naringi crenulata (Roxb.) Nicolson	T	Rutaceae	Benta
Neolomarckia cadamba (Roxb.) Bosser.	T	Rubiaceae	Kadamba
Nyctanthes arbor-tristis L.	T	Oleaceae	Ganga siuli
Oroxylum indicum (L.) Kurz	T	Bignoniaceae	Phonophonia
Pavetta crassicaulis Bremek.	T	Rubiaceae	Pengu
Phyllanthus emblica L.	T	Euphorbiaceae	Amla
Pongamia pinnata (L.) Pierre	T	Fabaceae	Karanja
Protium serratum (Wall.ex Colebr.) Engl.	T	Burseraceae	Sarupatrimohi
Psydrax dicoccos Gaertn. (Canthium dicoccum (Gaertn.) Teijsm. & Binnend.)	T	Rubiaceae	Kuruma
Pterocarpus marsupium Roxb.	T	Fabaceae	Piasal
Putranjiva roxburghii Wall. (Drypetes roxburghii (Wall.) Hurusawa)	T	Euphorbiaceae	Poitundia
Santalum album L.	T	Santalaceae	Chandan
Schleichera oleosa (Lour.) Merr.	T	Sapindaceae	Kusuma
Semecarpus anacardium L.f.	T	Anacardiaceae	Kalabhalia
Senna siamea (Lam.) H.S. Irwin & Barneby. (Cassia siamea Lam.)	T	Caesalpiniaceae	Bada chakunda
Shorea robusta Gaertn.f.	T	Dipterocarpaceae	Sal
Streblus asper Lour.	T	Moraceae	Sahada
Strychnos potatorum L.f.	T	Loganiaceae	Kataka
Syzygium cumini (L.) Skeels	T	Myrtaceae	Jamu
Syzygium praecox (Roxb.) Rathakr. & N.C. Nair (Syzygium roxburghianum Raizada)	T	Myrtaceae	Labanisara
Tamarindus indica L.	T	Caesalpiniaceae	Tentuli
Terminalia alata Heyne ex Roth	T	Combretaceae	Sahaja
Terminalia bellirica (Gaertn.) Roxb.	T	Combretaceae	Bahada
Terminalia chebula Retz.	T	Combretaceae	Harida
Vitex negundo L.	T	Verbenaceae	Nirgundi
Vitex peduncularis Wall. ex Schauer	T	Verbenaceae	Chadeigudi
Xylia xylocarpa (Roxb.) Taub.	T	Mimosaceae	Tangini/Dhamana
Ziziphus jujuba Mill. (Ziziphus mauritiana Lam.)	T	Rhamnaceae	Barakoli
Ziziphus xylopyrus (Retz.) Willd.	T	Rhamnaceae	Gotho

Note: H - Herb, S - Shrub, T – Tree

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