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LAGERSTROEMIA SPECIOSA (JARUL) – A POTENTIAL HOST PLANT TO IMPROVE TASAR SILK PRODUCTION

Yadav, H*., Doss, S. G., Aparna, K., Kumar, B. and Sathyanarayana, K.
Host Plant Improvement Laboratory, Central Tasar Research and Training Institute, Piska Nagri, Ranchi – 835 303. Jharkhand
*For correspondence – arboriculturectrti@gmail.com

ABSTRACT

Indian tropical tasar silkworm, *Antheraea mylitta* Drury which synthesized tasar silk predominantly feeds on major host plants viz., *Terminalia arjuna*, *T. tomentosa* and *Shorea robusta.* Due to longer gestation period in establishment of Arjun, Asan in block/economic plantations, 4 & 6 years respectively, tasar rearers are deprived of returns from unit land in unit time. Hence, it is essential to identify a suitable tasar host plant with fast growing nature to facilitate short establishment period for the benefit of tasar farmers. CTRTI, Ranchi, has identify one such plant ie., *Lagerstroemia speciosa*, which is a fast growing, early sprouting and easily propagated through juvenile stem cuttings and produces profuse foliage within 60 days of pruning than that of Arjun and Asan. Due to short gestation period in Jarul (2 years) as compared to in Arjun and Asan,farmers can initiate tasar silkworm rearing after 3 years of plantation and Jarul plants can support two consecutive rearing (1st and 2nd crop) in a year from a same plant. Besides, the incidence of major foliar diseases viz., leaf gall, leaf spot, powdery mildew, Black nodal girdling are not observed in Jarul or very less within ETL and the plant is also possess inherent drought tolerant capacity. Jarul can be propagated through juvenile cuttings with 85 – 90 % of rooting in nursery. Through adaptation of integrated farming of short-duration agricultural crops viz., leguminous (black gram, green gram, horse gram, pegion pea, cow pea), oil seed (ground nut, sesame seed, mustard seed, niger), tuber (sweet potato, yam, elephant yam, beet root, carrot, radish) cash crops (ginger, turmeric, garlic, onion)in 10' x 6' spacing, a benefit: cost ratio of 2.08:1.0 can be obtained. Farmer entrepreneurs interested in mass production and sale of saplings of Jarul in nursery can obtain a benefit: cost ratio of 1.5: 1.0. Thus, Jarul is one of the ideal tasar host plant with high potential to improve the cocoon production per unit are in unit time besides uplifting the livelihood of tasar farmers in the country.

Keywords: Tasar host plant, Jarul, *Lagerstroemia speciosa*, drought tolerance.

Introduction

Indian tropical tasar silkworm, *Antheraea mylitta* Drury is a natural fauna of tropical India. Wide distribution and polyphagy of this insect had resulted in extensive variation in its population. As high as 44 eco races have been reported in this species which fed primarily on *Terminlaia arjuna*, *T.tomentosa* and *Shorea robusta.* (Ojha *et al*., 2000; Srivastava and Suryanarayana, 2005; Srivastava *et al*., 2012). Apart from *Terminalia arjuna* and *T. tomentosa*, it also feeds on *Lagerstroemia speciosa, L. parviflora,L. indica, Anogeissus latifolia, Zizyphus jujube, Terminalia belerica, T. chebula, T. paniculata, Sizigium cumini, Careya arborea* and *Hardwickia binata* etc., which are known as secondary food plants, besides several other food plants of minor importance. These food plants are available as natural associate of the Sal in dry deciduous forests of the Chota Nagpur region, which extends across the states of Jharkhand, part of Bihar, Madhya Pradesh, Chhattisgarh and West Bengal. Due to short gestation period in Jarul (2 years) as compared to in Arjun and Asan (4 & 5 years, respectively) farmers use Jarul which is a fast growing, early sprouting and easily propagated plant which can be used within a short period of2/3 years, and can support two consecutive rearing (1st and 2nd crop) in a year from a same plant.

The genus *Lagerstroemia* has 53 species with a center of diversity in tropical Asia and Australia. The species is widely distributed in Cambodia, China, Indonesia, Laos, Malaysia, Myanmar, Philippines, Thailand, Vietnam and Singapore. In India it is distributed more or less throughout the country especially in Assam, Bengal, Deccan peninsula and foot of Western Ghats. It is found at low to medium altitudes up to 2000 feet in comparatively open habitats, in disturbed or secondary forests, grassland and along rivers. The habitat varies from well drained to occasionally flooded soil. *Lagerstroemia speciosa*, also known by the common name Pride-of-India, has a wide spreading crown. It is a small to medium-sized tree growing to 50 feet, deciduous to semi-deciduous, drought tolerant, fast growing, grassfire as well as water logging tolerant, and has extensive root system. The leaves are oblong, up to 30 cm long and 13 cm wide, and are quite leathery. Due to its dense and wide spreading root system it is widely recommended for agroforestry, erosion

control, living fence, afforestation, reforestation and rain forestation of both arid and frequently inundated areas (Rehman, 1977). It is also cultivated for ornamental purposes and as a roadside tree, boundary or barrier or support. Fruits are used to cure mouth ulcers. The roots are astringent and the seeds narcotic. The wood is resistant to water logging and is used for the construction of boats, furniture, wagons, and buildings. Leaf extracts are suitable for the treatment of hyperglycemia, obesity resulting from type II diabetes and kidney diseases. A tea produced from the leaves of *Lagerstroemia speciosa* is currently available. The tree coppices freely and crown is usually bushy and spreading which makes it a suitable plant for large scale block plantation for Tasar silkworm rearing.

Based on the systematic researches it is recommended that plantation of *L. speciosa* can be taken up for tropical Tasar culture as additional tropical Tasar silkworm food plant species under block as well as forest plantation.

1. Standard cultivation practices for block / economic plantation of *L. speciosa:*

1. Raising of saplings from softwood cuttings: Softwood branch cuttings of *L. speciosa* should be collected from the basal portion from 6 years old trees during April - October. Cuttings made from these shoots by selecting 1st, 2nd and 3rd nodes. Place the cuttings in 0.2 % carbendazim (a systemic fungicide) for 5 minutes and planted in poly bags of 30 x 15 cm size filled with sand. Place the poly bags in sub- soil pits of dimension 6' x 3' x 3' (l x b x d) made under shade and cover with translucent polythene sheet. Provide support to polythene sheet by wooden cross bars. Sprinkle water sprinkling 2 – 3 times in a day on the planted cuttings and walls of the sub-soil pits to maintain the humidity around 90 per cent. After root emergence (i.e., 30-45 days), saplings should be taken out from the poly bags by tearing it and transfer them to growth medium [Soil: Sand: FYM in 1:1:1 (w/w) ratio]. These saplings should be kept either in the same pits or shady places for growth for 2-3 months for developing sturdy saplings suitable for transplantation to the field (Fig. 1, 2 & 3).

Fig. 1 : Selection of juvenile shoots from nursery grown Jarul plants for preparation of softwood cuttings.

Fig. 2 : Preparation of softwood cuttings from juvenile shoots of Jarul plants and its treatment with Bavistin solution [0.2% (w/v) in water].

Fig. 3 : Preparation of polythene nursery packets with sand, plantation of softwood cuttings of Jarul and its maintenance inside the sub-soil pit [6' x 3' x3' (l x b x d)] in nursery.

Fig. 4 : Rooted saplings transferred to rooting media [Soil : Sand : FYM in 1 : 1 : 1 (w/w) ratio] in black polythene nursery packets.

2. Raising of block/ economic plantation: One year old saplings of *Lagerstroemia speciosa* should be used for planting in the field under 10' x 5' or 10' x 6' spacing. For establishment of saplings in the field 2 years are required. Plants are to be pruned at 5' from ground level for maintain appropriate height after 3 years of plantation to facilitate pruning of branch and maintain crown height at 8 -10' level and tasar silkworm rearing activities viz., chawki rearing, transfer of worms from plant to plant and cocoon harvesting etc. (Fig. 4).

Fig. 5 : Transplantation of Jarul saplings to the field and its maintenance for establishment.

3. Inputs and cultural operations of block/ economic plantation: Basal application of recommended dose of fertilizer @50:25:25 kg of NPK Kg/ha/year are recommended to be applied to the plants after plantation of saplings in the field for the 1st and 2nd year of plantation. From 3rd year onwards, the recommended dose of fertilizer @100:50:50 kg of NPK Kg/ ha/year are to be applied to the plants. After each fertilizer application, the soil is ploughed for thorough mixing for easy availability of nutrients to the plants (Fig. 5).

Fig. 6 : Application of fertilizers followed by ploughing the Jarul Plot planted in 10' x 6' spacing.

4. Pollarding and pruning of block/ economic plantation: After 5-6 years of establishment, the main trunk of the plants has to be pollarded (cut horizontally) at 5' from ground level during the month of Mar–Apr to facilitate development of branches and plant canopy in manageable heights and also to generate qualitatively superior leaves for 1st crop rearing to be taken up during July-Aug. After completion of first crop rearing, the shoot and leaves grow faster within a month's period and the foliage is formed for second crop rearing which is conducted during Sept.–Nov. the same bushes of *Legerstroemia speciosa*.

Fig. 7 : Maintenance of Jarul plants through pruning and pollarding techniques for tasar silkworm rearing; comparison of leaf size in Jarul, Asan and Arjun.

ii. Management of soil moisture and fertility and rain water harvesting: Whole plantation area is to be bunded, except some places at higher elevation from where runoff will enter in to the plantation area. The flat soil / land are to be divided in to compartments whereas undulating soils / land are to be brought under terrace / bench plantation or to be bunded across the slopes. Along the bunds grass covered channels (1 foot wide x 1 foot deep) are to be formed. Bunds (2' feet wide x 1 foot high) are to be formed on the row line of the plantation *i.e.*, 10' (ten feet). The roots of *L. speciosa* plants will facilitate soil binding on the bunds. Width of the bund is to be kept 2' (two feet) to facilitate convenient movements during silkworm rearing. Therefore, if 1' (one foot) wide channels are made on two sides of the plantation; the soil of the channels can be used for making 2' wide bund. Channels will not only retain water in the immediate vicinity of *L. speciosa* but also facilitate controlled movement of runoff towards On Farm Reservoirs (OFRs) / Open Dug Wells (ODWs) / ditches. The basic principle is to enhance retention of rain water for a longer period in the field and also to increase its percolation into the deeper layer of soil, during monsoon season. Pre-, and post monsoon conservation tillage encompassing residue management is to be done. If agricultural crops are grown, one tillage at the time of sowing the crops and tillage after harvesting the crops is sufficient. While the bunding checks run off loss of water and ensures its standing in field for longer duration, the ploughing helps deeper percolation of water.

In order to replenish the nutrient in the soil, which are constantly absorbed by plants, both cow dung / farm yard manure (CDM / FYM) and chemical fertilizers are applied. CDM / FYM application improves the physical conditions of soil which help in improving moisture retention capacity, moderating the temporal shocks to root zone, it also adds to nutrients, particularly micronutrient and to some extent mega nutrient. Besides, organic contents are also known to serve as seat for 'N' and 'P' fixing organism, which gradually adds to soil fertility. FYM @ 400 cft/ha should be applied every alternate year to the plantation. FYM is applied at the onset of monsoon during June by making 15 to 25 cm deep circular trenches around the base of plant and filling of approximately 2 kg of FYM into it and covering it.

iii. Plant protection measures:

When the fresh foliage starts sprouting the plants need to be protected against various pests and diseases, which may cause considerable leaf loss, both in terms of quality and quantity. Therefore, spray of Rogor @ 0.3% (Dimethoate 30%EC; a systemic insecticide) and Bavistin @ 0.2% (Carbendazim 50%WP; a systemic fungicide) is to be done at 15-20 days interval, keeping 15 days safe period for silkworm rearing.

iv. Intercropping in the field:

In between the rows of *L. speciosa* plants intercropping of agricultural crops (rainy season's leguminous, oil seed, spices and vegetables etc. depending on the soil type and the area) is to be adopted.Sowing of leguminous crops will enhance soil fertility, check the soil erosion and generate the income during gestation period of the plantation. Apart, it checks infestation by weeds. In the areas where intercropping of agricultural crops is not possible, wild leguminous crops can be grown. Mulching of these crops and/or weeds is to be resorted.

At the onset of first monsoon showers, the land is thoroughly ploughed after broadcasting of farmyard manure @ 4000 kg (i.e. 400 cft)/ha. Before sowing of the agricultural crops, chemical fertilizer (@50N:25P:25K) is broadcasted and mixed well in the soil as per the recommended dose for full-grown *L. speciosa* plantation. Sowing of agricultural crops is done leaving 1-foot space on both the sides for convenient movements and operations during silkworm rearing.

Cropping patterns for integrated farming in *L. speciosa* plantation

L. speciosa + Ground nut (*Moongfali*)
L. speciosa+ Pigeon pea (*Arhar*)
L. speciosa+ Green gram (*Moong*)
L. speciosa+ Black gram (*Urd*) – Gram (*Chana*)
L. speciosa+ Black gram (*Urd*) – Mustard (*Sarson*)
L. speciosa+ Black gram (Urd) + Pigeon pea (*Arhar*)
L. speciosa+ Cowpea (*Lobia*)
L. speciosa+ Cowpea (*Lobia*) + Pigeon pea (*Arhar*)
L. speciosa+ Horse gram (*Kulthi*)
L. speciosa+ Niger (*Sarguja*)
L. speciosa+ Ginger (*Adarak*)
L. speciosa+ Turmeric (*Haldi*)
L. speciosa+ Any of above during rainy season-Winter vegetables (*viz.*, Spinach, Fenugreek, Coriander, Radish, Carrot etc.)
L. speciosa+ Elephant foot yam (Ole)
L. speciosa+ Sweet potato (Sakarkand)

Fig. 8 : Preparation of Jarul plot for intercropping and raising of leguminous green manure crops & mulching for enriching the soil with nitrogen & OC% content through green manure plant biomass.

3. Standard of package for silkworm rearing:

First crop silkworm rearing is done during July–Mid August. Plants are shaped simultaneously with the transfer of worms. Cultural operations are attended and second dose of Urea is applied immediately. Second crop silkworm rearing is conducted during September – October.

After an establishment period of 2 years, Jarul plants can be used for tasar silkworm rearing which is usually conducted during July–Aug. (First crop) and Sept.–Nov. (Second crop) on established plants of *Legerstroemia speciosa* planted under 10' x 5' or 10' x 6' spacing in the field. Newly hatched healthy tropical Tasar silkworm larvae were brushed on the foliage of *L. speciosa* and reared till the harvesting of cocoons. Standard package of practices viz., field disinfection, foliage disinfection, spraying of insecticide/ pesticide to prevent harmful pest and predators and foliar disease-causing microbes etc., are followed during the entire rearing period. 1st and 2nd crop rearing are conducted on the same bushes in *L. speciosa*.

4. Economics of Nursery seedlings, intercropping and silkworm rearing :

Table 1 : Unit cost of 10000 cuttings/sapling of *L. speciosa*

S. No.	Particulars	Inputs/ Quantity	Rate	Cost /Amount
A. 1	One white poly tube (25x5cm) @ Rs- 0.35	10000	Rs-0.35	3500
2.	One Man day's filling in one day 250 polytube	40 Manday's	200/Manday	8000
3.	200 cft sand @ 4000			4000
4.	Cuttings planted into sand rooting media 250 cuttings/person per day	40 Manday's	200/Manday	8000
5.	One manday/day	60 Manday's	200/Manday	12000
6.	Making of sub-soil pit (6x3x3ft) 1 person/day/pit	10man days	200/man day	2000
7.	White Polythene sheet for covering cutting growth pit (6x3x3ft)	1kg	175/kg	175
8.	Miscellaneous; Bavistine @ 0.1g/litre	1 k.g	300/kg	300
B. 1.	Black poly Tube required	8000	0.50/piece	4000
2.	FYM/soil/sand rooting media	300	3/k.g	900
3.	Rooting media preparation	2 Manday's	200/Manday	400
4.	Rooting media filling in Black Polytube (25x10 cm) 200 tube/day person	30 Manday's	200/Manday	6000
5.	Cuttings are planted into rooting media (3:2:1) 250 cuttings planted/ person/day	24 Manday's	200/Manday	4800
6.	One Manday's for watering	90 Manday's	200/Manday	18000
7.	Miscellaneous:	Insecticides /fungicides		500
Vegetative propagation through juvenile cuttings (Part-A) One cutting cost @ Rs- 3.8				37975
Seedling development in rooting media (Part-B) One sapling cost @ Rs- 5.6				33600
Input Cost for One sapling (A+B) = Rs. 9.4				
Selling price of 1 sapling by Nursery entrepreneur = Rs. 20/-				
Benefit cost ratio =				**2.13 : 1.00**

Table 2 : Input cost for 1 hectare *Lagerstroemia speciosa* plantation with intercrops and silkworm rearing

Sl. No.	Crops	Land preparation (Rs.)	Labour cost (Rs.)	FYM (Rs.)	Chemical Fertilizer (Rs.)	nsecticide Fungicide (Rs.)	Seeds (Rs.)	Irrigation (Rs.)	Total (Rs.)	Cost of dfls* (200 dfls/ha@ Rs. 12	Cost of Chemicals (Rs.)	Total	Total input cost (A+B)
1	ole Tasar foo plant	2400	0	11100	3180	550	0	0	17230	2400	700	3100	20330
2	Tasar food plant+Gnut	2400	7326	11100	4890	1100	10200	250	37266	2400	700	3100	40366
3	Tasar food plant+GrGrm	2400	8316	11100	4675	1100	1890	250	29731	2400	700	3100	32831
4	Tasar food plant+ BlkGm	2400	7326	11100	4675	1100	1800	250	28651	2400	700	3100	31751
5	Tasar food plant+Msd	2400	4752	13875	5345	1100	920	500	28892	2400	700	3100	31992
6	Tasar food plant+ EleP	2400	29700	13875	1885	1100	80000	500	129460	2400	700	3100	132560
7	Tasar food plant+Ginger	2400	17622	13875	1885	1100	70000	500	107382	2400	700	3100	110482
8	asar food plar + Turmeric	2400	31482	13875	1885	1100	72000	500	123242	2400	700	3100	126342

Table 3 : Economics of with *Lagerstroemia speciosa* cultivation, silkworm rearing& intercrops.

Sl. No.	Crops	Gross income (Rs. / ha.) (A)			Input cost (Rs./ ha.) (B)			Net income (A-B) (Rs. / ha.)	Additional income Intercrop (Rs. / ha.)	Total	Benefit: cost ratio (B:C)
		Rearing (60 Cocoon / DFLs @2.5 /cocoon	Intercrop produce	Total	Plantation	Rearing	Total				
1	Sole Tasar food plant	31000	0	31000	17230	3100	20330	10670	1000	11670	1.52 : 1
2	Tasar food plant+Gnut	31000	112000	143000	37266	3100	40366	102634	17586	120220	1.77 : 1
3	Tasar food plant+GrGrm	31000	42500	73500	29731	3100	32831	40669	12910	53579	1.63 : 1
4	Tasar food plant+ BlkGm	31000	62300	93300	28651	3100	31751	61549	16777	78326	1.74 : 1
5	Tasar food plant+Msd	31000	68000	99000	28892	3100	31992	67008	4494	71502	1.64 : 1
6	Tasar food plant+ EleP	31000	180000	211000	129460	3100	132560	78440	12000	90440	1.59 : 1
7	Tasar food plant+ Ginger	31000	297000	328000	107382	3100	110482	217518	7000	224518	1.84 : 1
8	Tasar food plant + Turmeric	31000	360000	391000	118742	3100	121842	269158	6500	275658	1.90 : 1

Economics of Tasar silkworm rearing on *Lagerstroemia speciosa*

Spacing 10' x 6', No. of plants/ha- 1852, Avg leaf yield/ plant- 3 Kg , Avg leaf yield/ ha- 5556 Kg, Quantity of leaf required/ DFL = 15 Kg (50 eggs/ DFL@ 300 g leaves/ worm), Rearing capacity (DFLs)/ ha = 250 DFLs, Cost of DFLs = 3000/- (@Rs. 12/- per DFL), No. of eggs/ DFL = 50, Cocoon yield (No.)/ha = 12500, Gross income from 250 DFLs = 37500 (@Rs. 3.00 / cocoon), Expenditure/ha 18000 (Cultural operations + FYM & fertilizers + Manpower + DFL cost), Net income (Profit) = 19550 and Benefit : Cost ratio = 2.08 : 1.00.

Conclusion

Overall growth performance and leaf yield /plant of 2-years-old-plants of *L.speciosa* was higher than *T.arjuna* under 10x 6' spacing in the field which makes it more suitable plant as compared to *T.arjuna* for block plantation. *L. speciosa* is an early sprouting and fast-growing plant species when compared to *Terminalia arjuna* and *T. tomentosa*.

The bioassay and grainage performance of the silkworm is better in *L. speciosa* as compared to *T. arjuna* except the larval duration. Silk ratio and filament length were at par with Arjun and Asan which may be due to the similar level of protein and moisture contents in the leaves of Jarul resulting quality-wise equality of leaves with other major host plants of tasar silkworm. Slight increase in larval duration might be due to high quantity of phenols in leaves of *L. speciosa*. Phenols are considered as the ideal quantitative defense mechanism in the plants and found in abundance in *L. speciosa*. According to Loomis and Battelle (1966) the phenol protein complexes are stable at acidic and neutral pH levels but dissociate at higher alkaline pH. Since the gut pH in *A. mylitta* is highly alkaline therefore, higher phenol level in the leaves might be utilized by the silkworm for its own benefit. This has been corroborated by Pandey (1977) in *Antheraea proylei* J. fed on leaves of *Quercus* sp. He found that the presence of tannin in cocoon shell corresponded with leaf tannin contents and concluded that it seems reasonable that alkalinity in larval gut reflects adaptation of *A. proylei* to tannin contents in oak leaves.

High quantity of proline in *L. speciosa* as compared to *T. arjuna* is an indication of adaptation of Jarul to water stress conditions in dry and deciduous forests. Based on the better performance of *L. Speciosa* observed in bioassay studies, it can be taken up for tropical Tasar culture as additional tropical Tasar silkworm food plant species under block as well as forest plantation. It is very easy to propagate and fast growing as compared to *T. arjuna* and *T. tomentosa*. Furthermore, it has an added advantage over *T. arjuna* that two consecutive rearing can be taken up on same plants. By generating saplings of Jarul, a farmer can generate an additional income to the tune of B:C ratio of 2.13:1, apart from tasar silkworm rearing (B:C ratio 2.08: 1) and intercropping of short duration crops (B:C ratio 1.52 to 1.90).

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