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LAC CULTIVATION TRIALS ON *MOGHANIA MACROPHYLLA* (WILLD.) O. KTZE (SYN. *FLEMINGIA CONGESTA* ROXB. VAR. *SEMIALATA* BAK.)

By

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Introduction

The existing method of lac cultivation on tree hosts involves considerable cost on labour for the different cultivation operations such as pruning, inoculation, *phunki* removal, harvesting etc. With a view to reduce the cost of cultivation, and thereby add to lac's competitive power vis-a-vis synthetic resins in the world markets, various investigations have been carried out, of which those with bush type host species are described here. With such a host, cultivation operations can be carried out from the ground and the laborious process of climbing huge tall trees is avoided. Besides, bushes lend themselves to various farming treatments such as manuring, irrigation, control of pests etc., and thereby, for intensive cultivation of lac.

Trials conducted on *Moghania macrophylla* (Syn. *Flemingia congesta* var. *semialata*) (Hindi *bhalia*) have proved that, it is a satisfactory lac host being capable of taking inoculations of both *rangeeni* and *kusmi* lac strains. Results of experiments on the raising of this species and its exploitation for lac cultivation are recorded in this paper.

Moghania macrophylla (Family: Leguminosae, Subfamily: Papilionaceae): This is a tall erect shrub growing to a height of 8'-10' with sulcate silky branches, and is widely distributed in the Himalayan and Sub-Himalayan forests from Chamba to Bhutan, in Khasi and Naga Hills in Assam, the hills of Parashnath and Visakhapatnam and along the Western ghats in South India upto a height of 5000 feet. It is known to be one of the minor lac hosts of Assam, chiefly in Mikir hills for growing *rangeeni* lac. Its use for lac cultivation, however, is being gradually discontinued in those areas.

Silvicultural notes on the raising of the plants.

Experiments were conducted on the raising of these bushes on a plantation scale both by direct sowing of seeds and by transplantation of nursery raised seedlings, and it was found that both the methods are satisfactory. However, transplanting of nursery-raised seedlings has the advantage of initial quick growth and should be preferred.

Direct sowing of seeds.

For direct sowing of seeds, pits $1\frac{1}{2}' \times 1\frac{1}{2}'$ and 2' deep may be dug in March-April at a spacing of 6' between the rows and 4' within the rows. The soil in the pits should be thoroughly mixed with farmyard manure at the rate of 5 to 10 cart loads per acre depending upon the soil fertility. In June, taking advantage of the summer showers, three to four seeds may be sown close together in well-loosened soil in each pit. Weeding should be carried out regularly once every two weeks during the rainy season. In the subsequent seasons the loosening of the soil and weeding round the plants should be done before the onset of the rains. The idea of sowing three to four seeds in each pit is to allow for mortality and also to ensure bushy growth of plants right from the beginning. At this rate about 6 oz. (170 gm.) of seeds will be required for raising a plantation of 1800 bushes per acre. The plants thus raised attain a height of 4' to 6' within 12 to 15 months and become full grown in 4-5 years. They, however, get ready for inoculation in about 18-24 months from the time of sowing.

Transplanting nursery raised seedlings.

Nursery beds may be prepared in March by deeply digging the beds. Seven beds, $4' \times 30'$ each, will be required to raise seedlings sufficient for planting one acre. The beds should be heavily manured with farmyard manure at the rate of about $1\frac{1}{2}$ md.

(or 55 kg.) per bed. Seeds may be sown at a spacing of 6'' x 6'' in the beds and regularly watered till the monsoon sets in. Because of heavy manuring and copious watering of the nursery beds, germinating seedlings grow up quickly and attain a height of 1' to 1½' within 2½ to 3 months. Meanwhile, pits in the field should be got ready as in the case of direct sowing, and transplanting may start with the onset of the monsoon rains. The transplanted seedlings grow vigorously, and attain a height of about 4-6 feet in about 6 to 9 months' time and get ready for initial lac crop inoculation by the second year, i.e., 12 months after transplanting in the main field.

Regular lac cultivation from the second or third year onwards, on the bushes raised by either transplanting or direct sowing, leads to profuse tillering and a gradual increase in the size of the stool. The plants coppice well and produce a large number of coppice shoots. A four to five year old plant gives rise to 10 to 20 coppice shoots of lengths varying from 4 to 8 ft.

The plants stand repeated cropping quite well, and following every harvest, either in January-February or June-July, a large number of buds appear which develop into shoots in course of time. The main period of growth is from April to September and the coppice shoots continue to grow satisfactorily till the inoculation is repeated again following one year's rest.

At the Institute's plantation, plants raised 9 years ago and regularly inoculated with lac crops from the third year onwards, still continue to coppice well and put forth coppice shoots satisfactorily, thus indicating that the plantation once raised can continue for many years without having to be replaced.

Lac cultivation trials.

Inoculation with both *rangeeni* and *kusmi* strains of the lac insects was tried. To start with, experiments were conducted with the *rangeeni* strain only. Two-year old plants were inoculated in 1954 and onwards and regular lac cultivation was carried out till 1959 in both the *Katki* and *Baisakhi* seasons. The results of the experiment are furnished in Table I. *(Please see page 307).*

It may be observed that with the average brood to yield ratio (Sticklac) as 1 : 3.4 in the *Katki* and 1 : 2.5 in the *Baisakhi* season the crop performance of the *rangeeni* strain on this bush may be regarded as satisfactory. The yield per plant, however, is not much because of the encrustation getting quite sparse towards crop maturity.

Investigations were initiated in 1958 on the possibility of utilising this bush as an alternative host for raising *kusmi* crop. Encouraging results were obtained and hence research on all aspects of cultivation for developing it into a successful alternative *kusmi* host was intensified, particularly in regard to the three following aspects, namely:

(i) if *M. macrophylla* can do well as an alternative host for the *kusmi* strain in both the *Aghani* and *Jethwi* seasons,

(ii) to study the effect and possibilities of cultivating *kusmi* strain of the lac insects continuously on this species,

and (iii) if the *kusum* and *M. macrophylla* could be successfully alternated to grow the *Jethwi* crop on *kusum* and the *Aghani* crop on *M. macrophylla*.

Three sets of experiments on the above aspects were conducted. In all the cases, one-year-old coppice shoots were inoculated.

Experiment I.

To test the performance of *M. macrophylla* in the *Jethwi* and *Aghani* seasons the trials were conducted on the following lines. Bushes were inoculated with *kusum* broodlac or progeny of *kusmi* strain in January-February for raising *Jethwi* crop and harvested in June-July when the crop matured. Similarly, the *Aghani* inoculation was carried out in another plot in June-July with fresh *kusum* broodlac or progeny of *kusmi* strain and the crop was harvested in January-February. The results of the experiment are given in Table II. *(Please see page 308.)*

Table I

Crop data on the inoculation experiments with *Moghania macrophylla*.

Year	No. of plants inoculated	Quantity of broodlac used				Yield of broodlac as lac sticks		Total Yield				Ratio of brood to yield	
		Lac sticks		Scraped lac				Lac stick		Scraped lac		Lac sticks	Scraped lac
		lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.		
						Katki Crop							
1954	20	4	0	1	0	12	12	33	12	6	6	1:8.6	1:6.5
1955	50	6	4	1	7	13	0	33	12	6	9	1:5.4	1:4.6
1956	50	10	0	1	3	5	0	43	4	3	12	1:4.3	1:3.2
1957	100	13	8	2	2	28	12	58	0	5	0	1:4.3	1:2.5
1958	60	15	0	2	0	17	4	32	8	2	8	1:2.2	1:1.2
1959	75	34	8	5	11	40	6	109	6	13	1	1:3.2	1:2.3
Average	59	13	14	2	4	19	8.3	51	9	6	3.3	1:4.7	1:3.4
Average yield (Stick lac) per plant 1.69 oz.													
						Baisakhi Crop							
1954—55	50	12	4	2	12	3	2	61	8	6	5	1:5.0	1:2.3
1955—56	50	13	0	2	5	10	0	50	0	4	10	1:3.8	1:2.0
1956—57	The crop was a failure												
1957—58	170	20	0	2	8	7	8	65	8	6	8	1:3.3	1:2.6
1958—59	100	16	0	3	2	15	0	80	0	9	11	1:5.0	1:3.1
Average	92.5	15	5	2	10.8	8	14.5	64	4	6	12.5	1:4.3	1:2.5
Average yield (Stick lac) per plant 1.17 oz.													

Table II

Crop data on the performance of *M. macrophylla* in *Jethwi* and *Aghani* seasons.

Year	No. of plants	Quantity of brood used				Yield of broodlac		Total Yield				Ratio of brood to yield	
		Lacsticks		Sticklac				Lacsticks		Sticklac			
		lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	Lacsticks	Sticklac
						Jethwi crops							
1958	64	16	0	6	14	6	14	46	14	10	8	1:2.9	1:1.1
1959	60	23	8	9	3	8	8	28	8	5	0	1:1.2	1:0.5
1960	100	62	8	34	12	77	4	357	4	51	0	1:5.7	1:1.5
Average	75	33	10.7	16	15	30	14	144	3.3	22	3	1:4.3	1:1.3
Average yield (Sticklac) per plant : 4.73 oz.													
						Aghani crops							
1958—59	70	23	12	7	5	44	0	84	4	16	4	1:3.5	1:2.2
1959—60	100	53	12	22	0	34	0	86	8	29	2	1:1.6	1:1.4
1960—61	100	77	4	12	4	35	0	115	0	29	5	1:1.5	1:2.4
Average	90	51	9.3	13	13.7	37	10.6	95	4	24	14.3	1:1.8	1:1.8
Average yield (Sticklac) per plant : 4.42 oz.													

FIG. I

A growing bush.

FIG. II

Lac inoculated bushes in rows.

FIG. III

A close up view of a bush showing large number of shoots with lac encrustration.

FIG. IV

Area showing harvested bushes.

It may be seen that the crop performance on the whole is satisfactory in either season. On an average, a yield per plant of 4.73 oz. and 4.42 oz. for the *Jethwi* and *Aghani* crops respectively was obtained, although the corresponding ratios of brood used to crop yield were 1:1.3 and 1:1.8. That is to say that inspite of the ratios being less as compared to the *rangeeni* crops, the per plant-yield in the case of *kusmi* crops is nearly three times that of *rangeeni* crops.

Between the two *kusmi* crops, the *Aghani* crop is quite satisfactory, and much better than the *Jethwi* in which the cell development was comparatively poor owing to the extreme drought during the summer.

To see if the effect of summer heat could be mitigated by such measures as irrigation and manuring, the plants in the *Jethwi* season (1960) were manured with farm yard manure and also irrigated during the summer. The plants responded well, each yielding half a pound of sticklac.

Experiment II.

The effect and possibilities of raising the *kusmi* strain of the lac insect on *M. macrophylla* continuously was studied as follows:

The plants were inoculated in January-February with fresh *kusum* broodlac for producing *Jethwi* 1958 crop. The crop harvested in June-July 1958 and the broodlac obtained was again inoculated on *Moghania* bushes for raising the *Aghani* 1958-59 crop. The brood obtained from this crop was utilised to raise the next *Jethwi* (1959) crop on *Moghania* and again the fourth generation crop (*Aghani* 1959-60) was also raised on *Moghania* plants. The crop having failed due to severe infestation of enemy insects, the experiment was restarted in *Jethwi* (1960) season and the second generation was raised on *Moghania* in *Aghani* (1960-61) season.

The results of the experiment are given in table III.

Table III

Crop data on continuous growing of *kusmi* strain on *M. macrophylla*.

Crop & year	Brood history	No. of plants	Quantity of broodlac used				Yield of brood lac & lac sticks	Total Yield		Ratio of brood to yield	
			Lac sticks		Stick lac			Lac sticks	Stick lac	Lac sticks	Stick lac
			lb.	oz.	lb.	oz.	lb. oz.	lb. oz.	lb. oz.		
Jethwi '58	*1st generation* *Kusum* x *Moghania macrophylla*	64	16	0	9	10	6 14	46 14	10 8	1:2.9	1:1.1
Aghani '58-59	*2nd generation* M.m (K) x M.m	30	6	14	1	8	9 8	19 8	4 0	1:2.8	1:2.7
Jethwi '59	*3rd generation* M.m (KxM.m) x M.m	20	9	8	2	8	8 3	11 0	2 12	1:1.2	1:1.1
Aghani '59-60	*4th generation* M.m (K x M.m x M.m) x M.m	12	3	8	0	14	—	—	—	—	—
Jethwi '60	*1st generation* *Kusum x Moghania macrophylla*	100	62	8	34	12	77 4	357 4	51 0	1:5.7	1:1.5
Aghani '60-61	*2nd generation* M.m (K) x M.m	100	77	4	12	4	35 0	115 0	29 5	1:1.5	1:2.4

It is evident from the crop data that the *kusmi* strain can be grown continuously on *Moghania* bushes although there was the usual interference due to drought in the *Jethwi* (summer) season and enemy insects in the *Aghani* (rainy) season. Again the performance in the *Aghani* season was better than that in the *Jethwi* season inspite of the predatory enemies as is evident from the ratios of broodlac to crop yields (in terms of stick lac).

There was no difference in the crop durations or in the quality or other characteristics of the lac crop.

Experiment III.

In view of the fact that these bushes can take successfully heavier inoculations in the *Aghani* season, alternation of *M. macrophylla* and *kusum* for production of *kusum* crop was investigated as follows. *Kusum* brood from *Jethwi* crop (1958) raised on *kusum* trees was used to raise the *Aghani* (1958-59) crop on *M. macrophylla*. The brood obtained from matured crop in January-February 1959, was used to inoculate *kusum* trees for raising the *Jethwi* (1959) crop. The latter was cropped in June-July, 1959 and the brood obtained from this crop was again taken back to *M. macrophylla* to raise the *Aghani* (1959-60) crop.

The results of this experiment are given in table IV.

Table IV

Crop Data on Alternation of *Kusum* in *Jethwi* and *Moghania* in *Aghani* Seasons.

Crop & year	Brood history	No. of plants	Quantity of broodlac used		Yield of brood lac as sticks	Total yield		Ratio of brood to yield	
			Lac sticks	Scraped lac		Lac sticks	Scraped lac	Lac sticks	Scraped lac
			lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.		
Aghani 58-59	*1st generation* *Kusum x Moghania macrophylla*	40	10 0	4 6	25 4	45 4	8 4	1:4.5	1:1.9
Jethwi 59	*2nd generation* M.m (K) x *Kusum*	1	11 4	2 8	4 8	12 4	3 11	1:1.1	1:1.5
Aghani 59-60	*3rd generation* K (KxM.m) x M.m	12	4 8	1 7	3 8	7 8	1 14	1:1.7	1:1.3

The results indicate that the *kusum* tree and *Moghania* bushes can be successfully alternated in the *Jethwi* and *Aghani* seasons respectively. It may also be noted that the performance of *Moghania* is as good as that of *Kusmi*.

Analysis of *Moghania* lac samples.

To ascertain the effect of propagating the *kusumi* strain on *Moghania*, samples of lac grown on both *Moghania* and *kusum* were tested for the bleach—and colour—index.

Results of analysis are given in table V. It will be seen that lacs grown on either host have more or less the same bleach—and colour—index.

Table—V.

Results of testing samples of lac raised on *kusum* trees as well as *Moghania* bushes with the *Kusmi* strain.

Sample No.	Particulars	Aghani '59-60 crop		Jethwi '60 crop	
		Kusum x Kusum	Kusum x M. macrophylla	Kusum x Kusum	Kusum x M. macrophylla
I	Bleach index	83	85	78	82
	Colour index (Seedlac)	12	15	17	21
II	Bleach index	83	78	—	—

Also samples of *kusmi* strain lac raised continuously on *Moghania* for three seasons (generations) were analysed and it was found that the bleachability and colour index were within the *kusmi* range, even in the third-generation samples, indicating that there is no deterioration in quality due to the change of host.

Table VI.

Analysis of lac samples raised on *Moghania* continuously for three seasons.

Particulars	Jethwi '58 (K x M.m)	Aghani '58-59 Mm. (K) x M.m	Jethwi '59 M.m (K x M.m) x M.m
Bleach index	75	75	84
Colour index (Seedlac)	9	11.7	14

Notes on the use of *M. macrophylla* for the cultivation of *kusmi* lac.

From the experimental studies carried out as above it has been established that *M. macrophylla* is a very satisfactory alternative host for raising lac crops of *kusmi* strain. Because of other additional advantages, such as the reduced cost of cultivation, possibility of intensive cultivation, and the fact that it can be raised easily and in the shortest possible time in all uncultivated and cultivable waste lands, lac cultivation on this species is highly promising in our attempt to achieve targets of increased production of *kusmi* lac, which is of a superior quality.

Bushes from about the 2nd year onwards can be put under lac. Inoculation should be light to start with and may be gradually increased in intensity as the plant grows. When the bushes are full grown, i.e., 4 to 5 years old, they can take full crop inoculations, and yield big crops. Thereafter, they will continue to yield heavy lac crops for many years to come. Bushes about 5 years old will need about 6 to 8 oz. of brood lac and may yield as much as half a lb. of scraped lac. At this rate, for inoculating 1800 bushes in an acre about 9 md. of brood lac will be required and a yield of upto ten md. of stick lac may be obtained.

It has been found that bushes from which a lac harvest has been reaped will be ready for re-inoculation in a year's time and, therefore, a rest of one year will be required by these bushes between any two crops. These bushes need no special pruning treatment, as the crop-harvest in January–February or June–July also serves the purpose of pruning. Hence the harvesting should be carried out carefully. While reaping the lac crop, the bushes should be given a clean cut at a height of 9"–12" above the ground.

Some of the advantages of this host are : (i) inoculation of the crop., *phunki* removal and harvesting of the lac are carried out from the ground; (ii) the bushes are concentrated and the branches being thin and tender, are easily cut; (iii) pruning as a separate operation is not required; (iv) guarding of lac towards crop maturity becomes effective and cheap. These factors contribute towards reduced costs of cultivation. Another important advantage is that effective control of insect enemies of lac crops through timely hand picking and destruction is made possible. There is also scope for intensifying crop production through agronomical treatments like manuring and irrigation which are being taken up for further study.

The only disadvantage is that this bush is badly broused by cattles and goats and should, therefore, be properly guarded against this menace. If possible, the plantation should be fenced to keep off cattles and goats.

Coupe system of cultivation

For raising *kusmi* crops continuously on *M. macrophylla* on a plantation scale, working the area on a three coupe system will be found necessary as these bushes need one year's rest after a six-month crop. Plantations raised with these bushes should, therefore, be divided into three Sub-plots or coupes (to be called A, B & C) of equal area with same number of bushes to be worked in rotation one after the other according to the following scheme :

Operations to be carried out	*Coupe 'A'*	*Coupe 'B'*	*Coupe 'C'*
Inoculation	Jan.–Feb.	June–July of the same year.	Jan.–Feb. of next year.
Cropping	June–July of the same year.	Jan.–Feb. of next year.	June–July of next year.
Inoculation	June–July of next year.	and so on	

For the *Jethwi* crop it may be found advisable to have somewhat lighter inoculation, so that crop development and broodlac survival are better during the summer season.

Alternation with *kusum* tree.

These bushes can be planted in areas where *kusum* trees occur naturally, and exploited for lac cultivation along with the *kusum* trees for augmenting the *kusmi* crop production. Such an alternation may also prove useful in maintaining the vigour of the insect strain. Under such conditions, the existing number of *kusum* trees should be divided into two equal coupes and each of the coupes planted with adequate number of *M. macrophylla* bushes, so that the brood produced from one of the *kusum* coupes is fully used up for inoculation of the *M. macrophylla* bushes within the same coupe. Thus, in all, there will be four coupes, i.e., two of *kusum* and two of *M. macrophylla*.

The rotation to be followed with the four coupes will be as follows with one and a half year's rest for both *kusum* & *M. macrophylla*.

Operation to be carried out	*Coupe I* (kusum)	*Coupe II* (M. macrophylla)	*Coupe III* (kusum)	*Coupe IV* (M. macrophylla)
Inoculation	Jan.–Feb.	June–July of same year.	Jan.–Feb. of next year.	June–July of next year.
Pruning and harvesting	June–July of same year.	Jan.–Feb. of next year.	June–July of next year.	Jan.–Feb. of third year.
Inoculation	Jan.–Feb. of third year.	and so on		

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