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Analysis of rangeeni lac production on two host trees in different agro climatic zone of Madhya Pradesh

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Abstract
The study conducted in the Seoni and Balaghat districts of MadhyaPradesh, India during the year 2019-20 focused on comparing the safety and yield of two crops, *Katki* and *Baishakhi*, on two host trees, *Z. mauritiana* and *B. monosperma*. After analyzing the data, it was found that *Katki*crop was significantly safer than *Baishakhi* on both host trees. Additionally, it was observed that the total yield of lac was higher on *B. monosperma* due to its larger canopy size, while the lac yield per foot stick was higher on *Z. mauritiana* tree. This suggests that *Z. mauritiana* may be a more efficient host plant for lac production, while *B. monosperma*may be more suitable for overall lac production.

Keywords: Lac cultivation, *Rangeeni* lac, lac host, *Z. mauritiana* and *B. monosperma*

Introduction

Lac is a natural resin that is produced by a tiny insect called Kerria lacca (Kerr), belonging to the family Tachardiidae (Homoptera) (Meena *et al*. 2022) [6]. This insect feeds on plant sap and secretes a resinous substance (lac) on the branches of its host tree (Singh *et al*. 2009) [9], which hardens when it comes in contact with air. The adult lac insects are protected by a hard lac crust, and the resin they produce is completely natural, biodegradable, and non-toxic. As a result, it is widely used in various industries including food, textiles, and pharmaceuticals (Chen *et al*. 2010) [3]. The lac insect has been found to have around 113 host tree species and can complete its life cycle on them (Kumar, 2013) [4]. However, only three traditional host plants – Kusum (*Schleichera oleosa*), *Palas* (*Butea monosperma*) and *Ber* (*Ziziphus mauritiana*) are used for commercial lac cultivation (Kumar, 2013). In India, there are two major strains of the lac insect known as *Kusmi*and *Rangeeni*, each with specific host plants. *S. oleosa* is the suitable host for the *Kusmi* strain while *B. monosperma* is suitable for the *Rangeeni* strain. However, *Z. mauritiana* is a common host for both strains of the lac insect (Kumar *et al*. 2015) [5].

The Rangeeni lac insect has been a major contributor to the national lac crop production, accounting for 80% of the total production (Anees and Monobrullah. 2016 [1] This particular strain of lac insect is known for its ability to produce two crops in a year - the summer crop, also known as baisakhi crop, and the rainy season crop, also known as *Katki* crop. The summer crop matures in June-July, taking about 8 months, while the rainy season crop matures in October-November, taking only 4 months. Before starting lac cultivation, it is important to consider two key factors - the suitable host plant on which the lac insect can thrive and the climatic conditions of the area. This ensures a successful lac cultivation process and a high yield of lac production.

As the state Madhya Pradesh is situated in the central part of India, it holds a significant position in the production of *Rangeeni* lac. During the year 2013-14, Madhya Pradesh contributed to 2,497 tons of the total 21,008 tons of lac produced in India. The production of *Rangeeni*lac in Madhya Pradesh is mainly dependent on two major host trees, *B. monosperma* and *Z. mauritiana*, which are abundantly available in the state. With the availability of these host trees and favorable climatic conditions, the state has been able to achieve high production levels of *Rangeeni* lac. In order to further understand the production capabilities of *Rangeeni*lac, a present study was conducted in Madhya Pradesh, covering both major host trees and two different agro-climatic zones. This study also aimed to understand the seasonal variations and production capabilities of *Rangeeni* lac in Madhya Pradesh. This study aimed to provide valuable insights into the production potential of *Rangeeni* lac in the state and contribute towards its growth and development in the future.

Materials and Methods

The study was conducted in two districts, Seoni and Balaghat, of the state of Madhya Pradesh, India during the year 2019-20. These districts were selected as they represent different agro-climatic zones, with Seoni falling under the Kymore plateau zone and Balaghat under the Chhatishgarh plains. Ten villages were selected from each district and ten farmers (5were chosen from each village for data collection. The study recorded data such as lac yield per tree, lac yield per foot lac stick, and dry weight per 100 cells from each farmer. Statistical analysis of the data was conducted using ANOVA and t-test. This study provides valuable insight into the production of lac in these districts and highlights the impact of different agro-climatic conditions on lac production.

Table 1: Study area and name of villages selected for study

S. No.	Agro-climatic zone	Name of district	Name and no. of village covered	No. of Lac growers covered
1	Kymore plateau	Seoni	(1) Dharna Kala, (2) Sarekha Kala, (3) Janamkhari, (4) Chimakheri, (5) Dulhapur, (6) Dhobisarra, (7) Dondiwada (8) Gokulpur, (9) Saila, and (10) Avri	100
2	Chhattisgarh plain	Balaghat	(1) Siwar Ballan, (2) Basegano, (3) Katangjhari, (4) Rategaanv, (5) Pipariya, (6) Mehkapat, (7) Naadgaanv, (8) Deemrutola, (9) Paraswada, (10) Panbhari	100

Results and discussion

Data collected from 10 villages of each district (Seoni and Balaghat) was analyzed and described under following head

1. Lac production per plant

The data showed that in the Seoni district, lac production per plant was significantly higher during the *Katki* season on both hosts, with 4.74 kg/plant from *Z. mauritiana* and 5.61 kg/plant from *B. monosperma*. This was compared to the Baishakhi crop, which had a production of 4 kg/plant from *Z. mauritiana*and 5.33 kg/plant from *B. monosperma*. The difference in lac production may be due the climate change. Temperature increase in summer can decline the yield of lac (Mohansundram *et al*, 2014) [7]. Anees and Monobrullah (2016) [1], also suggested that *Katk*i crop is most safe and in comparison, to *Baishakhi* crop. However, in the Balaghat district, there was no significant difference in lac production per plant during both seasons on both hosts. In the *Katki* season, the production was recorded at 5.09 kg/plant and 3.43 kg/plant from *Z. mauritiana*and *B. monosperma* trees respectively, while in the Baishakhi season it was 5.34 kg/plant and 3.16 kg/plant from *Z. mauritiana*and *B. monosperma* trees respectively. Further analysis revealed that lac production per plant was significantly higher on *B. monosperma*, with 5.61 kg/plant in the *Katki* season and 5.33 kg/plant in the Baishakhi season in Seoni district. In Balaghat district, the production was recorded at 5.12 kg/plant in the *Katki* season and 5.34 kg/plant in the Baishakhi season on *B. monosperma* trees specifically. This may be due to large canopy of *B. monosperma*tree.

Table 2: Mean lac production in district Seoni

S. no.	Villages	Mean Lac production/plant (In kg.)			
		Katki		Baishakhi	
		Ber	Palash	Ber	Palash
1	Dharna Kala	4.1	6.43	3.1	5.69
2	Sarekha Kala	5.15	5.27	3.64	5.00
3	Janamkhari	4.87	5.10	3.81	4.89
4	Chimakheri	5.15	6.02	4.62	5.13
5	Dulhapur,	5.12	4.98	3.77	5.63
6	Dhobisarra	4.70	4.90	4.21	4.85
7	Dondiwada	4.52	6.32	3.87	5.80
8	Gokulpur	4.52	6.23	4.14	5.72
9	Saila	4.72	4.94	4.05	4.77
10	Avri	4.48	5.86	4.75	5.86
Mean		4.74	5.61	4.00	5.33

Table 3: ANOVA (Seoni)

Source	DF	SS	MSS	F cal	CD	F tab 5%
Season	1	2.57	2.57	10.98	0.310	4.11(S)
Plant	1	12.21	12.21	52.23	0.310	4.11 (S)
Season x Plant	1	0.54	0.54	2.32	0.439	4.11 (NS)
Error	36	8.42	0.23			
Total	39	23.73				

Table 4: Mean lac production in district Balaghat

S. no.	Village	Mean Lac production/plant (In kg.)			
		Katki		Baishakhi	
		Palas	Ber	Palas	Ber
1	Siwar Ballan	5.69	3.25	6.43	2.85
2	Basegano	5.58	2.56	6.32	3.15
3	Katangjhari	4.98	2.47	5.17	3.25
4	Rategaanv	5.05	3.45	5.20	4.15
5	Pipariya	5.13	5.12	4.87	3.25
6	Mehkapat,	4.91	4.15	5.40	2.50
7	Naadgaanv,	4.98	4.25	4.73	3.00
8	Deemrutola,	4.95	3.15	4.66	2.50
9	Paraswada,	4.83	2.5	5.30	3.75
10	Panbhari	5.09	3.75	5.30	4.12
Mean		5.12	3.43	5.34	3.16

Table 5: ANOVA (Balaghat)

Source	DF	SS	MSS	F cal	CD	Ftab 5%
Season	1	0.00	0.00	0.00	0.399	4.11 (NS)
Plant	1	34.97	34.97	90.15	0.399	4.11 (S)
Season x Plant	1	0.47	0.47	1.20		4.11 (NS)
Error	36	13.96	0.39			
Total	39	49.40				

2. Lac yield per foot stick lac

In the Seoni district, the Katki season showed higher lac yield with 45.78 g/foot stick from *Z. mauritiana* and 40 g/foot stick from B. *monosperma*, compared to the *Baishakhi* season which had a production of 43.45 g/ foot stick from *Z. mauritiana* and 36.77 g/foot stick from *B. monosperma*. Similar results were seen in the Balaghat district, with a production of 41.67 g/ foot stick and 38.83 g/ foot stick from *Z. mauritiana* and *B. monosperma* trees respectively during the *Katki* season, and 39.85 g/ foot stick and 37.36 g/ foot stick during the *Baishakhi* season. Further analysis showed that *Z. mauritiana* trees had significantly higher lac yield per foot stick in both districts, with 45.78 g/ foot stick in the *Katki*season and 43.45 g/ foot stick in the *Baishakhi* season in Seoni district, and 41.67 g/ foot stick in the *Katki* season and 39.85 g/ foot stick in the *Baishakhi* season in Balaghat district specifically. These findings highlight the importance of seasonal variations and host plants in determining lac production per foot stick, with *Z. mauritiana* being a more favorable host for lac production in both districts. Similarly, Netam *et al* (2019) [8] reported that *Z. mauritiana*is the much better host for *Rangeeni*lac production in comparison to *B. monosperma.* Biyani *et al* (2022) [2] also revealed that *Z. mauritiana*is the more suitable host for *Rangeeni*lac cultivation.

Table 6: Mean lac yield per foot stick in district Seoni

S. no.	Village	Lac yield per foot stick lac (In g.)			
		Katki		Baishakhi	
		Ber	Palash	Ber	Palash
1	Dharna Kala,	44.53	39.74	52.65	39.74
2	Sarekha Kala	49.35	38.51	42.23	37.78
3	Janamkhari	51.02	45.40	49.25	28.86
4	Chimakheri	48.57	37.43	41.36	36.74
5	Dulhapur,	44.82	41.38	40.52	40.56
6	Dhobisarra	45.15	43.10	42.48	32.32
7	Dondiwada	41.25	40.01	38.95	40.85
8	Gokulpur	43.17	39.67	40.87	37.26
9	Saila	44.15	34.72	42.75	36.80
10	Avri	39.75	34.85	37.36	33.19
Mean		45.78	40.00	43.45	36.77

Table 7: ANOVA (Seoni)

Source	DF	SS	MSS	F cal	CD	F tab 5%
Season	1	73.04	73.04	4.83	2.494	4.11 (S)
Plant	1	367.66	367.66	24.31	2.494	4.11 (S)
Season x Plant	1	1.36	1.36	0.09	3.527	4.11 (NS)
Error	36	544.39	15.12			
Total	39	986.44				

Table 8: Mean lac yield per foot stick in district Balaghat

S. no.	Village	Lac yield per foot stick lac (In g.)			
		Katki		Baishakhi	
		Palash*	Ber	Palash*	Ber
1	Siwar Ballan	38.36	42.35	39.74	41.42
2	Basegano	39.12	40.07	37.78	38.51
3	Katangjhari	35.32	39.85	40.85	40.01
4	Rategaanv	41.35	43.62	37.26	39.67
5	Pipariya	42.05	42.61	40.56	41.38
6	Mehkapat,	40.74	44.35	32.32	43.10
7	Naadgaanv,	38.36	41.98	40.85	40.01
8	Deemrutola,	36.75	39.75	37.26	39.67
9	Paraswada,	37.42	40.45	33.19	34.85
10	Panbhari	38.64	44.36	39.34	38.79
Mean		38.83	41.67	37.76	39.85

Table 9: ANOVA (Balaghat)

Source	DF	SS	MSS	CD	Fcal	Ftab 5%
Season	1	23.93	23.93	1.500	4.38	4.11 (S)
Plant	1	61.36	61.36	1.500	11.22	4.11 (S)
Season x Plant	1	4.24	4.24	2.121	0.77	4.11 (NS)
Error	36	196.92	5.47			
Total	39	286.45				

3. Fresh and dry weight of 100 lac cells

The analysis of fresh and dry weight in two different districts, Seoni and Balaghat, suggested that fresh weight was significantly higher in both *katki* and Baishakhi seasons. In Seoni, the fresh weight of 100 lac cells was 4.29 g in *katki* season and 3.70 g in Baishakhi season, indicating a higher growth rate during *katki* season. However, there was no significant difference in the dry weight of 100 lac cells between the two seasons in this district. Similar results were seen in Balaghat, where the fresh weight of 100 lac cells was 4.19 g in *katki*season and 3.70 g in Baishakhi season, with no significant difference in dry weight. These findings suggest that environmental factors, such as temperature and precipitation, may have a significant impact on the fresh weight of cells during different seasons (Mohansundram *et al*, 2014, Singh *et al*, 2021) [10]. Further research is needed to determine the specific factors influencing these results and their potential implications for cell growth and production in these districts.

Table 10: Mean fresh and dry weight of 100 lac cells in district Seoni

S. no.	Village	Mean fresh and dry weight of 100 lac cells			
		Fresh weight		Dry weight	
		Katki	Baishakhi	Katki	Baishakhi
1	Dharna Kala,	4.04	4.08	2.43	2.53
2	Sarekha Kala	3.66	4.01	2.24	3.32
3	Janamkhari	3.38	3.14	2.63	2.36
4	Chimakheri	4.88	3.61	4.09	2.88
5	Dulhapur,	3.42	3.51	2.63	2.61
6	Dhobisarra	5.06	3.39	3.98	2.28
7	Dondiwada	5.27	3.88	4.24	2.83
8	Gokulpur	4.88	3.77	3.91	2.85
9	Saila	4.03	3.89	2.43	2.50
10	Avri	3.36	3.87	2.24	2.81
Mean		4.29	3.70	3.18	3.70
Df		18		18	
$t_{0.05}$		1.88		1.35	
P		0.04 (S)		0.10 (NS)	

Table 11: Mean fresh and dry weight of 100 lac cells in district Balaghat

S. no.	Village	Mean fresh and dry weight of 100 lac cells			
		Fresh weight		Dry weight	
		Katki	Baishakhi	*Katki*	Baishakhi
1	Siwar Ballan	3.66	4.02	2.24	2.28
2	Basegano	4.03	4.08	2.43	2.54
3	Katangjhari	4.88	3.61	3.73	2.80
4	Rategaanv	4.82	3.64	2.43	2.54
5	Pipariya	4.9	4.65	3.69	2.91
6	Mehkapat,	3.42	2.98	2.43	2.54
7	Naadgaanv	4.88	3.61	3.7	2.59
8	Deemrutola	3.37	3.07	2.62	2.36
9	Paraswada	3.75	4.02	2.27	3.33
10	Panbhari	3.94	4.08	2.55	2.54
Mean		4.19	3.74	3.74	2.84
Df		18		18	
$t_{0.05}$		1.51		0.75	
P		0.07 (S)		0.23 (NS)	

Conclusion

The production of *Rangeeni*lac heavily relies on the environment and suitability of the host tree. In this regard, *Katki*crop has proven to be a safer option compared to *Baishakhi* crop. The summer season, characterized by increased temperatures, poses a threat to the yield of lac. the suitability of the host tree is equally important, the Ber tree has been found to be more suitable for lac cultivation than the Palas tree**.**

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