

PRODUCTIVITY BASED PERFORMANCE AND LIFE CYCLE OF LAC INSECT, *Kerria lacca* (Kerr) (HEMIPTERA: KERRIIDAE) IN SELECTED DISTRICTS OF MAHARASHTRA, INDIA

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ABSTRACT

A field study was conducted to evaluate the productivity and life cycle parameters of the lac insect, *Kerria lacca* (Kerr), on *Flemingia macrophylla* host plants during the Baisakhi crop season across nine districts of Maharashtra, India. The objective was to identify regional variations affecting lac cultivation performance. The mean duration of crawler emergence varied significantly, ranging from 58 days in Sindhkhede Raja, Buldhana, to 43 days in Chandori, Bhandara. Initial crawler settlement density was highest in Surkuda, Gondia (87.33 ± 4.17 crawlers/cm²), and lowest in Beed (44.53 ± 3.69 crawlers/cm²), with corresponding initial mortality rates ranging from 20.31% to 40.87%. After 21 days of settlement, the maximum nymphal density remained in Surkuda (56.11 ± 2.75 nymphs/cm²), while Beed recorded the lowest (28.00 ± 4.38 nymphs/cm²). The proportion of male insects was highest in Beed (85%) and lowest in Chandori, Bhandara (43.89%). Final female cell density at crop maturity showed a similar pattern, with the highest in Surkuda (9.88 ± 0.64 cells/cm²) and the lowest in Beed (1.53 ± 0.19 cells/cm²). Other developmental stages also varied, the pre-sexual stage lasted between 103.2 ± 0.37 and 109.2 ± 0.37 days, and male emergence occurred between 123.2 ± 0.58 and 126.4 ± 0.60 days. The female maturity period ranged from 235.2 ± 0.58 days in Buldhana to 256.2 ± 0.80 days in Loha, Nanded. These findings indicate considerable regional differences in lac insect development and productivity, influenced by local environmental and ecological conditions. The results provide critical insights for selecting optimal cultivation sites and timing interventions to improve lac yield and sustainability in Maharashtra.

Keywords: Life cycle, *Kerria lacca*, Productivity, *Rangeeni* strain

Insects are the most abundant organisms on earth comprising up to 80 per cent of all organisms (May, 1988). They are an integral part of our ecosystem and contribute in the global food production. Insects deliver a host of ecological services that are fundamental to the survival of mankind. Productive insects are also known as beneficial insects which includes honey bees, silkworm and lac insect which are adapted to the local environment. The main products obtained from these beneficial insects include honey, silk and shellac. The exportation and domestic sale of insects' products generate huge amount of revenue and thus serves as a means of livelihood to the insect farmers (Niyonsaba *et al.*, 2021).

Lac insects are commercially exploited for their valuable secretions, resin, dye, and wax, which have a wide range of applications in industries such as food, pharmaceuticals, cosmetics, paints, and varnishes (Ramani *et al.*, 2007). These secretions are produced by the tiny scale insect *Kerria lacca* (Kerr), a member

of the family Kerriidae, superfamily Coccoidea, and order Hemiptera (Pal, 2009; Mohanta *et al.*, 2012). Lac insects primarily thrive on the tender shoots of specific host plants, and over 400 plant species have been reported globally as potential hosts (Roonwal *et al.*, 1958; Sharma *et al.*, 2006). In India, traditional lac cultivation has predominantly relied on a few key host tree species, including Palash (*Butea monosperma*), Kusum (*Schleichera oleosa*), and Ber (*Ziziphus mauritiana*). More recently, non-traditional host plants such as *Flemingia macrophylla* and *Flemingia semialata* have been successfully evaluated for lac cultivation, demonstrating promising potential in terms of insect survival and resin yield (Yogi *et al.*, 2017).

Kerria lacca exists in two distinct strains, namely *rangeeni* and *kusmi*, each adapted to specific host plants and seasonal cycles. The *rangeeni* strain is primarily cultivated on *Butea monosperma* and *Ziziphus mauritiana*, while the *kusmi* strain is associated with *Schleichera oleosa* (Kusum) trees. Both strains complete two life cycles per year, resulting in two harvestable crops annually. The

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crops of the *rangeeni* strain are termed *Katki* (July-November) and *Baisakhi* (November-July), whereas the *kusmi* strain yields the *Jethwi* (January-July) and *Aghani* (July-January) crops. The *Baisakhi* and *Jethwi* crops are harvested during the summer, while the *Katki* and *Aghani* crops are collected in winter (Sharma and Jaiswal, 2002).

The life cycle of the lac insect begins with the emergence of crawlers, which are the first instar nymphs. These mobile crawlers actively disperse over the tender shoots of host trees and settle to feed on phloem sap by inserting their proboscis into the vascular tissue (Mohanta *et al.*, 2014). After settlement, the nymphs undergo three successive molts, culminating in the adult stage. During their feeding phase, the insects secrete a resinous substance that encases their bodies, later harvested as raw lac. To prevent occlusion of vital body openings by resin, lac insects also secrete a white, thread-like protective wax. The duration of each developmental stage is influenced by several factors, including host plant species, crop season, and prevailing environmental conditions (Mohanta *et al.*, 2014).

In addition to influencing the quantity of lac produced, significant variations in biological parameters such as sex ratio, fecundity, and nymphal mortality have been reported across different lac populations (Chauhan and Teotia, 1973; Monobrullah *et al.*, 2016). These variations directly affect encrustation density and consequently impact overall lac yield.

The state of Maharashtra, located in western India along the Arabian Sea, spans an area of 307,713 km², accounting for 9.36% of the country's total geographical area. It encompasses three major

physiographic zones: the Deccan Plateau, Western Ghats, and Coastal Plains. Maharashtra experiences a tropical monsoon climate, with average annual temperatures ranging between 25 °C and 27.5 °C and annual rainfall ranging from 1,600 to 2,000 mm. The state's recorded forest area is 61,965 km², which constitutes approximately 20.14% of its total area (Government of Maharashtra, 2022).

Maharashtra ranks as the fourth-largest lac-producing state in India, contributing approximately 1,465 tonnes annually, which represents about 8% of the national lac output (Yogi *et al.*, 2018). The primary lac-producing districts within the state include Gondia, Bhandara, and Gadchiroli, where lac cultivation is a traditional practice among local communities. However, there is a lack of documented information on the occurrence and performance of lac insects in other districts of the state.

The present study was undertaken to comprehensively assess the productivity and life cycle characteristics of *Kerria lacca* populations across multiple locations in Maharashtra. The focus was specifically on the *rangeeni* strain during the *Baisakhi* season, with the goal of identifying region-specific biological and productivity-linked parameters. Findings from this study could be instrumental in expanding lac cultivation beyond traditional districts and optimizing practices for enhanced lac yield and sustainability across the state.

MATERIALS AND METHODS

Collection of lac insect samples

The present study was carried out in November 2022-July 2023 (Baisakhi crop) at Regional Field Gene Bank situated in State Forest Research Institute Jabalpur (M.P.). To carry out the present study brood

Table 1. Sample collection sites of Maharashtra

Site name	Block	District	Collected host	GPS locations	
				E	N
Loha	Loha	Nanded	<i>Albizia saman</i>	77° 7' 14.05"	18° 57' 27.75"
Ambad	Ambad	Jalna	<i>Ficus religiosa</i>	75° 54' 22.8"	19° 50' 38.2"
Secta	Aurangabad	Aurangabad	<i>F. religiosa</i>	75° 37' 21.02"	19° 52' 14.08"
Washim	Washim	Washim	<i>F. religiosa</i>	77° 8' 27.93"	20° 6' 28.68"
Beed	Beed	Beed	<i>A. saman</i>	75° 45' 33.91"	19° 1' 53.88"
Chandori	Bhandara	Bhandara	<i>Butea monosperma</i>	80° 42' 28.83"	21° 6' 45.10"
Malhivra	Kalamnuri	Hingoli	<i>F. religiosa</i>	77° 18' 21.6"	19° 40' 36.0"
Sindhkhede Raja	Sindhkhede Raja	Buldhana	<i>F. religiosa</i>	76° 06' 10.3"	19° 56' 43.3"
Surkuda	Aamgaon	Gondia	<i>B. monosperma</i>	80° 17' 20.64"	21° 20' 13.06"

lac samples were collected from nine different districts of Nanded, Jalna, Aurangabad, Washim, Beed, Bhandara, Hingoli, Buldhana, Gondia districts of Maharashtra (Table 1).

To establish a gene bank of lac host plants, seeds of *Flemingia macrophylla* were procured from the National Institute of Secondary Agriculture (NISA), Ranchi. The seeds were initially sown in sand beds under open environmental conditions to facilitate germination. After a period of two months, healthy seedlings were transplanted into polybags for further growth and development. Once the plants reached a suitable physiological stage, brood lac was inoculated onto the healthy individuals of *F. macrophylla*. At the time of inoculation, the *F. macrophylla* plants exhibited an average height of 1.30 meters and an average collar girth of 9.2 millimeters, indicating their readiness to support lac insect colonization.

Observations

To study the productivity and life cycle of the lac insect (*Kerria lacca*), broodlac samples were collected from nine distinct locations, each representing a different district of Maharashtra. Each broodlac sample was inoculated onto five healthy *Flemingia macrophylla* plants under controlled field conditions. To protect the developing insects from predators and parasitoids, the broodlac was cut into small segments weighing approximately 10 grams and enclosed within 60-mesh nylon net bags. Observations were recorded from the lower, middle, and upper canopy regions of each plant, which were pre-marked to ensure consistent sampling across all replicates. The methodology adopted for broodlac inoculation, insect settlement, and observational data collection followed the standardized protocol described by Mohansundaram *et al.* (2016).

Duration of crawler emergence (Days)

The crawler emergence period of lac insect was observed using a magnifying lens. Visual observation started on the day the first crawler was seen and continued until no new crawlers were observed for several consecutive days. The total number of days between these two points was considered as the duration of the crawler emergence period.

Initial density of settlement (number per square cm)

To record the initial density of settlement of lac insect crawlers, the card board paper with one cm² area cut window was placed on the three sites of

plants (lower, middle and upper). Then, their average value was taken as the initial density of settlement of that particular source.

Initial mortality (%)

After 21 days of lac insect settlement the larvae which were unable to find suitable sites for settlement, died due to starvation were counted at all the three (lower, middle and upper) sites and their average value was calculated and taken as mean initial mortality.

Initial mortality =

$$\frac{\text{Initial density} - \text{Density after 21 days of settlement}}{\text{Initial density}} \times 100$$

Density of lac insect after 21 days of settlement

Density of settlement was again observed after 21 days of inoculation of brood lac when the crop had matured. Surviving lac insects after 21 days of settlement were counted at all the three (lower, middle and upper) sites and the average value was calculated in the same manner as in case of initial density.

Sex ratio (% of male insects)

During the sex differentiation stage, larvae can be differentiated into male and female lac insects based on their morphological differences (males are elongated and females are round shaped). The number of male and female cells per square cm was counted by placing the graph paper with a cut window of one square cm on the stem of host plant with the help of a magnifying lens. Then, their average value was calculated and taken as the mean sex ratio.

$$\text{Male \%} = \frac{\text{Number of male insects}}{\text{Total number of insects}} \times 100$$

Density of lac insect at crop maturity (number per square cm)

The surviving female lac insects were counted following the emergence of male insects, corresponding to the crop maturity stage, identified by the appearance of the characteristic yellow spot. Counts were recorded separately from the lower, middle, and upper canopy regions of each host plant, and the average of these values was calculated to determine the mean female density at crop maturity.

Duration of pre sexual stages (Days)

During the sex differentiation stage, the total time elapsed between broodlac inoculation and sex

differentiation stage of the lac insect was recorded as duration of pre sexual stages (days).

Duration of male emergence (Days)

During the sex differential stage, the total time elapsed between broodlac inoculation and initiation of male emergence of lac insect was recorded as duration of male emergence (Days). The duration between initiation of male emergence to its completion was recorded as male emergence period (Days).

Life period (days) of the female cell

To record the life period of female cells, the total time elapsed between date of inoculation and crop harvesting (crawler emergence) was recorded as life duration of the female lac insect.

Statistical analysis

The statistical analysis was performed following methodology described by Kalahal *et al.* (2017). The data were analyzed for mean, standard error, critical difference, critical variance to assess the significance of variations among treatments.

RESULTS AND DISCUSSION

Duration of crawler emergence

The data revealed that the longest duration of crawler emergence occurred in Sindhkhede Raja, Buldhana (58 days), followed by Malhivra, Hingoli and Surkuda, Gondia (both 53 days), and Ambajogai, Beed (52 days). In contrast, the shortest duration was recorded in Chandori, Bhandara (43 days), followed by Loha, Nanded and Shekta, Aurangabad (both 47 days) (Fig. 1).

Mean initial density of settlement

The mean initial settlement density (crawlers per cm²) exhibited significant variation across different locations. The highest mean density was recorded in Surkuda, Gondia (87.33 ± 4.17 crawlers/cm²), followed by Shekta, Aurangabad (81.07 ± 8.91 crawlers/cm²) and Sindhkhede Raja, Buldhana (80.77 ± 3.14 crawlers/cm²). In contrast, the lowest mean density was observed in Beed (44.53 ± 3.69 crawlers/cm²), followed by Malhivra, Hingoli (46.16 ± 1.77 crawlers/cm²) and Ambad, Jalna (46.22 ± 2.92 crawlers/cm²) (Table 2).

Mean initial mortality (%)

The highest mean initial mortality percentage was recorded in Shekta, Aurangabad (40.87%),

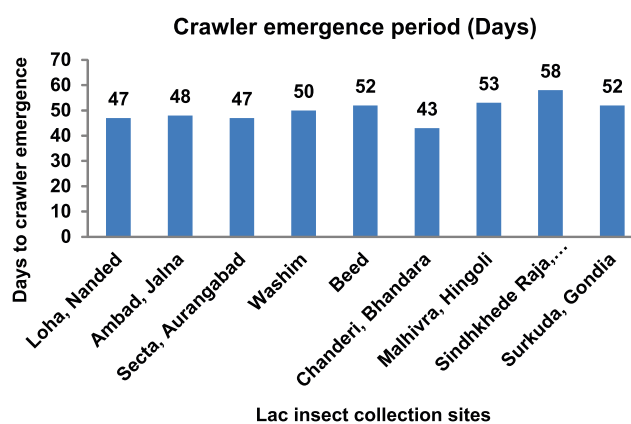


Fig. 1. Crawler emergence period in Maharashtra

followed by Ambad, Jalna (36.78%), Beed (36.42%), Surkuda, Gondia (35.75%), Washim (35.02%), and Sindhkhede Raja, Buldhana (34.39%). The lowest mean initial mortality was in Chandori, Bhandara (20.31%), followed by Loha, Nanded (27.76%), and Malhivra, Hingoli (30.87%) (Table 2).

Mean density after 21 days of settlement

After 21 days, the mean density of settlement (nymphs per cm²) showed a significant difference across locations (Table 2). The highest density was recorded in Surkuda, Gondia (56.11±2.75 nymphs/cm²), followed by Chandori, Bhandara (54.13±3.67 nymphs/cm²) and Loha, Nanded (53.60±4.42 nymphs/cm²). In contrast, the lowest density was found in Beed (28.0±4.38 nymphs/cm²), followed by Ambad, Jalna (29.22±2.64 nymphs/cm²) and Malhivra, Hingoli (31.91±1.67 nymphs/cm²) (Table 2).

Percentage of male insects

The highest male population percentage was recorded in Beed (85%), followed by Shekta, Aurangabad (56.73%), Malhivra, Hingoli (55.60%), Sindhkhede Raja, Buldhana (54.25%), and Loha, Nanded (53.47%). The lowest male population percentage was found in Chandori, Bhandara (43.89%), followed by Ambad, Jalna (45.60%) (Table 2).

Density of female cells at crop maturity

The highest density of female mature cells was found in Surkuda, Gondia (9.88±0.64 cells/cm²) and Loha, Nanded (9.20±0.86 cells/cm²), followed by Chandori, Bhandara (8.83±0.96 cells/cm²), Ambad, Jalna (6.77±0.65 cells/cm²), and Shekta, Aurangabad (6.40±0.62 cells/cm²). The lowest density of female mature cells was recorded in Beed (1.53±0.19 cells/cm²), followed by Sindhkhede Raja, Buldhana

Table 2. Productivity linked performance of lac insect samples at various sites of Maharashtra

Location	Mean initial density of settlement (No./cm ²) (Mean±SE)	Mean initial mortality (No./cm ²) (Mean±SE)	Mean initial mortality (%)	Mean final density after 21 days of settlement (No./cm ²) (Mean±SE)	Average percentage of male (%)	Female density at crop maturity (cm ²) (Mean±SE)
Chandori, Bhandara	67.67±4.49	13.53±1.26	20.31	54.13±3.67	43.89	8.83±0.96
Washim	75.00±5.26	26.27±4.61	35.02	48.73±3.47	52.91	5.80±0.59
Loha, Nanded	74.20±4.63	20.60±2.26	27.76	53.60±4.42	53.47	9.20±0.86
Beed	44.53±3.69	16.53±1.76	36.42	28.00±4.38	85	1.53±0.19
Ambad, Jalna	46.22±2.92	17.00±1.75	36.78	29.22±2.64	45.6	6.77±0.65
Shekta, Aurangabad	81.07±8.91	33.13±4.26	40.87	47.93±6.31	56.37	6.40±0.62
Surkuda, Gondia	87.33±4.17	31.23±2.85	35.75	56.11±2.75	52.6	9.88±0.64
Malhivra, Hingoli	46.16±1.77	14.25±0.87	30.87	31.91±1.67	55.6	4.50±0.49
Sindhkhede Raja, Buldhana	80.77±3.14	27.77±2.43	34.39	53.00±3.45	54.25	1.89±0.32
CD ($p \leq 0.05$)	13.22	7.601		10.835		1.81

(1.89±0.32 cells/cm²), Malhivra, Hingoli (4.50±0.49 cells/cm²), and Washim (5.80±0.59 cells/cm²). (Table 2).

Duration of pre sexual stages (Days) at Maharashtra

Duration of pre-sexual stages (Days)

The shortest duration of pre-sexual stages was observed in Washim (103.0±0.32 days), followed by Shekta, Aurangabad (103.2±0.37 days), Ambad, Jalna (104±0.45 days), and Loha, Nanded (104.2±0.37 days). The longest duration was in Amgaon, Gondia (109.2±0.37 days), followed by Chandori, Bhandara

(109±0.45 days), and Sindhkhede Raja, Buldhana (109±0.32 days) (Table 3).

Duration of male emergence (Days)

The shortest mean duration of male emergence was recorded in Ambad, Jalna (123.2±0.58 days), followed by Sindhkhede Raja, Buldhana (123.6±0.51 days), Chandori, Bhandara (124±0.55 days), Shekta, Aurangabad (124.2±0.80 days), and Washim (124.2±0.49 days). The longest duration of male emergence was in Loha, Nanded (126.4±0.60 days), followed by Beed (125.2±0.37 days), and Surkuda, Gondia (125.2±0.37 days) (Table 3).

Table 3. Duration of pre sexual maturity period, duration of male emergence period (days), maturity period (days) in Maharashtra

Site	Duration of pre sexual maturity (days)	Average duration of male emergence period (days)	Mean duration of male emergence (days)	Lac insect maturity period (days)
Loha, Nanded	104.2±0.37	126.4±0.60	8.2±0.37	256.2±0.80
Ambad, Jalna	104±0.45	123.2±0.58	7.4±0.24	245.2±0.86
Secta, Aurangabad	103.2±0.37	124.2±0.80	10±0.32	247.8±0.58
Washim, Washim	103.0±0.32	124.2±0.49	10.4±0.24	241±0.71
Beed	104.8±0.37	125.2±0.37	4.6±0.40	242.4±0.51
Chandori, Bhandara	109±0.45	124±0.55	6.4±0.24	247.2±0.58
Malhivra, Hingoli	106.2±0.37	125±0.32	5.4±0.24	251±0.55
Sindhkhede Raja, Buldhana	109±0.32	123.6±0.51	6.4±0.20	235.2±0.58
Surkuda, Gondia	109.2±0.37	125.2±0.37	5.4±0.24	245±0.55
CD ($p \leq 0.05$)	1.081	1.599	0.860	1.538

The data presented on the mean duration of male emergence revealed that shortest duration was recorded in Beed (4.6 ± 0.40 days, followed by 5.4 ± 0.24 days in Surkuda (Gondia) and Malhivra, Hingoli, 6.4 ± 0.20 days in Sindkhede Raja (Buldhana) and Chandori, Bhandara, 8.2 ± 0.37 days in Loha (Nanded) and 7.4 ± 0.24 days in Ambad (Jalna), whereas the longest duration of male emergence was recorded in Washim i.e. 10.4 ± 0.24 days followed by 10 ± 0.32 days in Seckta (Aurangabad) (Table 3).

Lac insect maturity period

The shortest mean maturity period for the *Rangeeni* strain of lac insect was in Sindkhede Raja, Buldhana (235.2 ± 0.58 days), followed by Washim (241 ± 0.71 days), Beed (242.4 ± 0.51 days), Surkuda, Gondia (245 ± 0.55 days), and Ambad, Jalna (245.2 ± 0.86 days). The longest maturity period was in Loha, Nanded (256.2 ± 0.80 days), followed by Malhivra, Hingoli (251 ± 0.55 days), Chandori, Bhandra (247.2 ± 0.58 days), and Shekta, Aurangabad (247.8 ± 0.58 days) (Table 3).

Lac insect productivity is a multifaceted process influenced by a combination of biotic and abiotic factors that affect the insect's growth, feeding behaviour, resin secretion, and oviposition. These factors collectively determine the overall resin yield per host plant (Mishra *et al.*, 2000). The present study recorded a significant variation in the duration of crawler emergence, ranging from 43 to 58 days across different locations. These findings are consistent with previous reports by Swami *et al.* (2017), Swami *et al.* (2017), and Sharma (1991), which documented an emergence period of approximately 49 days for the *Rangeeni* strain. Such variability in the emergence period is primarily attributed to fluctuations in ambient temperature. Lower temperatures delay crawler emergence, and activity resumes only when favourable thermal conditions are restored.

The initial settlement density of crawlers on host plants also showed considerable variability. The highest mean density was observed in Surkuda, Gondia (87.33 ± 4.17 crawlers/cm²), while the lowest was recorded in Beed (44.53 ± 3.69 crawlers/cm²). These results are broadly in agreement with the findings of Mohanta *et al.* (2014), who reported settlement densities ranging from 92.58 to 126.74 crawlers/cm² and 93.12 to 109.62 crawlers/cm² for the Kusmi strain on Kusum and Ber trees, respectively. Similarly, Kalahal *et al.* (2017) observed that the initial settlement density of first instar crawlers on pigeonpea (*Cajanus cajan*) varied across different

plant parts, ranging from 20 to 121 crawlers/cm² for the *Rangeeni* strain during the Katki season.

The inability of some crawlers to locate suitable settlement sites resulted in considerable initial mortality, which ranged from 20.31% to 40.87% across the study locations. This observation aligns with the findings of Swami *et al.* (2021), who reported mortality rates ranging from 8.84% to 15.64% on various host plants. The final density of settled nymphs after 21 days, considered a key indicator of early survival and establishment, ranged from 28.00 ± 4.38 to 56.11 ± 2.75 nymphs/cm². These results are comparable to those reported by Swami *et al.* (2021), who observed nymphal densities ranging from 54.70 to 106 crawlers/cm² on different host species.

The sex ratio of the lac insect population is a critical determinant of resin yield, as only fertilized females contribute significantly to lac production. In the present study, the proportion of males varied substantially between locations, ranging from 43.89% to 85.00%. This variation has direct implications for productivity, as a high male bias may result in fewer fertilized females and reduced resin output. These findings corroborate the results of Sharma *et al.* (2006), who highlighted that an imbalanced sex ratio, particularly one skewed towards males, can negatively impact lac yield due to insufficient female fertilization. Further support for this relationship is provided by Mohanta *et al.* (2013) and Singh *et al.* (2022), who also established a strong correlation between sex ratio and final lac productivity.

Our study revealed that the final female cell density at crop maturity varied from 9.88 ± 0.64 cells/cm² to 1.53 ± 0.19 cells/cm². This result is consistent with the findings of Singh *et al.* (2022), who reported that during the Baisakhi crop, the mean density of female cells on *Ziziphus mauritiana* was 5.13 ± 0.31 cells/cm². At the time of emergence, larvae cannot be differentiated into males or females. However, after a certain period of growth, larvae can be distinguished based on morphological differences, males are elongated, whereas females are round-shaped (Mohansundaram *et al.*, 2016). Our study found that the differentiation of male and female lac insects into distinct morphological forms occurred between 103.0 ± 0.32 and 109.2 ± 0.37 days after settlement. This observation aligns with findings by Sharma (1991) and Swami *et al.* (2017), who reported durations of 6-7 weeks and 48.36 days, respectively. The emergence of adult males for copulation

was observed to occur between 123.2 ± 0.58 and 126.4 ± 0.60 days after settlement. This is comparable to previous reports by Vajpayee (2019), who observed male emergence on the 129th day, and by Mohanta *et al.* (2013) and Bhalerao (2013), who reported emergence at 111 and 110 days, respectively.

Finally, the mean maturity period of the female lac insect was found to range between 235.2 ± 0.58 and 256.2 ± 0.80 days. This result aligns with the findings of Mohanta *et al.* (2013), who reported a life cycle duration of 8 months and 5 days, and Sharma and Jaiswal (2002), who documented a 250-day life cycle for the Rangeeni strain during the Baisakhi season. As with other life cycle parameters, this variation in the maturity period may be influenced by environmental conditions and host plant suitability, as suggested by Rathore (2011) and Bhattacharya (2007). The performance of *Kerria lacca* on *Ziziphus mauritiana* in Punjab, as studied by Singh *et al.* (2022), further supports these findings. Their study reported that the Katki crop had a life cycle of approximately 108 days, while the Baisakhi crop ranged from 222 to 237 days.

CONCLUSION

Based on the evaluation of key productivity-related life cycle parameters of *Kerria lacca* collected from various districts of Maharashtra, the Surkuda (Gondia) population exhibited the highest mean initial settlement density and final nymphal density after 21 days per cm². The lowest mean initial mortality was recorded in the Chandori (Bhandara) collection, while the highest mean female density at crop maturity was observed in Surkuda (Gondia) and Loha (Nanded). These findings indicate that the lac insect populations from Surkuda (Gondia), Loha (Nanded), and Chandori (Bhandara) possess superior productivity potential and can be effectively utilized for further multiplication and large-scale commercial cultivation. The study highlights the high lac-producing potential of these regional strains and highlights the scope for expanding lac cultivation in Maharashtra. Promotion of commercial lac farming among local farmers, forest protection committees (*Van Samitis*), and NGOs is recommended to enhance rural livelihoods and sustainable resin production in the state.

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Authors' contribution

Conceptualization and designing of the research work (AM, BL); Execution of field/lab experiments and data collection (BL, RT, NJ, BSA); Analysis of data and preparation of manuscript (BL, AM).

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