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CONTENTS

Foliar supplementation of micronutrients on Palash [*Butea monosperma* (Lam.) Taub.] for enhanced productivity of rangeeni lac, *Kerria lacca* (Kerr, 1782) (Hemiptera: Kerridae)

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ABSTRACT: An experiment titled "Foliar supplementation of micronutrients on palash for enhanced productivity of rangeeni lac, *Kerria lacca*" was conducted during 2023–24 in the village of Gadpichhawadi, Kanker district, Chhattisgarh. The study was conducted to analyze the effect of various micronutrient treatments on lac productivity using Palash (*Butea monosperma*), the host plant for the *Katki* crop. Brood lac inoculation (BLI) was carried out, and multiple productivity parameters were assessed. Among the treatments, T_1 (Zinc) consistently outperformed others. The average number of stick lac per plant was greatest in T_1 (27.00) and lowest in the control, T_7 (15.33). Similarly, T_1 produced mean maximum stick lac length (55.00 cm), weight per 30 cm (42.33 g), scraped weight per 30 cm (20.33 g), The mean fresh weight of 100 lac cells was 6.73 g, while their dry weight was (3.98 g) were all significantly higher in T_1. The highest mean yield of stick lac per plant was recorded in T_1 (5.70 kg) and minimum in T_7 (2.40 kg). T_1 recorded the greatest sex ratio of lac insects, with a value of 3.08 per 2.5 cm^2, followed by T_4 (2.99), and lowest in T_7 (2.30). In economic terms, the highest net profit per tree was obtained in T_1 (Rs. 1769.39), followed by T_4 (Rs. 1730.39), and lowest in T_7 (Rs. 661.44). The cost-benefit ratio was also maximum in T_1 (1:7.84), indicating the superior efficiency of zinc application. The results clearly demonstrate that zinc treatment significantly enhances both productivity and profitability in lac cultivation on Palash trees.

Keywords: *Butea monosperma, Kerria lacca*, micronutrients, productivity, rangeeni lac, Zinc

India is the leading producer of lac in the world, and its cultivation serves as a crucial livelihood source for millions of tribal and forest-dependent communities Chandrakar *et al*. (2025). Beyond its economic value, the lac insect plays a vital role in ecological restoration and environmental sustainability through multiple ecological functions. It supports land reclamation by aiding regeneration and conservation of host trees, helps in combating desertification by reducing soil erosion and improving soil structure, and contributes to biodiversity conservation by creating a microhabitat for flora and fauna. Additionally, lac cultivation promotes habitat restoration in degraded and abandoned forest areas, maintains ecosystem balance through strengthening trophic interactions and nutrient cycling, and encourages community engagement and livelihood security by ensuring sustainable income opportunities (Sharma *et al*., 2006; Sankarganesh, 2017; Maheshwari, 2024). Moreover, the lac insect serves as an ecological bio-indicator species reflecting forest health and environmental changes (Chen *et al*., 2011). Overall, lac production broadly contributes to environmental conservation while providing significant socio-economic support especially to economically weakest sections of the Indian population, People living in the forest and sub-forest areas of Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal, Maharashtra, Odisha, Andhra Pradesh, Gujarat, the North Eastern Hill region, and parts of Uttar Pradesh where the effects of globalization and industrialization are still limited cultivate this crop. It is known to be highly profitable, offering substantial economic benefits to farmers and contributing to the nation's foreign exchange earnings through exports Sarvade *et al*., (2018). Chhattisgarh and Jharkhand are major lac-producing states of India. In Chhattisgarh, lac is produced on its natural host Palash (*Butea monosperma*), Ber (*Ziziphus mauritiana*), and Kusum (*Schleichera oleosa*) in forests, field bunds, and waste lands (Paul *et al*., 2013; Meshram, 2018). Korba is the major lac-producing district in Chhattisgarh, followed by Kanker. In both these districts, 66 percent of cultivation relies on the *Jethwi* crop mainly because of the availability of host trees for *Kusumi* Lac, along with favorable weather conditions (Netam *et al*., 2019).

Micronutrients play a crucial role in plant development, with zinc (Zn) and boron (B) being particularly important. Zinc is essential for the synthesis of the growth hormone indole acetic acid (IAA), which promotes protein synthesis, phosphorylation, and the activity of green plastid enzymes (Marschner, 1995; Pedler *et al*., 2000). In the phloem sap, zinc forms complexes with organic acids, thereby enhancing the concentration of vital metabolites available to the plant (Kochian, 1991). It also contributes significantly to sugar transport, cell wall formation, lignification, metabolism, respiration, and membrane transport (Parr and Loughman, 1983).

Phloem sap serves as a key nutritional source for Hemipteran insects (Douglas, 2003) and contains proteins, sugars, hormones, minerals, and amino acids (Kehr, 2006). Amino acids are essential for the growth, survival, fecundity, and population density of lac insects. Changes in the concentration of available micro- or macronutrients through external supplementation can influence crop physiology and modify insect–plant interactions (Gurjar, 2016). Therefore, maintaining an optimal nutrient balance and adopting integrated nutrient management strategies are vital for enhancing insect growth, density, and population on host plants (Bi *et al*., 2001).

MATERIALS AND METHODS

The experiment was conducted during the year 2023-24 at a farmer's field located in the village Gadpichhawadi**,** Kanker District, Chhattisgarh. A total of 21 Palash (*Butea monosperma)* trees with succulent branches were selected and marked for the study.

The experiment was laid out in a Randomized Block Design (RBD) with three replications. In each replication, seven plants were selected, making a total of 21 plants across all replications. Productivity parameters like number of stick lac/plant, length (cm) of stick lac per plant, mean weight (g) of 30 cm stick lac, mean weight (g) of scrapped lac (30cm) stick, fresh weight (g) of 100 lac cells and dry weight (g) of 100 lac cells and yield (kg) of lac/ tree recorded at the time of harvesting.

Yield potential = Total raw lac per tree (g) /Total inoculated brood lac per tree (g)

Sex ratio is an important factor in the lac production, because the female lac insect produces the lac. number of male and female lac were counted per 2.5 sq. cm stick lac counted at three places (upper, middle, lower). Male cell was counted at 48 -50 days after Brood lac inoculation (BLI), the 2.5 sq. cm lengths were measured by using the vernier calipers scale, and the sex ratio was calculated with the help of the following formula.

Table 1: Treatment details

S.No.	Micronutrients	Trade name	Dose/L
T_1	Zinc (12%)	Zincamin	1g/L
T_2	Boron (20%)	Grow bor	2g/L
T_3	Zinc (12%) + Humic acid (18%)	Zincamin + Humic ash	1g+30ml/L
T_4	Multi-micronutrient (Cu-1.00%, B-2.00%, MO- 0.30%, Mn- 3.00%, Fe- 4.00%, Zn – 5.00%)	Stanesmicrofood	2.5ml/L
T_5	Boron (20%) +Humic acid (18%)	Grow bor+ Humic ash	2g+ 30ml/L
T_6	Multi-micronutrient + Humic acid (18%)	Stanesmicrofood+Humic ash	2.5ml + 30ml/L
T_7	Control		Water spray

Sex ratio = Number of female lac insects/ Number of male lac insect

RESULTS AND DISCUSSION

In the present study, several productivity parameters of lac production were evaluated at harvest, including the number of stick lac per plant, average length (cm) of stick lac per plant, mean weight (g) of 30 cm stick lac, mean weight (g) of scraped lac from a 30 cm stick, fresh and dry weights (g) of 100 lac cells, and yield (kg) of lac per tree recorded at the time of harvesting.

The average number of stick lac per plant ranged from 15.33 to 27.00 (Table 1). The highest mean was recorded in T_1 (27.00), followed by T_4 (24.67), T_6 (22.33), T_3 (20.67), T_5 (20.33), T_2 (19.00), and the lowest in T_7 (15.33). Statistical analysis indicated significant variation among treatments. These results agree with findings by Sahu (2016). The mean number of stick lac per tree at harvest varied from 16.44 T_5 (Humic acid + Multiplex) to 22.00 T_6 (Humic acid + Bolt). There was a significant difference in the mean number of stick lac in T_5 and T_3 (Multiplex) while it was at par with rest of the treatments. Netam (2019) who reported that the mean number of sticklac per tree at harvest. The mean stick lac length ranged from 47.67 to 55.00 cm, with the maximum length observed in T_1 (55.00 cm), followed by T_4 (53.00 cm), T_6 (50.67 cm), T_3 (49.67 cm), T_5 (48.33 cm), T_2 (49.00 cm), and T_7 (47.67 cm). Treatments T_1 and T_4 differed significantly. These findings are comparable with those of Sahu (2016).) The mean length of sticklac per tree varied from 68.66 cm (T_1 Humic acid) to 77.56 cm. (T_2). Treatment T_2(Auskelp super) had significantly longer sticklac over T_1 (Humic acid) and T_8 (Control). The mean weight of a 30 cm stick lac segment ranged between 31.33 g and 42.33 g, with the highest in T_1 (42.33 g), followed by T_4 (40.00 g), T_6 (36.00 g), T_3 (34.67 g), T_5 (33.67 g), T_2 (32.33 g), and T_7 (31.33 g). Significant differences were observed among treatments. These results align with Netam (2019), who reported an average fresh weight of 34.27 g for a 30 cm stick lac on palash. The mean weight of scraped lac from a 30 cm stick ranged from 13.67 to 20.33 g, being highest in T_1 (20.33 g), followed by T_4 (18.33 g), T_6 (16.67 g), T_3 (16.00 g), T_5 (14.33 g), T_2 (14.00 g), and T_7 (13.67 g). Significant variations were recorded among treatments. The present findings are in accordance with Netam (2019), who reported raw lac weights of 7.54 to 22.37 g per 30 cm stick in the rangeeni strain. stick lac yield per plant varied from 3.40 to 5.70 kg, with the maximum in T_1 (5.70 kg), followed by T_4 (5.60 kg), T_6 (5.47 kg), T_3 (5.16 kg), T_5 (4.63 kg), T_2 (4.47 kg), and the minimum in T_7 (2.40 kg). These results are consistent with Patel *et al.* (2014), who recorded yields ranging from 4.00 to 5.70 kg in the kusumi strain and 3.20 to 4.55 kg in the rangeeni strain on *Z. mauritiana*. The mean yield of scraped raw lac ranged between 1.93 and 3.70 kg, with T_1 (3.70 kg) producing the maximum, followed by T_4 (3.64 kg), T_6 (3.50 kg), T_3 (3.01 kg), T_5 (2.56 kg), T_2 (2.50 kg), and T_7 (1.22 kg). The present finding is in agreement with Ghugal *et al.* (2015) The per cent increase in overall mean raw lac yield (kg) per plant was highest in case of T_4 (103.96%) over control followed by T_2 (78.21%), T_3 (67.32%), T_1 (20.29%) and T_5 (18.31%). There was a significant difference in the overall mean yield of raw lac per plant. The mean fresh weight of 100 lac insect cells ranged from 4.94 to 6.73 g, with T_1 (6.73 g) being the highest, followed by T_4 (6.51 g), T_6 (6.50 g), T_3 (5.72 g), T_5 (5.47 g), T_2 (5.19 g), and T_7 (4.94 g). The differences between T_1 and T_7 were significant. These observations agree with Ghugal *et al.* (2015). The mean dry weight of 100 lac cells varied between 3.63 and 3.98 g, with T_1 (3.98 g) recording the highest, followed by T_4 (3.95 g), T_6 (3.94 g), T_3 (3.94 g), T_5 (3.88 g), T_2 (3.78 g), and T_7 (3.63 g). Similar trends were reported by Kumar *et al.* (2017), who found 4.95 to 8.21 g in the rangeeni strain on palash. The yield potential across treatments ranged from 2.43 to 7.40, with the highest in T_1 (7.40), followed by T_4 (7.27), T_6 (6.99), T_3 (6.03), T_5 (5.11), T_2 (5.04), and T_7 (2.43). These findings are comparable to those of Meshram (2018), who reported a maximum yield potential of 11.01 on ber (*Z. mauritiana*) for the rangeeni strain during the Baisakhi (summer) crop, compared to 7.01 on kusum (*S. oleosa*) for the kusumi strain in the Aghani (winter) crop. The net profit per tree was highest in T_1: Zinc (Rs. 1769.39), followed by T_4: Multi-micronutrients (Rs. 1730.39), T_6: Multi-micronutrient + Humic acid (Rs. 1576.39), T_3: Zinc + Humic acid (Rs. 1472.89), T_2: Boron (Rs. 1332.39), T_5: Boron + Humic acid (Rs. 1321.89), and lowest in control (Rs. 661.44). The cost–benefit ratio was also highest in Zinc (1:7.84) and lowest in control (1:3.70), corroborating the findings of Netam (2019). The cost benefit ratio per hectare varied from 1.45 to 4.00, it was maximum on kusum with (4.00) followed by semialata with (2.74) host plant of kusmi strain, while in rangeeni strain it was maximum on ber with (2.52) followed by palash with (1.45) host plant.

Sex ratio

The mean sex ratio of the lac insect varied from 2.30 to 3.08. The highest sex ratio was recorded in T_1 (3.08), which differed significantly from the lowest in T_7 (2.30). Treatments T_4 and T_6 recorded sex ratios of 2.99 and 2.86, respectively. These findings are consistent with Mohanta *et al.* (2014) and Netam (2019), who reported that male-to-female ratio in lac insects can vary depending on the host plant, crop type, strain, and season. Male insect emergence occurred 48-50 days after BLI. The mean number of male lac insects per *K. lacca* cell differed among treatments, ranging from 11.07 to 14.89. The highest male population was observed in T_1 (14.89), followed by T_4 (14.11), T_6 (13.55), T_3 (12.74), T_5 (12.34), T_2 (12.02), and the lowest in control (11.07), aligning with observations by Netam (2019). Across both kusumi and rangeeni strains, the mean male population per lac cell ranged from 13.20 to 19.08 insects. The mean number of female lac insects per cell varied from 25.33 to 45.67, with the maximum population recorded in T_1 (45.67), followed by T_4 (42.00), T_6 (38.67), T_3 (34.11), T_5 (32.08), T_2 (30.00), and the minimum in T_7 (25.33). Significant differences in female population densities were observed among treatments (Table 2).

CONCLUSION

The study confirms that micronutrient application significantly enhances the productivity and profitability of *Kerria lacca* on *Butea monosperma* (Palash). Among all treatments, zinc (T_1) was most effective, recording the highest sticklac yield (5.70 kg/plant), best quality parameters, highest sex ratio (3.08), and maximum net profit (Rs. 1769.39) with a cost-benefit ratio of 1:7.84. Thus, zinc application is recommended for improving lac yield and farmer income in the Katki crop under the agro-climatic conditions of Kanker, Chhattisgarh.

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Table 2: Sex ratio of lac insect from different treatments

S. No.	Micronutrients	Number of male lac insects/2.5 sq cm stick lac	Number of female lac insects/2.5 sq cm stick lac	Sex ratio
T1	Zinc (12%)	14.89	45.67	3.08
		(3.98)	(6.83)	(2.01)
T2	Boron (20%)	12.02	30.00	2.50
		(3.6)	(5.56)	(1.87)
T3	Zinc (12%) Humic acid (18%)	12.74	34.11	2.69
		(3.7)	(5.92)	(1.91)
T4	Multi micronutrient	14.11	42.00	2.99
		(3.88)	(6.55)	(1.99)
T5	Boron (20%) Humic acid (18%)	12.34	32.08	2.60
		(3.65)	(5.74)	(1.89)
T6	Multi-micronutrient + Humic acid (18)	13.55	38.67	2.86
		(3.81)	(6.29)	(1.965)
T7	Control	11.07	25.33	2.30
		(3.46)	(5.13)	(1.80)
	S.Em. ±	0.247	0.639	0.033
	C.D. at 5%	0.77	1.99	0.102

Figures in parentheses are root square transformed value

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