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Lac cell production on Palas (*Butea monosperma* Lam.) and transmission losses under different nutrient management

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Abstract
A trial was conducted from July 2015 to November 2015 to see the effect of nutrition on Lac cell production and transmission losses. The mean fresh weight of 100 mature healthy lac cells obtained from the sticklac at harvest varied from 6.36g (T_8-Control) to 11.14g (T_7). There was a significantly difference in the mean weight of 100 fresh cell weight in T_7, T_2 and T_3 over the control, however T_7 and T_2 were at par with each other. The mean dry weight of 100 healthy cells of lac insect was obtained seven days after shady drying varied from 4.95 g (T_8 – control) to 8.21g (T_7 – Humic acid + Auskelp). There was a significant difference in the mean dry weight in 100 lac cell of T_7, T_2 and T_3 over the Control (T_8), however but the former two were at par. The dry cell weight contributed significantly in the lac yield. The mean dry weight (g) of 100 cell of lac insect differed significantly among the different treatments.

Keywords: nutrition, lac cell, fresh weight, dry weight, humic acid

1. Introduction
The Indian lac insect, *Kerrialacca* (Kerr) (order- Hemiptera, suborder- Homoptera, super family- Coccoidea and family- Lacciferidae,) with its piercing and sucking mouth parts sucks plant sap [5] and secrets resin from their body. Lac insect completes its life cycle on several host taxa where it exclusively feed on phloem sap but *Schleichera oleosa* (Lour.) Oken, *Buteamonosperma* (Lam.) and *Zyziphu smouritiana* (Lam.) are its major host. Lac is a minor forest produce, produced by Lac insect- *K. lacca* while feeding on host trees [19]. *B. monosperma* is a moderate sized deciduous tree which is widely distributed throughout India, Burma and Ceylon. This is popularly and commonly known as '*dhak*' or '*palas*' and 'Flame of forest'. The family Fabaceae comprises of 630 genera and 18,000 species [17]. In India lac is mainly produced by two strains of lac insect viz., "*Rangeeni* and *Kusmi*". *Rangeeni* lac is produced on the tree of *B. monosperma* and *Z. mauritiana*. *Kusmi*lac is mainly produced on *S. oleosa* and to some extend on Ber tree [13].

The total Lac production was 21,008 tons in India and 2,497 tons in M.P during 2013-14**.** During the year 2013-2014, Jharkhand (12207 tons) was the highest lac producer in the country followed byChhattisgarh, Madhya Pradesh, Maharashtra and West Odisha [23].As nutrients deficient plants are weak and vulnerable to incidence of plant disease and insect pest attack [12, 16]. Low nitrogen content in the plant enhance the resistance of plants against pest but high nitrogen contents cause vigorous growth along with consequent decrease in resistance of plants against pest [2, 12]. The potential of organic amendments in suppression of insect pest population over synthetic inorganic fertilizer has long been recognized. Evidence of suppression of insect attack by various forms of organic amendments has been reported by different researchers [3, 21].

Though relatively small amount of micronutrient is required as compared to those of primary nutrient, but these are equally important for plant metabolism [15]. Humic acid foliar spray has remarkable effect on vegetative growth of plant and increase photosynthetic activity and leaf area index [8]. Sap feeders often had long-lasting physiological impacts on their host plant. Physiological changes are driven by both changes in plant nutrients and the production of secondary chemicals [11, 14]. Highest survivability of *K. lacca* on the *Z. mauritiana* treated with NPK may be due to increase in succulence and more availability of phloem sap [22]. Similarly Boron has an effect on cell wall structure and also has a major effect on cell elongation, root growth and transfer of sugar [1].

The production of lac cell depends on quality and quantity of phloem sap of its host. The sap content of phloem is highly correlated with nutrients status of the plants. Therefore, a trial was conducted to see the effect of nutrients on transmission losses and lac cell production.

2. Material and Methods

The present investigation was carried out from July 2015 to November 2015 on standing *B.monosperma* trees in Lac growers' field. The location of study was Malhara village, Barghat Block Seoni district. Geographically, the area forms a part of Maikal range of northern and eastern parts of Satpura Hills tending N-S, NE-SW and E-W. The highest topographic elevation in the district is 756 m above sea level in Seoni-Lakhanadon plateau region and the lowest is 430m above sea level in the plains of Wainganga-Hirri River.

Table 1: Details of the Experiment

Host trees	***Palash* (*B. monosperma*)**
Design	R.B.D.
No. of replications	3
Number of treatments	8
Number of trees per replications	3 trees
Total number of trees/treatments	9 trees
Treatment details	
T_1	Spraying of Humic acid 5%at 51, 63 days and 77 days after BLI*
T_2	Spraying of Auskelp super(N-0.59%, P-0.39%, K-3.19%, Ca-0.017%, S-0.64%,Fe-0.87%,Zn-14.2ppm,Mn-4.4ppm,Cu-4.2ppm,B-64ppm, Mg-0.46%,Na-0.20%,Co-0.14ppm, Mo-10ppm)at 51, 63 days and 77 days after BLI*
T_3	Spraying ofMultiplex(Zn-3%,B-0.1%,Mn-0.5%,N,Mg,S,Ca,Mn, Fe,Cu,B)at 51, 63 days and 77 days after BLI*
T_4	Spraying ofBolt(Humic acids-39%, Cold water kelp extracts-25%, Vitamin C-20%, E-1%, and B1-2%, Amino acids-9% and Myo-Inositol-14%)at51, 63 days and 77 days after BLI*
T_5	Spraying ofHumic acid + Multiplex at 51, 63 days and 77 days after BLI*
T_6	Spraying ofHumic acid + Bolt at51, 63 days and 77 days after BLI*
T_7	Spraying ofHumic acid + Auskelpat51, 63 days and 77 days after BLI*
T_8	Control (Lac growers practice i.e. no use of micronutrients)

**BLI- Broodlac Inoculation*

2.1 Broodlac inoculation

2.1.1 Brood inoculation

Healthy Broodlac weighing 600g to 1200g were used per *B.monosperma* tree for inoculation. Depending on the branch of the tree, the brood lac where divided into six to seven bundles for its inoculation in the month of July 2015.

2.1.2 Shifting

The Broodlac bundles were shifted carefully to different branches on the same tree after 7- 8 days of inoculation. This was to ensure uniform distribution of the brood on branches where there was no or insufficient larval settlement.

2.1.3 *Phunki* removal

Larvae of lac insect fromBroodlac settle on the tree in three weeks of its inoculation. The Broodlac without brood is called *phunki* is infactsticklac. *Phunki* usually consists of predators. It was removed after 21 days of Broodlac inoculation and scrapped to recover raw lac, and in this process the predators are removed.

2.2 Spraying of Humic acid and micronutrients

2.2.1 Preparation of spray solution

The solution of Humic acid and micronutrients was prepared by adding its desired quantity (@5ml of Humic acid/litre of water, in case of bolt @ 1g/litre of water, Auskelp @ 2ml/litre of water, Multiplex @ 3g/litre) in a small container followed by brisk stirring with a piece of stick. This concentrate solution was further diluted with clear water to make the spray solution.

2.2.2 Spraying

Spraying of Humic acid and micronutrients with a foot sprayer required two persons. One operated the pedal of the foot sprayer while other holding the lance of the sprayer sprayed the solution.

2.2.3 Spraying schedule

After 51-52, 63-64 and 77-78 days of BLI, first, second and third spray was done respectively.

2.3 Harvesting of sticklac

At maturity, the sticklac was harvested on 31thOctober to 3th November 2015for estimation of lac yield.

2.4 Statistical Analysis

Analysis of Variance

Table 2

Sources of variance	**Df**	**S.S.**	**M.S.S.**	**F Cal**	**F Tab**
Replications	(r-1)	SSR	VR	-	
Treatments	(t-1)	SST	VT	VT / VE	F at 5% (t-1), (r-1) (t-1)
Errors	(r-1) (t-1)	SSE	VE		
Total	(r.t-1)				

where
r = number of replications
t = number of treatments
VR= replication mean sum of square
VT=treatment mean sum of square
VE= error mean sum of square
The significance among different treatment means was judged by critical difference (C.D) at 5% level of significance for comparison among the treatments, the marginal means of each treatment was considered. The following formula was used for various estimations
i. Standard error of mean

$$S.Em \pm = \sqrt{\frac{E.ms}{r}}$$

ii. Critical difference (C.D) = SEm x √ 2 x t 0.05

where,
Ems = error mean sum of square
t =‘*t*’ value at 5 % level at error *d.f.*
r = number of replications

3. Results and Discussion

3.1. Mean of 100 lac Cells Fresh weight

The mean fresh weight of 100 mature healthy lac cells obtained from the sticklac at harvest varied from 6.36g (T_8-Control) to 11.14g (T_7). There was a significantly difference in the mean weight of 100 fresh cell weight in T_7, T_2 and T_3 over the control (Table 3), however T_7 and T_2 were at par with each other. Namdev *et al.*[18] reported the fresh weight of 100 cell to be highest 8.02 in N treated with NPK. It was followed that 7.20 in N, 6.89 (NP) and control (6.14 g). Patel [20] reported that the mean fresh weight (g) of 100 mature lac cells was 4.88 g in kusmi lac and 3.38 g in case of rangeeni lac.

Table 3: Mean Fresh weight (g) of 100 cells of lac insect

Replication	Mean Fresh weight (g) of 100 cells of lac insect in different treatments							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
R_1	7.60	9.62	7.12	7.65	7.08	6.37	11.52	6.69
R_2	6.33	10.50	8.00	6.64	6.96	7.72	11.88	6.16
R_3	6.68	10.63	7.27	7.22	6.91	6.40	10.01	6.24
Mean	6.87	10.25	7.47	7.17	6.98	6.83	11.14	6.36
SEm±	0.35							
CD 5%	1.06							

3.2 Mean of 100 lac Cells Dry weight (g)

The mean dry weight of 100 healthy cells of lac insect was obtained seven days after shady dryingvaried from 4.95 g (T_8 – control) to 8.21g (T_7 – Humic acid + Auskelp). There was a significant difference in the mean dry weight in 100 lac cell of T_7, T_2 and T_3 over the Control (T_8), however but the former two were at par (Table 4).The dry cell weight contributed significantly in the lac yield. The mean dry weight (g) of 100 cell of lac insect differed significantly among the different treatments. According to Namdev *et al.*[18] the mean dry weight of 100 lac cells was highest in NPK (7.08) followed by N(6.30), NP (6.01) and Control (5.18), while Patel (2013)[20] reported that the mean dry weight of 100 cell of kusmilac to be 4.66 g and 2.63 g in case of rangeeni lac.

Table 4: Mean Dry weight (g) of 100 cells of lac insect

Replication	Mean Dry weight (g) of 100 cells of lac insect in different treatments							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
R_1	6.71	6.76	5.58	5.67	5.43	5.35	7.42	4.76
R_2	5.50	7.49	6.81	5.69	6.14	5.35	8.53	5.14
R_3	5.23	8.39	6.56	5.25	5.63	5.40	8.67	4.96
Mean	5.81	7.55	6.32	5.54	5.73	5.37	8.21	4.95
SEm±	0.31							
CD 5%	0.95							

Treatment T_7 is a combination of Humic acid + Macro and Micro nutrients. This combination may have improved the nutrient uptake, metabolism and enrichment of phloem sap resulted in the growth as well as increase resin secretion by lac insect. Thus had highest weight gain of lac (100 cell weight).Unfortunately, there is scarcity of the worker done on the quality of phloem sap and lac production by lac insect. However, the relation can be batter understood by the work of [10]. According these workers the capacity of aphids to use plant phloem sap, with low essential amino acid content, has been attributed to their symbiotic bacteria, *Buchneraaphidicola*, which can synthesize these nutrients; but this has not been demonstrated empirically. It is proposed that this shortfall of methionine was met by aphid usage of the non-protein amino acid 5-methylmethionine in the phloem sap. From the mean amino acid content of phloem sap and volume of aphid honeydew produced, the meantotal amino acid nitrogen ingested by each two- to seven-day-old aphid was calculated as 2322 nmol. Thiswas eight times greater than the amount required for the observed protein growth (288 nmol) of the aphids, indicating that the diet supplied sufficient nitrogen for aphid growth. A second simplifying assumption has the opposite effect of overestimating aphid demand. It is that aphids derive phloem essential amino acids exclusively from free amino acids. Phloem sap contains other potential sources of amino acids, including proteins, small peptides and non-protein amino acids. For most essential amino acids, the significance of these alternative sources of amino acids is probably small [10]. Insects need considerable amounts of potassium, phosphorus, magnesium andsmall amounts of calcium, sodium and chlorides during their development. Minerals are important forionic balance, membrane permeability and enzyme activation [6].

3.3. Transmission loss percent of lac insect in different stage of lac crop

The transmission loss of lac insects on 62th day after BLI varied from 7.38 to 13.86 percent. The transmission loss was significantly less in T_6 (Humic acid + Bolt) over T_1, T_2, T_5 and T_8. The transmission loss was though significant less in T_4 (Bolt) over T_1 and T_5 but that of T_6 and T_4 were at par. The transmission loss on 76th day after BLI varied from 14.16 to 21.33 percent. The transmission loss was significantly less in T_6 over T_2 and T_8. The transmission loss was significantly less in T_4 (Bolt) over the control (T_8), but that of T_4 and T_6 were at par. At 94th day after BLI the transmission loss varied 22.99 (T_6) to 28.85 (T_8) percent. The transmission loss was significantly less in T_6 over T_8.

Table 5: Transmission loss (%)

Transmission loss (%) of lac insect on days after BLI			
Replication	**62th Days**	**76th Days**	**94th Days**
T_1	13.86 (21.79)	18.60 (25.48)	26.77 (31.14)
T_2	11.96 (20.20)	19.12 (25.89)	26.82 (31.17)
T_3	10.94 (19.19)	16.82 (24.00)	24.22 (29.44)
T_4	7.65 (16.02)	16.09 (23.62)	23.85 (29.21)
T_5	12.95 (21.01)	17.61 (24.79)	28.12 (31.99)
T_6	7.38 (15.19)	14.16 (22.02)	22.99 (28.58)
T_7	10.62 (18.96)	18.12 (25.17)	27.17 (31.38)
T_8	12.12 (20.27)	21.33 (27.46)	28.85 (32.41)
SEm±	1.58	1.2	1.14
CD 5%	4.8	3.66	3.47

Zinc (Zn) is an essential element for plant that act as a metal component of various enzymes or as a functional structural or regulatory cofactor and for protein synthesis, photosynthesis, the synthesis of auxin, cell division, maintain of membrane structure, iron is involved in the production of chlorophyll, also is a component of many enzymes associated with energy transfer, nitrogen reduction and fixation, and lignin formation. Iron is associated with sulfur in plants to form compounds that catalyze other reactions. Manganese is necessary in photosynthesis, nitrogen metabolism and to form other compounds required for plant metabolism. Copper is necessary for carbohydrate and nitrogen metabolism and, inadequate copper results in stunting of plants. Copper also is required for lignin synthesis which is needed for cell wall strength and prevention of wilting. Data mean comparison of micronutrients uptake (Fe, Zn, Mn, Cu) by Petunia hybrid L. showed that the effect of different levels of humic acid on the absorption rate was statistically significant compared to controls [4].

Govindasmy and Chandresakaran [9] found that the addition of humic acids improved sugar yield and nutrient concentration in leaf blades and sheaths of sugarcane. Defline *et al.* [7] reported that the foliar application of humic acids caused a transitional production of plant dry mass in corn with respect to the unfertilised control.

4. Conclusion

Lac production leads to losses of vigour in its host. Therefore application of nutrients is essential to maintain the health of tree and increase the production of lac and reduces the mortality of insect. It is concluded that highest mean fresh weight of Lac cell was recorded where humic acid and Auskelp was sprayed. Transmission losses were significant less where Bolt was spayed.

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