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Economic analysis of *Kusmi* lac production on *Zizyphus mauritiana* (Lamb.) under different fertilizer treatments

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Abstract: Lac is produced by *Kerria lacca*. Lac production and sale form major economic and environmental activities of farmers in the rainfed and forest areas of central and eastern India. Low lac productivity in the region is accredited to the present practices of lac production without nutrient management of the host trees. The present two year (2013-14 and 2014-15) experimental trial was carried out on *Zizyphus mauritiana* at lac grower's field in the village Panwas Tolla, Block Barghat, District Seoni, Madhya Pradesh, India to evaluate the effects of application of different combinations of primary nutrients to host plant on *Kusmi* lac production. The trial was laid in randomized complete block design (RCBD) with four treatments (N, NP, NPK and control) and six replications. The agro-economic indicators: yield and net returns were analyzed in the study. The results revealed that the production cost of *Kusmi* lac per *Zizyphus mauritiana* tree was highest in treatment NPK (INR 338.25) followed by NP (INR 319.51), N (INR 317.11) and control (INR 270.68) treatments. The net return per tree was highest in treatment NPK (INR 1059.75) followed by N (INR 1019.14), NP (INR 922.99) and control (INR 687.82) treatments. It is concluded that the application of NPK is economically suitable for *Kusmi* lac production.

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1. Introduction

Lac insects are exploited to yield various important products like resin, wax and dye, which have long history of wide range of applications in food, adhesives, cosmetics, jewelry, paints, pharmaceuticals, perfumes, polishes varnishes and textile dyes (Dave, 1950; Sarkar, 2002; Ramani et al., 2007). Lac is cultivated as a cash crop in different countries of south, southeast and east Asian countries including India, China (Ramani et al., 2007). It is only resinous compound of animal origin with great economic importance due to safety for human use, renewable and ecosystem friendly source of different chemicals (Ranjan et al., 2011). It is secreted by phytophagous scale insect *Kerria lacca* Kerr belonging to the family Tachardiidae (Kerriidae) and order Hemiptera (Ahmad et al., 2012). In India *K. lacca* covers almost all production of lac. *K. lacca* is represented by two strains or infra sub-specific forms, the *Rangeeni* and *Kusmi* strain, which differ by host preference, life cycle pattern, the quality and amount of lac produced (Kapur, 1962; Ramani, 2005).

K. lacca can infest more than 400 plant species (Sharma et al., 2006). This insect feed on stem, sometimes petiole, of host plant and is considered as phloem or salivary sheath feeder (Ahmad et al., 2012; Shah et al., 2014). Like other phytophagous insects it suck cell sap, but unlike many homopterans which suck plant sap, throughout its life-cycle lac insect inserts its mouthparts only once and remains sedentary and continuous feeding on the same host plant (Imms and Chatterjee, 1915). Therefore lac insect solely depends on host plant for its dietary requirements and cause depletion of nutrients and vigour in plants leading to few succulent branches and ultimately low productivity of lac in subsequent years (Shah et al., 2014). As host plants provide nutrients to herbivorous insects, any increase in its nutrient content is likely to increase its acceptability to pest populations (Scriber, 1984; McGuinness, 1987).

The role of nutrient in plant growth is widely acknowledged (Oskarsson et al., 2006; Dianda et al., 2009). Mineral nutrition status is known to influence factors such as growth and yield of crop plants by affecting changes in growth pattern, plant morphology, anatomy, and particularly its chemical composition. Thickness of epidermal cells, degree of lignifications, sugar concentrations, amino acid content in phloem sap and levels of defensive compounds are all influenced by nutritional status of

the plant (Marschner, 1995). Plant nutrient status have a positive effect on population dynamics, which contribute to higher survival rates, longer adult longevity and reproductive periods (Bi et al., 2001).

Although the impact of fertilizers in agriculture production and productivity is widely acknowledged but effect of these mineral fertilizers on lac hosts for the yield of lac is not well reported. Similar is the case with the economics of lac crop production. In this paper, efforts were made to evaluate operational cost and economical viability of lac production under different fertilizers combination.

2. Materials and Methods

The present study was designed in randomized complete block design (RCBD) with four fertilizer treatments (N, NP, NPK and control) having six replications during the year 2013-14 and 2014-15 on *Z. mauritiana* trees among lac growers in the village Panwas Tolla, Block Barghat, District Seoni, Madhya Pradesh, India. Geographically the village is located between 21°55'51"N latitude and 79°45'49"E longitude. Pruning of *Z. mauritiana* was done as per schedule. Basal doze of fertilizers (N, NP, NPK) according to recommendation (Paul et al., 2013) were manually applied as urea, single super phosphate and muriate of potash, one month before the broodlac inoculation (BLI) (Fig. 1). The basal dose of N, P and K was 100, 250 and 75 g per *Z. mauritiana* tree respectively. BLI was done between 15th to 20th July during the year 2013-14 and 2014-15, depending upon the emergence of larvae (Fig. 1C). *Phunki* (empty broodlac sticks after insect emergence) was removed 21 days after BLI. Lac Crop protection schedule as per recommendations i.e. two sprays of Cartap hydrochloride + Mancozeb were applied against predators attack on lac. First spray was done one month after the inoculation while second spray was conducted one month after the first spray. The solution of pesticides was prepared by adding 1g of Cartap hydrochloride 50 SP per litre of water + 1 g of Mancozeb (Dithane M-45) per litre of water (Patel et al., 2014). Harvesting was done at maturity of lac crop which was identified based on development of yellow spot on the lac encrustation.

The yield of lac obtained from host plants treated with different treatments was measured and the current market price was used to analyze the net profit. The operational and input costs were taken into account to calculate the net returns following the formula suggested by (Harphool et al., 1996).

Fig. 1: Different stages of Kusmi lac (*Kerria lacca*) production on *Zizyphus mauritiana* (A) close view of lac from *Kerria lacca*, (B) Broodlac ready for inoculation (C) Broodlac inoculated on *Zizyphus mauritiana* (D) Fertilizer placement around lac host tree (*Zizyphus mauritiana*) (E) larval settlement (F) Growth of lac on host tree

Table-1: Production cost and net returns of *Kusmi* lac on *Z. mauritiana* (Mean of 2013-14 and 2014-15)

A. Operational cost (INR) tree $^{-1}$				
Operations	**N**	**NP**	**NPK**	**Control**
Pruning	5.0	5.0	5.0	5.0
Fertilizer application	10.0	10.0	10.0	0.0
Inoculation	5.0	5.0	5.0	5.0
Phunki removal	2.5	2.5	2.5	2.5
Scraping of *Phunki* (Rs 20/kg)	3.1 (155.62 g)	2.8 (140.42 g)	3.04 (152.92 g)	2.88 (144.58 g)
Pesticide application	5	5	5	5
Harvesting	10.00	10.00	10.00	10.00
Scraping raw lac (Rs 20/kg)	103.8	96.6	108.8	73.8
Sub Total (A)	**144.4**	**136.9**	**149.34**	**104.18**
B. Input cost (INR) tree $^{-1}$				
*Brood (INR- 400kg^{-1})	164.8 (412.50g)	161.6 (404.17g)	166.4 (416.67g)	160 (400g)
Spray of Pesticide				
CHC 50 SP @Rs 100/100 g	5.0	5.0	5.0	5.0
Dithane M-45 @Rs 30/100 g	1.5	1.5	1.5	1.5
Fertilizer				
Cost of Fertilizers (INR)	1.41	14.51	16.01	0
Sub Total (B)	**172.71**	**182.61**	**188.91**	**166.5**
C. Total Production Cost (A+B)	**317.11**	**319.51**	**338.25**	**270.68**
D. Gross Return (INR) tree $^{-1}$				
Mean raw lac yield (kg tree^{-1})	5.19	4.83	5.44	3.69
**Economic Value (Rs. 250kg $^{-1}$)	1297.5	1207.5	1360	922.5
Phunki yield (kg tree^{-1})	0.155	0.140	0.152	0.144
Phunki value (Rs. 250kg $^{-1}$)	38.75	35	38	36
Total	**1336.25**	**1242.5**	**1398**	**958.5**
E. Net Return (INR) tree $^{-1}$ (D - A+B)				
Gross Return (D)	**1336.25**	**1242.5**	**1398**	**958.5**
Total cost (A)+(B)	**317.11**	**319.51**	**338.25**	**270.68**
Net Profit	**1019.14**	**922.99**	**1059.75**	**687.82**

*Cost of broodlac (INR) in 2013-14 was 500 while it was 300 in 2014-15
**Cost of raw lac (INR) in 2013-14 was 300 while it was 200 in 2014-15
1 INR is equal to 0.0157 USD (as per exchange rate on 23rd of June, 2015)

3. Results and discussion

The production cost and net returns of *Kusmi* lac on *Z. mauritiana* under different fertilizers combinations is presented in the "Table-1". The mean operational cost per *Z. mauritiana* tree in *Kusmi* lac production was highest in treatment NPK (INR 149.34) followed by N (INR 144.4), NP (INR 136.9) and the control (INR 104.18). Similarly, the input cost per tree was also highest in treatment NPK (INR 188.91). It was followed by NP (INR 182.61), N (INR 172.71) and the control (INR 166.5). Higher cost of complex fertilizers was the reason for increase in the cost of production under treatment NPK. The production cost of *Kusmi* lac on *Z. mauritiana* tree was highest in treatment NPK (INR 338.25) followed by NP (INR 319.51), N (INR 317.11) and the control (INR 270.68). The gross return per tree was highest in treatment NPK (INR 1398) followed by treatment N (INR 1336.25), NP (INR 1242.5) and it was lowest in the control (INR 958.5). Lac production is climate dependent as high summer temperature damage lac crop (Mishra et al., 1999; Sharma, 2007). India being the largest exporter of lac exports 75 percent of the total production. Years with low production of lac and high export demand increase the rate of lac in the local market, while the reverse is true.

The net profit per tree was highest in treatment NPK (INR 1059.75) followed by N (INR 1019.14) and NP (INR 922.99) and it was lowest in the control (INR 687.82). In the present investigation, the highest net profit was found in the treatment NPK. The percent increase in net profit was highest (54.07%) in treatment NPK over the control. It was followed by N (46.72%) and NP (34.19%) treatments. Economic output is the ultimate aim of any production process. Fertilizers proved to have significant effect on the output. In the present study, an additional investment of INR 16.01/plant towards cost of fertilizer in case of NPK treatment gave 1.75 kg extra lac yield over control. In case of N and NP treatments, an additional investment of INR 1.41 and 14.51/plant gave an extra lac yield of 1.5 and 1.14 kg respectively over control.

The net profit in case of treatment N was more as compared to NP which may be due to increase in dry matter accumulation by the application of P leading to decline in the growth and survivability of *K. lacca*. Veeresh (2003) reported an increase in total dry matter production of common bean plant due to increased phosphorous. Similar results were also reported by Jennifer (2000). The highest net profit per tree in case of NPK treated plants is because of the fact that NPK increases the yield of lac (Shah et al., 2014). Similar report by Ghallab et al., 2014 states that sucking pests attracted by plants treated by NPK more than N, P and K when used individually. The highest net profit in NPK may also be credited to the role of potassium in the reduction of dry matter per cent of inoculable shoots contributing to higher survivability of *K. lacca*. Similar result has been reported by (Abayomi, 1987) in sugarcane. The increase in yield may be due to the better growth of treated plants which supported survival and reproduction of *K. lacca*. NPK contains nitrogen which promotes better growth of plants on the other hand, attacking by sucking pests were increased (Baidoo and Mochiah, 2011). It can be observed that different level of fertilizer has significant effect on the economics of lac production.

4. Conclusion

Nutrient status of the host plant effects the growth and development of lac insect. The difference in the net profit between treatments NPK and N was very low. But in the long run, application of NPK will keep the host healthier than treated with N. Therefore for sustainable plant growth, lac production and economic return, *Z. mauritiana* may be treated with NPK.

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Competing Interests

The authors declare that there is no potential conflict of interest of whatsoever.

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