



## ***Kusmi* lac yield in winter season as affected by weather and directional effect on *ber* (*Zizyphus mauritiana*) trees\***

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Lac cultivation is a profitable venture and profitability increases significantly, when lac cultivation is done as broodlac purpose, rather than sticklac (scrapped lac encrustation) purpose. In recent years there is an increase in both demand and price of lac globally. Broodlac production capability varies widely due to inter and intra host differences which is attributed mainly due to nutrition supplying capacity of the host. But yield variations are supposed to be due to many environmental factors also eg ventilation, sunlight interception, location of host, temperature, rainfall, relative humidity etc. as lac is a living organism. Light interception has been established to be a better criterion over vegetative growth potential for higher fruit harvest in peach trees. (Grossman and DeJong 1986). In case of lac, the production increased significantly with the hosts having higher light interception (Ghosal and Mishra 2009). As there is an annual variation in the abiotic factors from season to season and year to year, the production also varies correspondingly. For maintaining rectangularity of one or more to ensure better utilization of light and other resources, row-to-row distance in plantation is kept in east-west directions. This being the cause why more sunshine interception is attenuated at southern side of the trees compared to northern side during growth period of winter season lac crop, ie during July to February in northern hemisphere. Due to sowing in east-west direction, 9% more sunlight interception was attenuated (Anonymous 2007). Due to changes in these abiotic factors, influence of the biotic factors particularly micro-organisms becomes crucial frequently due to change in micro-climate for which lac yield also varies significantly. Literature on different aspects of lac cultivation including directional effect and also the effect of weather is very infrequent and not validated. Therefore, an experiment was conducted to examine how the yield of lac on *ber* trees varied due to differential weather

conditions and also due to being positioned in southern and northern halves of the tree canopy. Generating information on influence of these non-monetary inputs will be of great importance to lac growers for taking corrective measures in time.

*Kusmi* brood lac inoculation for winter season (*aghani*) crop was done on 96 *ber* trees selected randomly in an established plantation (spacing – 4.5 × 4 m<sup>2</sup>) with 20 g broodlac/m shoot length during 2007–08 to 2009–10. Recommended crop protection measures were adopted (first spray with endosulfan 0.05% and carbendazim 0.01% at 30 days after inoculation (DAI); second and third spray with dichlorvos 0.03% and 0.01% carbendazim at 60 and 90 DAI).

Matured lac crop was harvested during 15–20 February. During harvesting, each tree was divided into two equal halves, ie southern and northern halves and yield was bifurcated for each tree. Paired t-test was performed for all the 96 sample trees for assessing yield difference between northern and southern halves of *ber* trees, for three different years. Data presented (Table 1) is as per class interval of per tree lac yield.

Initial growth of lac insect during inoculation to sexual maturity stage (up to first week of September) is slow and sensitive, followed by a rapid growth period (from sexual maturity stage and extends up to November). Therefore, pattern of rainfall distribution in relation to different growth stages of lac insect was also studied in detail (Table 2). The trees were categorized into different yield classes to visualize how lac yield is related to canopy size under different weather conditions in the study period.

Yield in general was higher in southern half than the northern half in all the yield classes for all the years. Difference in lac yield between southern and northern halves of the trees was significant in 2007–08 and 2008–09. But it was non-significant in 2009–10 (Table 1). Average lac yield in southern half was 26% higher than that of northern half in 2007–08 and the same was 21% higher in 2008–09.

\*Short note

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Sunlight can effect on the microclimate within the tree canopy by changing relative humidity and temperature. On northern hemisphere of the earth, the southern half of trees receive more sunlight than northern half during growth period of winter season *kusmi* lac insect. This difference was more severe in first year, when light intensity received was much less, as it had experienced much higher rainfall with maximum number of weeks with more than 50 mm rainfall during crucial growth period (Table 2). Recent researches suggested that warmer microclimate in western and southern quadrant of *Ficus nitida* tree is congenial for growth of scale insect (Al-Ahmed and Badawi 1991). Similar finding on scale insect was also reported by Schaffer and Mason (1990). Due to belonging in the same group, lac insect also might have behaved similarly by producing maximum in southern half of the tree when light was limiting.

As per above parameters, sunlight was not a limiting factor in 2009–10. Therefore, yield difference was non-significant.

Frequency distribution of trees under different yield class showed that pattern of normal distribution was there in 2009–10 (Table 1). Skewness for the same was 0.33 as against 1.48 and 0.81 in 2007–08 and 2008–09. A higher value of skewness in the first year was due to concentration of more number of trees (38%) in the lowest class. However, in the second and third year, yield class 4.0–5.99 kg remained with maximum frequencies (35% and 24% trees, respectively). Correlation coefficient between yield and canopy size was positively correlated with values 0.44, 0.43 and 0.64 and with corresponding R<sup>2</sup> values 0.19, 0.19 and 0.41 in the three years, respectively. Since closest normal distribution was recorded in the frequency distribution of third year, it can be considered that actual potential of lac production was manifested in that particular year.

If frequency distribution and mean canopy size of the third year is compared to that of first year, we find many trees with larger canopy size produced less and occupied a

place in the least yield class, ie 0–1.99 kg. Similarly, in the second year, trees with yield class more than 4.0–5.99 kg produced less and shifting of less performers took place in lower yield classes. Therefore, during these years, shifting took place from higher yield class to lower yield class. But in the third year, frequency of highest yield class increased to 16 from 5 and 6 in first two years respectively. In this case, shifting took place from lower yield class to higher. Therefore, it is evident that only congenial weather condition (year) can help to ascertain actual lac yield potential of trees.

Mean lac yield/tree and yield ratio as presented in Tables 1 and 2 respectively revealed that general yield performance of all the trees were superior in third year compared to other two years.

Possible explanation of experimental result can be obtained from weekly distribution of rainfall in Table 2. Data on lac yield ratio (output: input ratio) of three years suggested that performance of third year was superior over other two years, which is supposed to be due to weather condition of that particular year. Total rainfall received during the first 12 weeks of insect growth was 906.7, 768.2 and 665.9 mm respectively, in three different years. It indicated that intensity of rainfall was highest in the first year and lowest in the third year, with an average of 75.5, 64.0 and 55.5 mm/week. Number of weeks with more than 100 mm rainfall was 3, 3 and 2 respectively for three different years. Only two such weeks were consecutive at post sexual maturity stage at first year. It could be the cause of considerable damage to lac crop on that year. Lac mortality in 52.3% thick shoots (>1.0 cm basal diameter) was recorded on that particular year, as compared to 3.7 and 5.6% in second and third year. Number of weeks with more than 50 mm rainfall was also highest in the first year. Out of nine such weeks, seven weeks were continuous in pre-sexual maturity stage. The typical pattern of rainfall accompanied with cyclones had resulted in increased relative humidity in August in that year, which further resulted in lesser sunshine attenuation on lac crop and

Table 1 Lac yield/tree (kg) as affected by different years and position on tree canopy

Tree yield class interval	2007–08			2008–09			2009–10					
	No. of trees	Canopy size (m <sup>2</sup> )	Mean lac yield		No. of trees	Canopy size (m <sup>2</sup> )	Mean lac yield		No. of trees	Canopy size (m <sup>2</sup> )	Mean lac yield	
			Southern half	Northern half			Southern half	Northern half			Southern half	Northern half
0-1.99	37	15.3	0.49	0.46	14	14.1	0.67	0.66	10	14.3	0.68	0.52
2.0-3.99	16	12.9	1.58	1.34	28	15.1	1.69	1.34	15	15.1	1.61	1.42
4.0-5.99	17	18.1	3.01	2.06	34	15.6	2.68	2.12	23	22.7	2.64	2.42
6.0-7.99	14	18.6	3.52	3.48	9	24.6	3.82	3.08	20	25.0	3.57	3.43
8.0-9.99	6	22.5	5.48	3.09	6	23.8	4.94	4.15	12	35.9	4.57	4.21
>10.0	6	31.3	7.63	5.95	5	29.7	6.24	5.59	16	37.5	6.18	6.11
Av. yield (kg)			2.32	1.84			2.53	2.08			3.30	3.12
Paired t-test			*			*			NS			

\*Significant at 5%

Table 2 Pattern of rainfall distribution in respect to insect growth

Particular	2007–08	2008–09	2009–10
Rainfall (mm) received during first three months (29 <sup>th</sup> to 40 <sup>th</sup> standard week )	906.7	768.2	665.9
No. of weeks with rainfall more than 100 mm	3	3	2
No. of weeks with rainfall more than 50 mm in insect growth period	9	7	4
No. of consecutive weeks with $\geq$ 50 mm rainfall			
1. Before sexual maturity	7	2 & 4	0
2. After sexual maturity	2	1	1
Rainfall (mm) received after sexual maturity	383.4	237.7	133.1
No. of weeks from sexual maturity when last rainfall received	4	3	10
Mean yield ratio*	4.90	5.16	7.15
Rejected yield ratio*	1.77	0.99	2.68
Percent of thick shoots with lac mortality*	52.3	3.7	5.6
Percent of thin shoots with lac mortality	58.6	57.9	75.5
Mean canopy area with maximum number of trees (m <sup>2</sup> )	15.3	15.6	22.7

\*Significant at 5% level

tree canopy. As a result, much mortality of lac insect had taken place, particularly on trees of larger canopy size (Ghosal and Mishra 2009). Further, consecutive weeks of higher rainfall might have helped developing micro-climate unsuitable for lac growth and consequently lesser lac yield was obtained. As compared to third year, considerable reduction in number of trees under all yield classes beyond 4.0–5.99 kg has taken place in 2007–08. Weeks with more than 50 mm rainfall within sexual maturity stage in 2009–10 was only 2, which is far lower than first year. Bright sunshine was received due to lesser intensity of rain, almost throughout the growth period of lac insect. It can be considered good for survival of lac crop. Due to more number of trees occupying higher yield class, average yield of third year was much more than other two years.

Data revealed that maximum lac yield ratio and rejected yield ratio was produced in the third year. Higher values of rejected lac yield ratio in third year indicated that much lac mortality occurred when considerable growth of lac had taken place. By the time last rainfall received in the third year, i.e. 10 weeks from sexual maturity, lac insect had undergone development considerably. Rainfall during that period might have caused mortality of lac. But during first and second years, last rainfall received was after 4 and 3 weeks from sexual maturity. Therefore, lac did not grow much by that time and rejected yield ratio was less.

Study of yield difference through different years showed that weather parameters like high intensity of rainfall, number of consecutive weeks with more than 50 mm rainfall, rainfall received after sexual maturity etc. can be considered unfavourable weather for winter season *kusmi* lac. In general, the lesser the number of weeks with more than 50 mm rainfall during growth period of lac insect, the better it is for lac production. Successive occurrence of such weeks aggravated the problem greatly. Consecutive weeks with rainfall more than 100 mm at post sexual maturity, hampered the crop largely, as it damaged the crop on thick shoots also. The larger the canopy area, the more is the damage due to adverse weather (rainfall mainly). Therefore, *ber* trees with smallest canopy size are affected only at the worst weather conditions. Further, yield loss of lac crop is significantly lesser in southern half of tree canopy.

#### SUMMARY

An experiment consisting of 96 trees was laid out in the Institute Research Farm during June 2007–February 2010 to assess the influence of factors like directional effect of lac on *ber* trees (northern and southern halves) and rainfall pattern on lac yield and yield ratio (output: input of broodlac). Average lac yield ratio in southern half was 26% higher than northern half in 2007–08 and the same was 21% higher in 2008–09. More sunlight might have kept the tree canopy warmer, which might have boosted up growth and development of the lac insect on the southern half in first two years. Due to meager rainfall in third year, sunlight was not a limiting factor influencing yield which resulted in a non-significant difference. At the same time, mean lac yield ratio was 4.9 in first year as against 7.15 in the third year; difference was significant and it could be attributed to weather differences. The typical patterns of rainfall in three different years have been described in details which revealed that lac yield decreased significantly with intensity of rainfall, number of consecutive weeks with 50 mm rain, amount of rainfall received after sexual maturity etc. As a result, 31% reduction in lac yield ratio was observed in first year compared to third year. The study also indicated that lac yield from trees of smaller canopy spread are least affected due to adverse weather condition

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