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Study on the bio-efficacy of micro-nutrients on lac production

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Abstract

Pigeon pea (*Cajanus cajan*) is widely grown in Madhya Pradesh with acreage of 3.63 m ha. *C. cajan* is generally grown in undulating land with little care. *C. cajan* is one among the 114 host plants of the insect (*Kerria lacca*). However, *C. cajan* is not exploited commercially for lac production in India. Presently, lac production in MP is carried on *Butea monosperma*, *Ziziphus mauritiana* and *Schleichera oleosa*, where farm women find it difficult to climb and perform operational procedures of lac production. In such a condition *C. cajan* is a good option for lac production, if grown in backyard with limited irrigation and resources. Lac consists of resin, wax and dye, thus has a wide range of applications in food, pharmaceuticals, cosmetics, perfumes, varnishes, paints, polishes, adhesives, jewellery and textile dye, since ancient times. It is an important intervention/ cultivation to increase the household income of small and marginal farmers with efficient utilization of available resources. Lac insect belongs to order Hemiptera, and family Tachardiidae (Kerriidae) its host range more than 150 host plants. The experiment was carried out during 2016-2017 on Pigeon pea (*Cajanus cajan*) at Madhya Pradesh on aspects of survival rate, lac production and also production of Pigeon pea yield by using micronutrients and plant growth regulators. Results revealed that there was an increase in the mean Dry pod weight/plant highest (4.396gm) in T₈ (Micronutrients + *Auskelp* + *Arbuscular Mycorrhiza* + *Aspergillus niger*) followed by 4.135gm in T₁ (Micronutrients + *Auskelp*) over control (1.139gm). Similarly, the mean dry seed weight/plant was also highest (2.87gm) T₈ followed by 2.80gm T₆ (Micronutrients + Plant Growth Regulators + *Arbuscular Mycorrhiza*) and 2.58gm T₇ (*Arbuscular Mycorrhiza*) over control (0.51gm).

Keywords: *Cajanus cajan*, bio-efficacy, micro-nutrients, lac production

Introduction

Pigeon pea (*Cajanus cajan*) is widely grown in Madhya Pradesh [1] with an acreage of 3.63 m ha [2]. *C. cajan* is generally grown in undulating land with little care. *C. cajan* is one among the 114 host plants of the insect (*Kerria lacca*). However, *C. cajan* is not exploited commercially for lac production in India. Presently, lac production in MP is carried on *B. monosperma*, *Z. mauritiana* and *S. oleosa*, where farm women find it difficult to climb and perform operational procedures of lac production. In such a condition *C. cajan* is a good option for lac production, if grown in backyard with limited irrigation and resources.

Lac is one of the most valuable gifts of nature to man, the only resin of animal origin secreted by a tiny scale insect, belonging to the family Tachardiidae (Kerriidae), superfamily Coccoidea of the order. Family Kerriidae consists of nine genera, while the number of species reported varies from 90 to 100 species [3].

Two genera found in India, while genus important as it has 19 species [4, 5]. *K. lacca*, the most important and widely exploited insect for lac cultivation in India is represented by two strains or infra subspecific forms, the Rangeeni and Kusmi strain, which differ by host preference, life cycle pattern, the quality and amount of lac produced [6]. The Kusmi strain is grown on *Kusum* (*Schleichera oleosa*) while Rangeeni strain thrives on hosts other than *Kusum* [4, 7, 8].

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 extent on Ber tree [9].

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 by Chhattisgarh, Madhya Pradesh, Maharashtra and West Odisha [10].

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Lac can be successfully produced on pigeon pea without comprising the yield of *C. cajan*. Lac production of pigeon pea can help farm women to double income. Lac production on pigeon pea in the backyard can help to rural household to overcome protein mal-nourishment also. The objective of the present study was to analyze the effect of micro-nutrients and plant growth regulators on lac production.

Materials and Methods

Pigeon pea, *C. cajan* (L) Millsp variety TJJT -501 was evaluated for lac production. The field research work was conducted during the year 2016-17 in the farmer's field in Jhiria, Jabalpur, Madhya Pradesh. The experiment was laid in Randomized Block Design (RBD), with nine treatments and three replications (Table 1). Each treatment had nine plants. The plant to plant spacing was 6x6 feet within the replication. The spaces between the replications were 6 feet.

Table 1: Details of treatments

No. of treatment	Treatment details
T ₁	PSB + <i>Trichoderma viride</i> + Rhizobium + DAP + MoP + micro + macro nutrient + (Auskelp)
T ₂	PSB + <i>Trichoderma viride</i> + Rhizobium + DAP + MoP + micronutrients (Multiplex)
T ₃	PSB + <i>Trichoderma viride</i> + Rhizobium + DAP + MoP + PGR (Plant Growth Regulators)
T ₄	T ₁ + AM (Arbuscular Mycorrhiza)
T ₅	T ₂ + AM
T ₆	T ₃ + AM
T ₇	AM
T ₈	T ₄ + <i>Aspergillus niger</i>
T ₉	Control

PSB (Phosphorous Solubilizing Bacteria) DAP- Diammonium phosphate, MoP -Murate of potash, Rhizobium and *Trichoderma viride* were be used as seed treatment. *T. viride*, AM and *Aspergillus Niger* were mixed in FYM separately and allow to grow under moist condition. Chemical fertilizers (DAP and MoP) were mixed in the soil before planting.

Agro climate of Jabalpur

The climate of Jabalpur district is typically Sub humid, featured by hot dry summer and cool dry winter. Jabalpur is geographically situated between 23° 09' North latitude and 79° 58' East longitudes at an altitude of 411.78 metres above the mean sea level. Jabalpur district lies in the Agro- climatic zone VII i.e. Kymore Plateau and Satpura Hills and Agro-ecological region number 10 [Central Highlands (Malwa and Bundhelkhand)], Sub region number 10.1, [hot sub-humid eco-region (Malwa Plateau, Vindhyan scarp land and Narmada Valley). Weather conditions were almost favourable for the growth and development of pigeon pea. The monsoon commences in the first week of July and terminates in the first week of October. Minimum and maximum mean temperature ranged from 4.80°C to 24.90°C and 28.50 to 41.80°C, respectively.

Statistical analysis

The data recorded for efficacy of different treatments were statistically analyzed using standard procedure for analysis of variance (ANOVA) of RBD. The survival percentage of lac insect was worked out using the formula given below.

$$\text{Survival percentage} = \frac{\text{No. of live cells/cm}^2 \text{ (before harvesting)} \times 100}{\text{Total no. of cells/cm}^2 \text{ (30 days)}}$$

Result and Discussion

The mean number of live lac insects per 2.5 cm² of branch (MNL) was recorded at 30, 45, 75, 90, 105, 120 and 140 days after BLI. The MNL declined continuously from 30 days after BLI till the harvest of the plants for lac crop in all the treatments. On 30th day after BLI, the MNL varied from 91.77 (T₉) control to 98.39 (T₈). The latter was significantly higher than T₉ control, T₃ and T₂ but was at par with T₁ (97.45), T₃

(95.19), T₅ (98.21), T₄ + AM (96.87), T₆ (97.74) and T₇ (AM) (97.03).

In some of the related studies, the MNL at 30 days after BLI varied from 60 to 95.80 [11], 28.13 to 40.53 [12], 51.35 to 64.08 [8], 37.95 to 58.24 [13], 38.31 to 43.37 [14], 37.05 to 39.34 [15] and 57.48 to 64.08 [16].

On 45th day after BLI, the MNL varied from 73.43 (T₉) control to 83.14 (T₅). The latter was significantly higher than treatments T₂ (73.88), T₆ (77.06) and T₃ (77.4) which were at par with each other. However, T₅ was at par with T₈ (83.03), T₇ (80.20), T₄ (80.15) and T₁ (80.29).

Recently, Khichi *et al.*, [17] reported MNL at 45 days to vary from 147.67 to 168.72 on different local genotypes of *C. cajan*. The mean population density (MPD) of lac insects on different host at 45 days after BLI was reported to vary from 33.00 to 67.33 [12], 60.00 to 95.80 [11], 73.80 to 96.00 [18], 64.27 to 73.58 [13], 39.75 to 43.90 [15] and 56.00 to 65.05 [16], 42.99 to 48.72 by Ghugal *et al.*, [19].

On the 75th day after BLI, the MNL varied from 44.98 (T₇) (AM) to 57.78 (T₈). The latter was significantly higher than T₉, T₄, T₃ and T₂ but at par with T₆, T₅, T₄, T₃, T₂ and T₁. MNL at 75 days after BLI to varied from 52.40 to 63.00 [20], 130.44 to 179.54 [21], 61.40 to 102.60 [11], 37.95 to 58.24 [13], 79.32 to 90.02 [108], 42.88 to 46.44 [14], 49.95 to 51.11 [19], 44.95 to 50.28 [15] and 84.01 to 88.54 [16].

On 90th day after BLI, the MNL varied from 42.11 (T₇) to 49.49 (T₈). The latter was significantly higher than T₇, T₈, T₄, T₃, T₂ and T₁ at par in rest of the treatments. There are earlier reports on the mean population density of *K. lacca* at 90 days BLI on different host trees. It varied from 22.88 to 27.88 in different nutrient managed *Z. mauritiana* [8], 25.07 to 28.65 [16], 34.00 to 42.60 [11] while on *B. monosperma* it was 19.87 to 30.00 [12] while in pigeon pea 118.39 to 149.39 [17].

On 105th day after BLI, the MNL varied from 38.58 (T₉) to 43.44 (T₆), but there was no significant among the treatments. At 105 days after BLI the MNL according to [19] varied from 19.08 to 30.09 while it was 33.53 to 41.77 [13], Namdev [8] and Janghel [12] reported MNL at 110 days after BLI varied from 15.57 to 18.43 and 19.87 to 29.87 respectively.

On 120th day after BLI, the MNL varied from 24.86 (T₉) to 36.67 (T₈). The latter was significantly higher than 24.86 (T₉), but at par in rest of the treatments. The earlier data on MNL at

120 days of BLI is lacking. However, a few workers have recorded MNL at 125 days after BLI. It varied from 60.00 to 95.80^[11], 28.13 to 40.53^[12], 51.35 to 64.08^[8], 38.31 to 43.37^[22], 37.05 to 39.34^[15] and 57.48 to 64.08^[16]. However all these were of MNL from host trees of lac insect.

On 140th day after BLI, the MNL varied from 29.33 (T₅) to 35.70 (T₈). Treatment T₈ and T₂ were significantly higher than rest of the treatments which were at par with each other. Significantly highest MNL was dynamic in respect to the treatment and period of plant and lac insect growth. This indicated the impact of nutrient of plant and insect in response to the treatment and age. The earlier data on MNL at 140 days of BLI is lacking. However, MNL at 130 days after BLI has been recorded by Namdev^[8] on *Z. mauritiana* and it varied from 16.50 to 20.33 and 20.07 to 23.26 Shah *et. al.*,^[16] in different treatments.

The MNL at before harvesting varied from 20.06 (T₉) to 28.07 (T₈). The latter was significantly higher than all the treatments. However, T₁, T₂, T₃, T₄, T₅, T₆ and T₇ were at par with each other but significantly higher than T₉. The percent survival of lac insects from 30 day after BLI to the harvest

was highest (28.53) in T₈, followed by T₃ (26.88), T₅ (25.97), T₇ (25.96), T₄ (25.95), T₆ (25.70), T₁ (25.55), T₂ (25.49), T₈ (28.53) and T₉ (21.86). Namdev^[8] found higher MPD in nutrient managed host trees at harvest/ maturity and it varied from 15.57 to 18.43. At 185 days after BLI the MNL in different treatment is reported to vary from 60.00 to 95.80^[11], 28.13 to 40.53^[12], 51.35 to 64.08^[8], 38.31 to 43.37^[22], 37.05 to 39.34^[15] and 57.48 to 64.08^[16].

The pooled data on the survival percent of lac insects from BLI to the harvest of the lac crop was highest (28.61) in T₈ followed by T₃ (26.70), T₅ (26.17), T₇ (26.03), T₄ (25.96), T₂ (25.67), T₆ (25.66), T₁ (25.03) and T₉ (22.33). The survival percent of lac on *C. cajan* reported by earlier workers varied from 24.91 to 38.13^[17], 48.00 to 61.54^[23], 33.53 to 41.77^[13], 33.78 to 79.11^[24], 34.08 to 51.53^[22], 20.86 to 26.05^[15] at harvest. Namdev *et al.*,^[8] and^[16] reported it to varied from 18.53 to 39.16 percent and 20.47 to 23.52, 37.93 to 58.95^[19], 22.00 to 27.00^[11], 27 to 32^[12], 21 to 25^[25] percent respectively. But, according to the finding of Mohanta *et al.*^[26], it was as low as 5.25% to 12.45% from BLI to maturity of lac crop.

Table 2: Mean number of live lac insect per 2.5 cm² (2016-17)

Treatments	Mean no. of live lac insects /2.5 cm ² on days after BLI								
	30	45	75	90	105	120	140	before harvesting	% Survival
T ₁ -PSB + T.v +Rh +DAP + MoP (micro + macro nutrient) Auskelp	97.45 (9.90)	80.29 (8.99)	56.40 (7.54)	47.36 (6.91)	40.49 (6.40)	33.11 (5.80)	29.84 (5.51)	24.90 (5.04)	25.55
T ₂ -PSB+T.v.+Rh+ DAP+ MoP, micro (Multiplex)	92.26 (9.63)	73.88 (8.62)	52.40 (7.27)	46.38 (6.84)	41.47 (6.48)	35.90 (6.03)	34.39 (5.90)	23.52 (4.90)	25.49
T ₃ - PSB+T. v. + Rh+ DAP + MoP + PGR	95.19 (9.78)	77.40 (8.83)	52.02 (7.23)	46.18 (6.83)	40.89 (6.43)	34.00 (5.87)	31.28 (5.64)	25.59 (5.11)	26.88
T ₄ - (T ₁ + AM)	96.87 (9.87)	80.15 (8.98)	53.91 (7.37)	47.26 (6.91)	41.95 (6.51)	34.12 (5.88)	31.48 (5.65)	25.14 (5.06)	25.95
T ₅ - (T ₂ + AM)	98.21 (9.93)	83.14 (9.14)	54.80 (7.42)	47.77 (6.94)	42.44 (6.55)	32.78 (5.77)	29.33 (5.46)	25.51 (5.10)	25.97
T ₆ - (T ₃ +AM)	97.74 (9.91)	77.06 (8.81)	54.84 (7.44)	47.79 (6.95)	43.44(6.63)	33.31 (5.81)	30.21 (5.53)	25.11 (5.06)	25.70
T ₇ -AM	97.03 (9.88)	80.20 (8.98)	44.98 (6.74)	42.11 (6.53)	42.27 (6.54)	33.60 (5.84)	30.65 (5.58)	25.19 (5.07)	25.96
T ₈ -(T ₄ + <i>Aspergillus niger</i>)	98.39 (9.94)	83.03 (9.14)	57.78 (7.63)	49.49 (7.07)	43.05 (6.60)	36.67 (6.09)	35.70 (6.01)	28.07 (5.34)	28.53
T ₉ - Control	91.77 (9.61)	73.43 (8.60)	46.25 (6.82)	42.83 (6.58)	38.58 (6.25)	29.90 (5.51)	24.86 (5.04)	20.06 (4.53)	21.86
SEm	0.057	0.091	0.215	0.133	0.106	0.081	0.137	0.094	-
CD 5%	0.172	0.274	0.645	0.399	0.319	0.243	0.410	0.282	-

Figure in parenthesis are transformed values is $\sqrt{x} \pm 0.5$
PSB (Phosphorous Solubilizing Bacteria) DAP- Diammonium phosphate, MoP- Murate of Potash, Rhizobium and

Trichoderma viride. were applied in the seed. *T. viride*, AM and *Aspergillus niger*.

Table 3: Mean of dry Lac weight (g)/plant in 2016—17

Mean of Lac (g)/plant			
Treatments	Mean live lac insect/2.5 cm ² at harvest	% Survival from BLI to harvest	Mean
T ₁ -PSB + T.v +Rh +DAP + MoP (micro + macro nutrient) Auskelp	24.90 (5.04)	25.55	318.67
T ₂ -PSB+T.v.+Rh+ DAP+ MoP, micro (Multiplex)	23.52 (4.90)	25.49	223.00
T ₃ - PSB+T. v. + Rh+ DAP + MoP + PGR	25.59 (5.11)	26.88	335.33
T ₄ - (T ₁ + AM)	25.14 (5.06)	25.95	218.00
T ₅ - (T ₂ + AM)	25.51 (5.10)	25.97	254.67
T ₆ - (T ₃ +AM)	25.11 (5.06)	25.70	316.00
T ₇ -AM	25.19 (5.07)	25.96	265.67
T ₈ -(T ₄ + <i>Aspergillus niger</i>)	28.07 (5.34)	28.53	531.00
T ₉ - Control	20.06 (4.53)	21.86	151.33
SEm	0.094	-	10.388
CD 5%	0.282	-	31.143

Figure in parenthesis are transformed values is $\sqrt{x} \pm 0.5$; PSB (Phosphorous Solubilizing Bacteria) DAP- Diammonium phosphate, MoP- Murate of Potash, Rhizobium and *Trichoderma viride*. were applied in the seed. *T. viride*, AM and *Aspergillus niger*.

Survival of insect on the host plant depends on various

factors, including nutrition. Treatments which promote growth and nutrients shatter of the host may also support lac insect.

Mean of dry Lac weight (g)/plant

The mean weight of raw lac per plant varied from 151.33g

(T₉) control to 531.00g (T₈). It was highest in T₈ (531.00g), followed by T₃ (335.33g), T₁ (318.67g), T₆ (316g), T₇ (265.67g), T₅ (254.67g), T₂ (223g), T₄ (218g) and T₉ (151.33g) over the control T₉ (151.33g). The mean weight of lac in T₁, T₃ and T₆ were at par, T₇ and T₅ were at par, T₂ and T₄ were at par with each other.

The percent survival percent of lac insects from BLI to harvest of *C. cajan* lac crop was highest (28.53) in T₈, so was the lac yield was highest in T₈ per plant. These two data reveals that the Treatment T₈ may have provided better nutrients to the lac insects feeding on its sap. This may have played an important role in the higher survival of lac insects. Thus all lac insects with access to nutrient rich food may have been a reason for in more resin secretion.

Conclusion

Lac can be successfully produced on pigeon pea without comprising the yield of *C. cajan*. The best treatment was (T₈) [(T₄ + *Aspergillus niger*) PSB + *Trichoderma viridae* + Rhizobium + DAP + MoP + macro nutrient + (Auskelp) + AM (Arbuscular Mycorrhiza) + *Aspergillus niger*]. Lac production of pigeon pea can help farm women to double income. Lac production on pigeon pea in the backyard can help to rural household to overcome protein mal-nourishment also.

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