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Survival of lac insect on nutrient managed pigeon pea

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Abstract
A field trial was conducted in 2017-18 at farmer's field in Jhiria, Jabalpur, Madhya Pradesh on Pigeon pea (TJT-501) to study the growth and survival of lac insect under the influence of added nutrition and bio-agents with nine treatments including control in randomized block design with three replications. The treatment combination T_8 (PSB + *Trichoderma viride* + Rhizobium + DAP + MoP + micro + macro nutrient + (Auskelp) + *Arbuskular mycorrhiza* + *Aspergillus Niger*) recorded highest density%, survival % and yield of lac per plant than all the treatments including control. It indicates that addition of nutrition to host plants promotes lac insect development and lac yield.

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

Introduction
Lac is a resinous secretion of the lac insect, *K. lacca* (Sharma *et al.*, 2006) [28]. Lac insect is a phloem feeder (Kehr.2006; Kaushik *et al*., 2012; Ahmad *et al.*, 2012; Shah *et al.*, 2014) [13,12,1,24]. The growth and development of *K. lacca* depends on the availability of phloem sap as well as its composition (Gimnig *et al.*, 2002; Namdev *et al.*, 2016; Shah *et al*., 2014) [8,17,24]. The survival, growth and development of insects are directly depends on the nutrients acquired from its host plants (Wellings and Dixon, 1987; Mc Guinness, 1987; Gogi *et al.*, 2012) [29, 15, 9]. The growth, survival, fecundity and density of insects are influenced by amino acid (Bi *et al.*, 2001) [2] as well as health status of host plant.
Pigeon pea is widely cultivated crop in the world (FAO, 2008) [4]. It is 2nd most popular pulse crop in India in terms of area and production. Pigeon pea being an annual cultivated host of lac insect there is lot of possibility in Madhya Pradesh. The effect of nutrients on growth and survival of lac insects on *Butea monosperma* (Sharma, 2015; Ghugal *et al.* 2016; Kumar *et al.* 2017) [26, 7, 14], Zizyphus *mauritiana* (Shah *et al*. 2015; Namdev *et al.* 2015; Shah and Thomas, 2018) [22, 18, 20] and *Schleichera oleosa* (Chen *et al.* 2010; Ghugal *et al.* 2015) [3,6] is well documented. However, study related to nutrient managed pigeon pea for lac production host is limited. Thus, an effort was made to study the effect of various nutrient sources on the growth and survival of lac insect on Pigeon pea.

Materials and Methods
Pigeon pea, *Cajan* (L) Millsp variety TJT-501 was evaluated for lac production. The field research work was conducted during the year 2017-18 in the farmer's field in Jhiria, Jabalpur, and 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.

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 23º 09' North latitude and 79 º 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 4.80ºC to 24.90 ºC and 28.50 to 41.80 ºC, respectively.

Statistical analysis

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

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

Result and Discussion

The experiment was laid in Randomized Block Design (RBD), with nine treatments and three replications. Each treatment had nine plants. The plant to plant spacing was 6x6 feet within the replication. The spaces between the replications were 6 feet. The experiment plot size was 150ft x 100ft. The second year field experiment was conducted in the year 2017-18.

Table 1: Details of treatments

Treatment No.	Treatment details
T_1	PSB + *Trichoderma viride* + Rhizobium + DAP + MoP + micro + macro nutrient + (Auskelp)
T_2	PSB+ *Trichoderma viride* +Rhizobium+DAP+ MoP+ micronutrients (Multiplex)
T_3	PSB + *Trichoderma viride* + Rhizobium + DAP + MoP + PGR (Plant Growth Regulators)
T_4	T_1 + AM (Arbuskular mycorrhiza)
T_5	T_2+ AM
T_6	T_3+AM
T_7	AM
T_8	T_4 +*Aspergillus niger*
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 allows to grow under moist condition. Chemical fertilizers (DAP and MoP) were mixed in the soil before planting.

Table 2: Mean number of live lac insect per 2.5 cm²

Treatments	Mean no. of live lac insects /2.5 cm² on days after BLI.								
	30 days	45 days	75 days	90 days	105 days	120 days	140 days	Before Harvesting	% Survival
T_1-PSB + *T.v* +Rh +DAP + MoP (micro + macro nutrient) Auskelp	97.36 (9.89)	86.79 (9.34)	62.49 (7.93)	51.51 (7.21)	44.01 (6.66)	35.70 (6.01)	29.46 (5.47)	23.85 (4.93)	24.22
T_2-PSB+*T.v.*+Rh+ DAP+ MoP, micro (Multiplex)	97.20 (9.88)	81.09 (9.03)	62.74 (7.95)	51.42 (7.2)	46.01 (6.82)	37.84 (6.19)	32.06 (5.7)	26.91 (5.23)	22.69
T_3- PSB+*T. v.* + Rh+ DAP + MoP + PGR	97.85 (9.92)	81.90 (9.08)	61.88 (7.89)	52.35 (7.27)	44.76 (6.73)	36.26 (6.06)	29.99 (5.52)	25.95 (5.14)	26.52
T_4- T_1+ AM	96.83 (9.87)	83.80 (9.18)	57.49 (7.61)	48.21 (6.98)	42.25 (6.54)	36.50 (6.08)	29.26 (5.45)	25.13 (5.06)	25.95
T_5- T_2+ AM	97.19 (9.88)	86.34 (9.32)	62.51 (7.94)	49.31 (7.05)	42.72 (6.57)	35.25 (5.98)	30.32 (5.55)	25.63 (5.11)	26.37
T_6- T_3+AM	97.26 (9.89)	82.96 (9.13)	59.69 (7.75)	52.04 (7.25)	46.62 (6.86)	37.18 (6.14)	30.55 (5.57)	24.93 (5.04)	25.63
T_7-AM	97.31 (9.89)	78.4 (8.88)	60.11 (7.77)	50.95 (7.17)	44.76 (6.73)	37.73 (6.18)	31.52 (5.66)	25.40 (5.09)	26.10
T_8-T_4 +*Aspergillus niger*	102.41 (10.14)	83.50 (9.16)	67.89 (8.27)	53.91 (7.37)	48.03 (6.96)	41.44 (6.47)	34.41 (5.9)	29.37 (5.46)	28.68
T_9- Control	93.66 (9.70)	76.25 (8.76)	52.61 (7.28)	46.48 (6.85)	37.53 (6.17)	33.89 (5.86)	26.41 (5.18)	21.33 (4.67)	22.77
SEm	0.046	0.106	0.136	0.117	0.121	0.110	0.090	0.112	-
CD 5%	0.137	0.317	0.406	0.350	0.361	0.331	0.270	0.336	-

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*.

Mean number of live lac insect per 2.5 cm² (MNL)

The MNL was recorded on 30, 45, 75, 90, 105, 120, and 140 after brood lac inoculation (BLI) and before harvesting. There was continuously decline in the MNL from 30 days after BLI to the harvest of the lac crop. This was also reported earlier by several workers in the past.

During the year of the experiment also the MNL declined in the same trend i.e. from 30 days after BLI till the harvest of the plants for lac crop (Table 2).

The MNL during the second year at 30 days BLI was almost the same. It varied from 93.66 (T_9) control to 102.41 (T_8) [(PSB + Trichoderma viride + Rhizobium + DAP + MoP + micro + macro nutrient + (Auskelp) + AM (Arbuscular mycorrhiza) +A Niger) PSB + T viride+ Rhizobium + DAP + MoP + macro nutrient + (Auskelp) + AM (Arbuscular mycorrhiza) +A Niger]. The MNL in all the treatments were significantly highest over the control T_9. The MNL at 30 days after BLI varied from 60 to 95.80 (Patel, 2013) [20], 28.13 to 40.53 (Jhanghel, 2013) [11], 51.35 to 64.08 (Namdev *et al.*, 2014) [18]. At 45 days after BLI the MNL varied from 76.25 (T_9) to 86.79 (T_1) (PSB + Trichoderma + Rhizobium + DAP + MoP +micro +macro nutrient+ (Auskelp). Treatments T_9, T_2 (81.09), T_7 (78.4) and T_3 (81.90) were at par with each other. Though, T_8 (83.50), T_4 (83.80), T_5 (86.34) and T_6 (82.96) were at par with T_1 (86.79), but were significantly higher than T_9.The MNL of lac insects on *B. monosperma* at 45 days after BLI was reported to vary from 33.00 to 67.33 (Janghel, 2013) [11]. At 75 days after BLI the MNL varied from 52.61 (T_9) to 67.89 (T_8). The former and T_4 (57.49) were at par with each other. Treatments T_8, T_2 (62.74), T_5 (62.51), T_1 (62.49) and T_3 (61.88) though were at par with each other but were significantly higher than control T_9 (52.61), T_6 and T_7. The

MNL varied from 28.37 to 33.46 after 76 days of BLI (Kumar *et al.*, 2017) [13] and 44.95 to 50.28 (Mohanta *et al.*, 2014) [17]. At 90 days after BLI the MNL varied from 46.48 (T_9) to 53.91(T_8). Treatments T_9, T_4 (48.21), T_2 (51.42), T_5 (49.31), and T_7 (50.95) were at par with each other. Similarly, T_2 (51.42), T_5 (49.31), T_6 (52.04), T_1 (51.51) and T_3 (52.35) were at par with T_8 (53.91), but were significantly higher than control T_9. The MNL of *K. lacca* at 90 days BLI varied from 22.88 to 27.88 in different nutrient managed *Z. mauritiana* (Namdev *et al*., 2014) [19], 25.07 to 28.65, (Shah *et. al*., 2018) [22a, 23b]. At 105 days after BLI the MNL varied from 37.53 (T_9) to 48.03 (T_8). The MNL in all the treatments were significantly higher over the control T_9 (37.53). Treatments T_8 (48.03), T_2 (46.01), T_6 (46.62), T_3 (44.76), T_1 (44.01) and T_3 (44.76) were at par with each other but significantly higher than control T_5. At 105 days after BLI the MNL according to Ghugal *et al.*, (2016) [7] varied from 19.08 to 30.09 while it was 33.53 to 41.77 (Sharma *et. al*., 2015) [23a, 24b]. At 120 days after BLI the MNL varied from 33.89 (T_9) to 41.44 (T_8). Treatments T_9, T_4 (36.50), T_2 (37.84), T_5 (35.25), T_6 (37.18), T_7 (37.73), T_1 (35.70), T_3 (36.26) and T_7 were at par with each other. Similarly, T_8 (41.44), T_2 (37.84), T_6 (37.18) and T_7 (37.73) were at par with each other but was significantly higher than control T_9. It varied from 51.35 to 64.08 (Namdev *et al*., 2014) [19], 38.31 to 43.37 (Gurjar, 2016) [10]. At 140 days after BLI the MNL varied from 26.41 (T_9) to 34.41 (T_8). The former and T_4 (29.26) were at par with each other. Treatments T_8, T_2 (32.06) and T_7 (31.52) were also at par with each other, but was significantly higher than control T_9. Treatments T_4, T_2, T_3, T_4, T_5 and T_1 were also at par with each other. MNL at 130 days after BLI has been recorded by Namdev *et al.*, 2014 [17] on *Z. mauritiana* and it varied from16.50 to 20.33 and 20.07 to 23.26, Shah *et al.*, (2018) [22a, 21b] in different treatments. Before harvesting the MNL varied from 21.33 (T_9) to 29.37 (T_8- T_4 + *Aspergillus Niger*). The former and T_1 (23.85) were at par with each other. Treatments T_8 (29.37), T_2 (26.91) and T_3 (25.95) were at par with each other but was significantly higher than control T_9. Treatments T_1, T_3, T_4, T_5, T_2 and T_7 were at par with each other. Namdev *et al.*, 2014[19] found higher MNL in nutrient managed host trees at harvest/ maturity and it varied from 15.57 to 18.43. Before harvesting the MNL varied from 21.33 (T_9) to 29.37 (T_8). The former and T_1 (23.85) were at par with each other. Treatments T_8 (29.37), T_2 (26.91) and T_3 (25.95) were at par with each other but was significantly higher than control T_9. Treatments T_1, T_3, T_4, T_5, T_2 and T_7 were at par with each other. The survival percent of lac insects from BLI to the harvest of the lac crop was highest (28.68) in T_8, followed by T_2 (26.52), T_3 (26.37), T_4 (26.10), T_5 (25.95), T_6 (25.63), T_1 (24.22), T_9 (22.77) and T_2 (22.69). The survival percent of lac insects is also studied by various workers in the past. It is varied from 27 to 32 (Patel, 2013) [21] and 21 to 25 (Janghel, 2013) [11].

Conclusions

Nutritional status of the host influences the growth and survival of the phloem feeder. This may be the reason for higher percent of survival of lac insects in $T_{8.}$ The improved mean density of live lac insect per 2.5 cm² before harvesting of lac as well as the percent survival throughout the life stages of lac insect and mean yield of lac per plant of pigeon pea over the control indicates that the use of nutrient sources and bio-agents provides good amount of nutrition to the host plant and ultimately to the lac insect as well as maintains the host plant in good health for the development of settled lac insect.

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