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Settlement of lac insect in relation to host's substrate and sink

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Abstract
Preference of lac insects depends on the quality and quantity of phloem sap from the its host Commercially, *Keria lacca* is reared on the naturally standing trees of *Butea monosperma, Zizyphus mauritiana and Schleicheria oleosa.* In the recent field trial, *Rangeeni* brood lac was inoculated on annual leguminous shrub *Cajanus cajan* (L) Millsp grown on different substrate. Though the mean number of primary branches per plant varied from 2.17 T_2, (*C. cajan* grown on S_2 with lac insects and picking of mature pods), T_6, (*C. cajan* grown on S_1 with lac insects and only one hand picking of mature pods followed by removal of flowers) to 2.67, T_4, (*C. cajan* grown on S_3 with lac insects and hand picking of pods). However, the mean number of secondary branches per plant varied from 6.17 (T_2) to 8.17 T_5, (*C. cajan* grown on S_1 with lac insects and removal of young pods). Lac insect settled of primary branches per plant was highest (94.44%) on *C. cajan* grown on substrate S_1 with removal of young pods (T_5). But the mean percent of lac insects settled secondary branches per plant was highest in both T_6 (85.95%) and T_3, (*C. cajan* grown on S_1 with lac insects and removal of flowers) (85.30%). Removal of sink enriches the nutrient status of phloem sap. Thus the data reveals that lac insect settlement or preference depends on the nutrient availability in the phloem sap of the host plant.

Keywords: preference lac insects, *Cajanus cajan*, branches, source, sink

Introduction
Insect plant interaction is one of the most interesting areas of study among the phytophagous insects (Sugio *et al*., 2015; Franco *et al*., 2017) [22, 6]. Selection of host plants (Endara *et al*., 2017) [5] and specific site of host plants ((Purcell *et al*., 2000) [18] are governed by numerous factors (Withers *et al*., 2000) [24]. Thus, it has to do with the chemical composition of host plants (Schantz *et al*., 1953) [19], plant architect (Andow and Prokrym 1990) nutrient supply (McGuinness, 1987; Gogi *et al*., 2012) [13] and even shelter ((Mello and Filho, 2002; Ohgushi *et al*., 2008) [14, 17]. The relationship is even more complex among phloem feeders (Casas and Djemai, 2002) [4]. Lac insect (*K. lacca* Kerr.) is also phloem feeder (Ahmad *et al*., 2012; Shah *et al*., 2014) [20] and feed on the phloem sap (Namdev *et al*., 2018) [16] with its piercing and sucking mouthparts (Imms and Chatterjee, 1915) [8] Preference of lac insect for settlement on succulent branches of host tree species is well known *B. monosperma, S. oleosa* and *Z. mauritiana.* However, preference of lac insects for settlement on annual shrub is not yet reported. *C. cajan* (L.) Millsp commonly known as pigeonpea is the most important *kharif* pulse cultivated in Madhya Pradesh (https://farmer.gov.in/ 2018-19). It is proven to be a good host plant of lac insect (Thomas 2003, 2006). Being an annual shrub, the stem and branches of *C. cajan* are comparatively more succulent than those of *B. monosperma, S. oleosa and Z. mauritiana.* In this context, there must be preferential selection of lac insect on type of branches of its settlement. The present study is an effort to find the preference of lac insects on the type of branches of *C. cajan* for its maximum settlement.

Material and Methods
A Field trial on *C. cajan* var. TJT-501 was conducted in Jawaharlal Nehru Krishi Vishwa Vidyalaya Jabalpur during the year 2019-20. Seedling raised in polythene bag was transplanted on 06.07.2019 in polypropylene bag (PPB) filled with 65kg substrate of three types. The trial conducted in RBD format consisted of six treatments (Table 1) and three replications.

Plant to plant and row to row spacing was 6 feet, while the replications were 10feet apart.

The seedling before and after transplantation were nipped at 10-12 days interval till the last week of September. Nipping operation was to induce branching. Substrate S_1 consisted of a combination of 45kg *Kapu* + 20 kg FYM, S_2 had only 65 kg FYM, while S_3 had only 65 kg *Kapu*. All the substrates were treated with *Trichoderma viride*.

Rangeeni brood lac raised on *B. monosperma* was purchased from Adarsh Lac Samiti, Jamankhari village, Tehsil Barghat, district Seoni, M.P. on 03.11.2019, *C. cajan* plants of all the treatments except T_4 was inoculated with brood lac on 05.11.2019. The *phunki* lac was removed on 26.11.2019 i.e 21 days after BLI. All the plant were treated with contact insecticide (Cartap hyodrochloride 50SP@ 1g/litre of water) to protect from foliage feeders and predators of lac insect. The number of primary and secondary branches with lac insect settlement per plant was counted. Removal of flower and young pods were the treatments (Table-1) followed to remove the sink.

Table 1: Treatments details

	Treatment details
T_1	*C. cajan* grown on S_1 with lac insects and hand picking of mature pods
T_2	*C.cajan* grown on S_2 with lac insects and picking of mature pods
T_3	*C.cajan* grown on S_1 with lac insects and removal of flowers
T_4	*C.cajan* grown on S_3 with lac insects and hand picking of pods
T_5	*C. cajan* grown on S_1 with lac insects and removal of young pods
T_6	*C. cajan* grown on S_1 with lac insects and only one hand picking of mature pods followed by removal of flowers

Substrate: S_1=FYM (20kg) + Kapu (45kg) in the ratio of 1:1(W/v) + *Trichoderma viride*
Substrate: S_2= FYM (65 kg) + *T. viride* **Substrate: S_3=** Kapu (65kg) + *T. viride*

Results and Discussion

Mean numbers of primary and secondary branches of *C. cajan*

The mean number of primary branches per plant varied from a minimum 2.17 in T_2, (*C. cajan* grown on S_2 with lac insects and picking of mature pods) to maximum 2.67 in T_4 (*C. cajan* grown on S_3 with lac insects and hand picking of pods). There was no significant difference among the treatments in terms of mean number of primary branches per plant. The mean number of secondary branches per plant varied from a minimum 6.17 in T_2 to maximum 8.17 in T_5, (*C. cajan* grown on S_1 with lac insects and removal of young pods) The difference in the mean number of primary and secondary branches of *C. cajan* may have been influenced by both nipping operation and the treatments. Earlier workers (Vajpayee *et al* 2019a, b.) also reported that nipping of growing tips lead to increase branching. Similarly, addition of soil microbes helps in mobilization of soil nutrients (Timmusk *et al*., 2017) [23] and resulted in plant growth. (Lopez-Bucio *et al*., 2003) [12] In the early growth stage of *C. cajan*, the nipping of growing tips were usually of the stem, later the primary branches were nipped, resulting on more number of secondary branches. In comparison to primary branches, there were more secondary branches (Table-2). Lac insect was inoculated in the month of November and observations on the mean number of branches were done till September, while the brood lac inoculation was done in the first week of November, 2019 i.e 36 days before BLI. The flower initiation was on 15 October 2019 i.e 20 days before BLI. The pod initiation was on 25 November i. e 15 days after BLI. The insects after BLI crawlers for about 20 days (Mohanta *et al*., (2014)) [15]. This period provides sufficient time for probing (Krishnaswami *et al*., 1964) [11].

Table 2: Mean number of primary branches and secondary branches of *C. cajan* under different treatments

Treatments	Mean no. of branches/plant	
	Primary	Secondary
T_1- *C. cajan* grown on S_1 with lac insects and hand picking of mature pods	2.50	7.50
T_2- *C.cajan* grown on S_2 with lac insects and picking of mature pods	2.17	6.17
T_3- *C.cajan* grown on S_1 with lac insects and removal of flowers	2.50	8.00
T_4- *C.cajan* grown on S_3 with lac insects and hand picking of pods	2.67	7.00
T_5- *C. cajan* grown on S_1 with lac insects and removal of young pods	2.50	8.17
T_6- *C. cajan* grown on S_1 with lac insects and only one hand picking of mature pods followed by removal of flowers	2.17	6.67

Lac insect settlement on primary and secondary branches *C. cajan* plant

The mean percent of primary branches per plant with lac insect settlement varied from 4.48 (T_5) to 5.57(T_6 & T_7). Secondary branches per plant with lac insect settlement, it varied from 4.54 (T_2) 5.32(T_6). All the treatments were nipped before transplantation. Observations were made to see if treatment influenced the preference of lac insects in choosing the type of branches for its settlement. The crawler stage of lac insects is agile for a very short period (6-7) days after its emergence and before settling on the host plants.

Earlier studies revealed that *K. lacca* preferred secondary branches more than the primary branches.(Vajpayee *et al*., 2019) In the present study, 94.44 percent of primary branches of *C. cajan* grown on S_1 with removal of young pods had lac insect settlement. However, 85.30 percent of the secondary branches of *C. cajan* grown on S_1 with flower removal (T_7) and pod removal (T_6) had highest lac insect settlement. Substrate influenced the number of secondary branches per plant as observed in T_3 and T_6. Preference of lac insect settlement on secondary branches of *C. cajan* was also reported by Vajpayee *et al* (2019a, b.), Kakade *et al*., (2020) [10] This was one of the reasons for encouraging nipping of the growing tips in *C. cajan* (Thomas, 2003) for lac production. *C. cajan* in T_2 had least number of secondary branches and also, least percent of secondary branches with lac insect settlement. The substrate in T_2 was only FYM, which indicate that there may have been a shortage in supply of nutrients to the *C. cajan* grown on it

Table 3: Mean percent of primary and secondary branches per *C. cajan* plant with lac insect settlement on 30th day after BLI

Treatments	% of branches/plant with lac insects settled 30days after BLI	
	Primary	Secondary
T_1- *C. cajan* grown on S_1 with lac insects and hand picking of mature pods	75.00 (4.96)	79.79 (5.12)
T_2- *C. cajan* grown on S_2 with lac insects and picking of mature pods	83.33 (5.18)	62.64 (4.54)
T_3- *C. cajan* grown on S_1 with lac insects and removal of flowers	88.89 (5.39)	85.30 (5.30)
T_4- *C. cajan* grown on S_3 with lac insects and hand picking of pods	61.11 (4.48)	80.79 (5.15)
T_5- *C. cajan* grown on S_1 with lac insects and removal of young pods	94.44 (5.57)	85.95 (5.32)
T_6- *C. cajan* grown on S_1 with lac insects and only one hand picking of mature pods followed by removal of flowers	94.44 (5.57)	80.91 (5.16)

Figure in parenthesis are transformed value $\sqrt{(x+0.5)}$

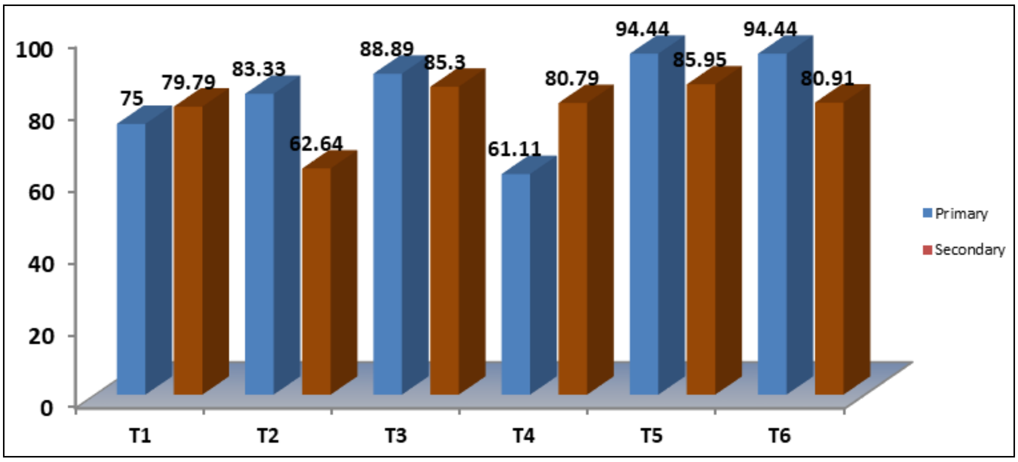

Fig 1: Mean percent of primary and secondary branches per *C. cajan* plant with lac insect settlement

Fig 2: Lac insects settled on branches

Conclusion

The data revealed that the mean percent of secondary branches with lac settlement was highest in T_3 and T_6 where the sink (Flower & pods) were removed. Removal of sink helps the plant to allocate the nutrients to other growing parts (Zhu *et al*., 2010) and enriches the phloem sap (Ainsworth and Bush, 2011). This may be the preference choice of lac insects on secondary branches. The mean percent of primary as well as secondary branches per plant with insect settlement was highest in T_6. This confirms the all hypothesis that lac insects preference is influence not only by the succulence of the branches but also by its nutrient status. On *C. cajan*, lac insects prefer to settle more on branches. Among the branches secondary branches are preferred. Among the treatments %lac insects settled secondary branches was highest on *C. cajan* grown on substrate combination of *Kapu* + FYM with removal of young pods. This means that when the sink is removed the phloem sap get rich in nutrient.

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