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Effects of host plant density and irrigation levels on lac yield

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Abstract
Plant density or spacing and the soil moisture has immediate effect on the flora and fauna. Wider spacing or high dense plant impacts the microclimate and also the biodiversity in the unit space. The immense research going on various aspect of lac production on *C. cajan*. The present study was done to study the impact of the plant density and moisture on lac yield. For this purpose the total length of lac encrusted branch per plant was measured to obtain total length of stick lac per plant and lac yield. The mean length of stick lac (MLS) per plant in different plant spacings varied from 447.56 cm (S_1), 563.81 cm (S_2) to 627.00 cm (S_3). It was significantly higher in S_3 than S_1 and S_2. The mean lac yield (g) per plant in different levels of irrigation on *C. cajan* varied from 168.51 g (W_1), 187.38 g (W_2) to 202.02 g (W_3). The latter (W_3) had significantly higher mean lac yield (g) per plant than that from plant is the remaining levels of irrigation. The findings of the present study open many windows in the field of lac cultivation on different host plant species.

Keywords: Host plant, microclimate, plant density, pigeonpea, stick lac

Introduction
Microclimatic condition has an immediate effect on the growth, reproduction and survival of flora (Sklenar *et al*., 2015) [20] and fauna (Rytteri *et al*., 2021) [15]. This is one of the many reasons for the plant or insects even is hostile climatic condition (Karthik *et al*., 2021) [10]. Occurrence of a small green patch in the entire dessert changes the biodiversity in comparison to that outside the green patch. Plant density or spacing and the soil moisture has immediate effect on the flora and fauna. Wider spacing or high dense plant impact the microclimate and also the biodiversity in the unit space (Asghar *et al*., 2021) [2]. The optimum plant density, which do not only utilize light, moisture and nutrients more efficiently but also avoids excessive competition among the plants (Amoako *et al*., 2022) [2]. There are numerous research finding on insect pest incidence in related to plant spacing or density (Asiwe *et al*., 2005) [4]. Lac production on *Cajanus cajan* (pigeonpea) is promoted in Madhya Pradesh since 2000 in varying dimension (Thomas, 2003) [22]. There immense research going on various aspect of lac production on *C. cajan*. It was thought to study the impact of the plant density and moisture on the survival of lac insects. Survival of lac insects till the harvest of lac crop on the *C. cajan*, decides the lac yield (Kakade *et al*., 2020) [9]. In this context the present field research was conducted.

Materials and Methods
The present field study was conducted in the experimental field, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, India from June 2020 to May 2021.The experimental field was earlier a bunded rice field with heavy soil. The field remained unploughed for on a last three year. Required physical facilities were adequately available to conduct the field experiment. The climate of Jabalpur region is typically Sub humid, featured by hot dry summer and cool dry winter. The field experiment was laid out in Split Plot Design with nine treatments replicated thrice. There were three pigeon pea plant in each replication per treatment.
Nursery of *C. cajan* was raised on the substrate (Kapu + FYM) filled in perforated polythene bag of size 18x16 cm. Seeds treated with *Trichoderma viridae*, Rhizobium and PSB were sown in perforated polythene bags to drain out excess irrigation water, applied at weekly intervals.

The growing tips of seedlings in the nursery were nipped at 15 days interval till its transplantation. The layout of the experiment was planned as per the treatments in the main plot with three plants spacing *viz*; S_1 (plant to plant 6 feet), S_2 (plant to plant 9 feet) and S_3 (plant to plant 12 feet). The row to row distance was maintained at 10 feet. There were three levels of irrigation *viz*; W_1- 2 litre/h, W_2- 4 litre/h and W_3- 8 litre/h. The discharge from the drip was adjusted with the dripers. Irrigation was given for one hour during each schedule.

The seedlings of *C. cajan* were transplanted in polypropylene bags (PPB) filled with substrate consisting of a mixture of river bed basin soil (Kapu) and well rotten Farmyard manure (FYM). The weight of substrate for each *C. cajan* plant in PPB was 45 kg i.e., 30 kg of soil + 15 kg of FYM. The soil and FYM in the above ratio were filled in the PPB in alternate layers.

Rangeeni brood lac was purchased from Adarsh Lac Samiti, Jamankhari village, Tehsil Barghat, district Seoni, Madhya Pradesh, on 30.10.2020. The brood lac was segregated to quality as well as predator free brood for its inoculation on *C. cajan*. Brood lac stick weighing 15 g was tied on the stem of *C. cajan* above one foot above the base with the help of a twine. *Phunki* was carefully removed from *C. cajan* plant 21 days after BLI without damaging the fresh lac insect settlement on the branches. *C. cajan* with lac crop was harvested on 25.05.2021. The harvested plants were shade dried and the lac was scrapped from the plant after keeping a clean and thick sheet of tarpaulin.

Results

Mean length (cm) of stick lac per plant

Main plot effect (Spacings)

The stick lac length is the measure of the branch or the twig with lac encrustation. The total length of lac encrusted branch per plant is measured to obtain total length of stick lac per plant. The mean length of stick lac is the mean of all plants in a replication or treatment.

The mean length of stick lac (MLS) per plant in different plant spacings varied from 447.56 cm (S_1), 563.81 cm (S_2) to 627.00 cm (S_3). It was significantly higher in S_3 than S_1 and S_2 (Table 1).

Sub plot effect (Levels of irrigation)

The mean length of stick lac (MLS) of *C. cajan* with different levels of irrigation varied from 495.73 cm (W_1), 522.65 cm (W_2) to 619.99 cm (W_3). The latter (W_3) had significantly higher MLS than the remaining levels of irrigation. The MLS in W_2 was significantly also higher than W_1. The per plant additional quantity of water was 132 litres (W_1), 264 litres (W_2) and 528 litres (W_3).

C. cajan plant with wider spacing had more number of primary and secondary branches at the time of brood lac inoculation. This proved on opportunity for the crawling lac insects to settle on more branches and resulted in more stick length.

Interaction effect

In the interaction effect of plant spacings and levels of irrigation the MLS varied from 393.36 cm (S_1W_1) to 693.01 cm (S_3W_3). The latter (S_3W_3) was significantly higher MLS than S_1W_1 but was at par with S_2W_3 (651.04 cm) and S_3W_2 (659.96 cm). The MLS in plants of S_1W_1 (393.36 cm) was Alsop at par with S_2W_1 (433.41 cm) and S_2W_2 (474.57 cm). However, the MLS of S_1W_3 (515.92 cm) was at par with S_3W_1 (528.03 cm) and S_2W_1 (565.81 cm).

Mean lac yield (g) per plant

Main plot effect (Spacings)

The stick lac is scraped with either a knife or an iron plate to obtain raw lac, which is a cash commodity. The total raw lac obtained per plant relates to the lac yield. The mean lac yield is the mean of the lac yield of plants in a replication or treatment. The mean lac yield (g) per plant in different plant spacings varied from 157.64 g (S_1), 198.89 g (S_3) to 201.38 g (S_2). The latter (S_2) had significantly higher mean lac yield (g) per plant than S_1 but was at par with S_3 (Table 1).

Sub plot effect (Levels of irrigation)

The mean lac yield (g) per plant in different levels of irrigation on *C. cajan* varied from 168.51 g (W_1), 187.38 g (W_2) to 202.02 g (W_3). The latter (W_3) had significantly higher mean lac yield (g) per plant than that from plant is the remaining levels of irrigation. The per plant additional quantity of water was 132 litres (W_1), 264 litres (W_2) and 528 litres (W_3).

Interaction effect

In the interaction effect of plant spacings and levels of irrigation the mean lac yield (g) per plant varied from 139.21 g (S_1W_1) to 229.85 g (S_3W_2). The mean lac yield per plant in S_3W_2 was significantly higher than that of S_1W_1 but was at par with S_2W_3 (226.82g). The mean lac yield (g) per plant in S_1W_1 (139.21g) was at par with S_1W_2 (152.82g), S_3W_1 (168.47g). However, the mean lac yield (g) per plant in S_2W_2 (179.47g) was at par with S_1W_3 (180.88g), S_2W_1 (197.84g) andS_3W_3 (198.35g) (Fig.1).

Discussion

The species of lac host plants (Bhatnagar *et al*., 2022) [6] and its health are crucial factors in lac yield (Sharma 2017) [19]. The soil nutrient status also affects the health of the lac host (Patidar *et al*., 2022) [14]. Numerous abiotic variables have a significant impact on lac production (Sarvade *et al*., 2018) [17]. Host plant health factor is an important deciding factor in the food web of phytophagous insects growth (Caroline *et al*., 2002) [7], survival (Okech *et al*., 2007) [13] and production (Kakade *et al*., 2020) [9]. Thus, nutritional status of host plant as well as its growth is equally important for lac insect growth (Kakade *et al*., 2020; Patidar *et al*., 2022) [9, 14]. Pigeonpea growth and its development vary in different farming situations (Saxena and Nadarajan, 2010) [18] and zones in agro-climatic. Variability in growth occurs even in the same area due to sowing dates, plant densities, irrigation methods and frequencies, nutrient and weed management techniques, and other cultural and management practises (Ahlawat and Rana 2005) [1]. Although tight row spacings cause variations in microclimate factors including light intensity, evapotranspiration, and soil surface temperature, plant density is a key element in enhancing crop output (Mula *et al*. 2011) [12]. One of the key elements that profoundly influence the development, growth and yield of a plant is its spacing from other plants. The right planting density maximizes space, light, and nutrient uptake, resulting in a high yield and higher-quality plant production (Asiry *et al*. 2022) [3]. Recently Azevedo *et al*. (2023) [5] conducted an experiment on effect of spacing between pigeonpea plants on their performance and reported that, pigeonpea plants with the lowest spacing had fewer leaves and a smaller leaf area due to reciprocal shading. Lowest spacing between pigeonpea plants causes leaves in the lower plant sections to abort, dry or drop. Self-shading also prevented leaf and branch development in the lower stem. They reported better performance of pigeonpea plants for the greater spacing used, which enabled less competition among plants and, consequently, improved their development. Plants that receive micro watering in the form of drips and sprinklers use water more efficiently. Since drip irrigation just wets the soil and maintains the ideal moisture level in the root zone, it can be regarded as an effective irrigation technique. Additionally, it provides various benefits for effective water management, such as timely water delivery and application. The many unique agronomic, water-, and energy-saving advantages of micro irrigation help irrigated agriculture overcome many current and future issues (Loganathan *et al*. 2017) [11]. The effects of different irrigation levels have been studied by Saritha *et al*. (2012) [16] and reported better performance of pigeonpea plants under higher irrigation system. According to their findings pigeonpea plants were able to absorb more nutrients from the soil due to continuous irrigation, which increased plant performance in comparison to others.

Table 1: Quantitative analysis of lac yield

Treatment	Stick lac length (cm)	Lac yield per plant (g)
Main plot treatments		
S_1	447.56	157.64
S_2	563.81	201.38
S_3	627.00	198.89
S.Em(±)	18.11	6.30
CD(5%)	71.12	24.72
Sub plot treatments		
W_1	495.73	168.51
W_2	522.65	187.38
W_3	619.99	202.02
S.Em(±)	19.74	6.47
CD(5%)	60.84	19.93
Interactions effects		
S_1W_1	393.36	139.21
S_1W_2	433.41	152.82
S_1W_3	515.92	180.88
S_2W_1	565.81	197.84
S_2W_2	474.57	179.47
S_2W_3	651.04	226.82
S_3W_1	528.03	168.47
S_3W_2	659.96	229.85
S_3W_3	693.01	198.35
S.Em(±)	34.20	11.20
CD(5%)	105.37	34.53

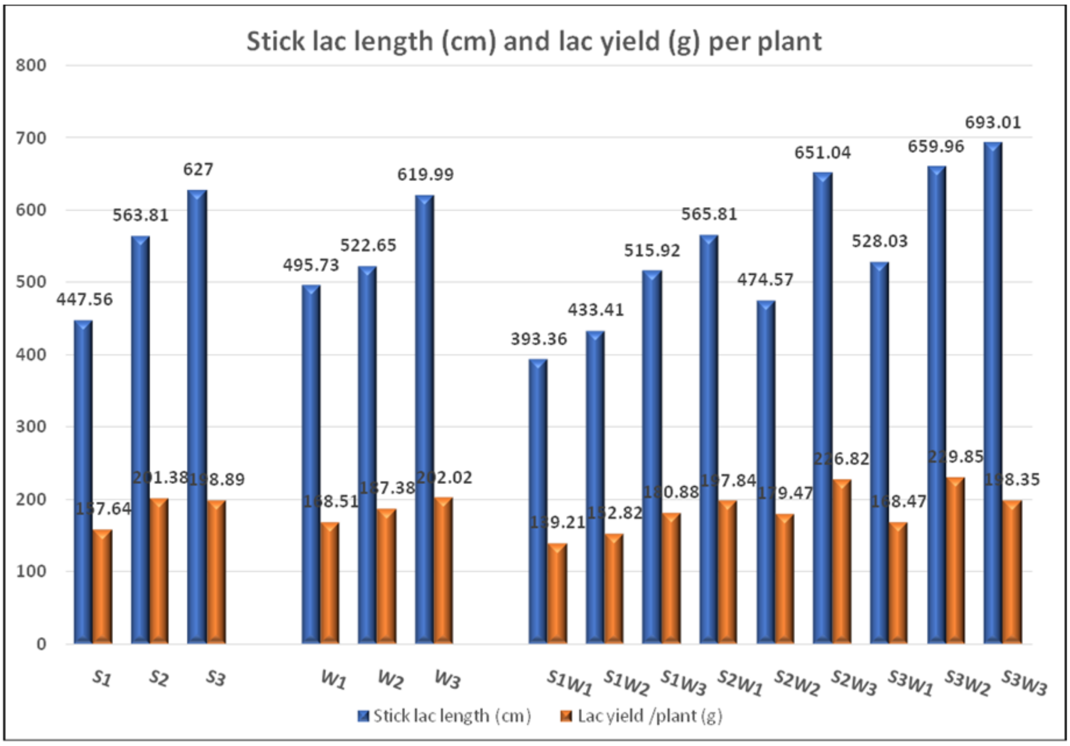

Fig 1: Lac stick length and lac yield per plant in different plant spacings and levels of irrigation

Conclusion

Plant density and soil moisture both are important factors to influence plant health. Lac yield always depends on the health of host plants. As healthy host plant provide better nutrition to the sucking insects. The findings of the present study indicated that lac yield was directly related with the spacing among pigeonpea plants as well as soil moisture level available for their development.

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