**Impact of Closer Spacing on Sucking Pests and Pink Bollworm Infestation in Cotton Crop**

**Abstract:**

 The present study was carried out at Dr. K.L. Rao Krishi Vigyan Kendra, Garikapadu, NTR District to find out the impact of plant spacing on population dynamics of sucking pest in two consecutive years of *kharif* 2023-24 and 2024-25 under special project on **“cotton targeting technologies to agro ecological zones large scale demonstrations of best practices to enhance the cotton productivity” CICR, Nagpur**. Two consecutive years major sucking pest population *viz,* leafhopper, thrips, aphids and whitefly incidence was recorded higher in closer spacing (90x30cm) compared to normal spacing (100x45cm). In both the spacings thrips population was dominated during the initial crop growth period followed by aphid population was gradually increased from 90 days after sowing (DAS), but closer spacing recorded 30-40% higher yields compared to normal spacing.

Key Words: closer spacing (90x30cm), normal spacing (100x45cm) and sucking pests.

**Introduction:**

 “Cotton (*Gossypium arboreum*) is an important commercial crop in India and stands first in the world with a production of 377.2 lakh bales and grown in an area of 13 m ha. However, India’s average productivity is about 439 kg lint/ha combining both irrigated and rain fed situations, which is much lower than the world average of 581 kg lint/ ha” (Anonymous., 2023). “The production and productivity of cotton remained low until recent years. Further improvements in cotton yields are possible only through changes in agronomic management and cropping systems. Due to mobilization of nutrients to the developing bolls the vegetative growth is restricted and the canopy size reduced, offering scope for planting cotton at higher planting densities in India” (Balkcom *et al.,* 2010). The manipulation of row spacing, plant density and the spatial arrangements of cotton plants for obtaining higher yield have been attempted by scientists for several decades in many countries. The concept of high density cotton planting, more popularly called as Ultra Narrow Row (UNR) cotton was developed by Briggs *et al.,* (1967). “High Density Planting Systems (HDPS) are commonly followed to obtain high yields with straight varieties across the world especially in the major cotton growing countries” (Anjum *et al*., 2010). “Generally wider row-to-row spacing is followed in deep soils and irrigated farms and ultra-narrow row spacing in rainfed conditions. The early maturity in soils that do not support excessive vegetative growth” (Jost and Cothern, 2001) “can make this system ideal for shallow to medium soils. Hence, the performance of cotton crop with reference to different spacing needs to be studied well in order to understand the effect of seed yield and quality” (Basanagouda and Patil, 2007).

 “The incidence and development of insect pests is dependent on the prevailing physical environmental factors and crop stand. The sucking pests and bollworms are major threats to cotton production under normal planting. Changes in plant density modify the microclimate and this may alter the incidence of pests and diseases” (Venugopalan *et al.,* 2014). However, there was concern over the fact that altered micro-climate under high density planting would aggravate insect pests and diseases. Studies on the influence of high density planting system and different nutrient levels in cotton on insect pest incidence across agro eco-logical systems are scanty. Hence, the study was taken upto explore the Impact of Closer Spacing on Sucking Pests and Pink Bollworm Infestation in Cotton Crop. Keeping these points inview, field investigation under irrigated conditions was carried out to know the sucking pest and bollworm reaction with different planting geometry with variable nutrient levels to get a sustained higher yield under the HDPS system.

**Materials and methods:**

 The present study on the incidence of sucking pests and pink bollworm in Closer Spacing (CS) of cotton was conducted during *kharif* 2023-2024 and 2024-25. The experiment was carried out in randomized block design at two different spacing (90 x 30 cm, and 90 x 45 cm) with siri (NCS 927) BG-II hybrid. The crop was grown following all recommended agronomic practices and plant protection measures. Observations on insect pests were recorded on five randomly selected plants in each plot at 10 days interval starting from 20 days after sowing. Number of aphids, jassids, thrips, whiteflies were recorded on three leaves one each from top, middle and bottom of the plant. Mealy bug was recorded in grade from whole plant basis. Incidence of bollworm was recorded at harvest on the basis of open boll damage and locule damage. Mean of the observations recorded on insect pests across the seasons was calculated and the data were transformed using square root and arc sign transformation before effecting statistical analysis. The collected data were subjected to the analysis. Mention the variety name, intial nutritional status and after pest data collection nutritional status data needed.

**Results and Discussion:**

Cumulative mean number of sucking pest and per cent pink bollworm damage during *kharif* 2023-24 and 2024-25

Table 1 : Sucking pest and per cent pink bollworm damage during *kharif* 2023-24 and 2024-25

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Leafhoppers | Thrips | whitefly | aphids | %Pink Bollworm incidence |
| DAS | Closer Spacing | Normal Spacing | Closer Spacing | Normal Spacing | Closer Spacing | Normal Spacing | Closer Spacing | Normal Spacing | Closer Spacing | Normal Spacing |
| 45 | 4.95(2.21)a | 3.25(1.79)a | 20.53(4.51)a | 15.36(3.90)a | 0.78(0.88)a | 0.60(0.77)a | 4.06(2.00)a | 3.82(1.93)a | - | - |
| 60 | 3.65(1.90)b | 2.95(1.71)b | 8.04(2.82)b | 8.35(2.87)b | 2.12(1.45)b | 1.50(1.21)b | 3.45(1.84)b | 4.74(2.16)ab | - | - |
| 75 | 3.94(1.97)b | 2.95(1.71)b | 5.27(2.28)c | 4.95(2.21)c | 0.72(0.84)c | 0.80(0.89)b | 8.52(2.91)b | 3.60(1.88)bc | - | - |
| 90 | 3.32(1.81)c | 1.70(1.29)c | 5.77(2.39)d | 6.50(2.53)cd | 0.84(0.91)d | 0.70(0.83)c | 7.23(2.67)c | 2.92(1.69)c | - | 5 |
| 105 | 2.45(1.56)d | 2.00(1.41)c | 5.28(2.29)de | 6.05(2.45)d | 1.43(1.19)e | 1.15(1.07)cd | 7.81(2.78)cd | 13.30(3.61)d | - | 18 |
| 120 | 2.10(1.44)e | 1.95(1.39)d | 6.49(2.53)de | 5.95(2.42)e | 1.28(1.12) ef | 0.65(0.80)de | 20.73(4.53)d | 10.06(3.15)e | 4 | 25 |
| 135 | 1.03(1.01)f | 2.20(1.47)d | 4.98(2.22)e | 5.40(2.31)ef | 1.09(1.03) ef | 0.90(0.95)e | 16.13(4.00)e | 11.24(3.32)ef | 8 | 32 |
| 150 | 1.07(1.03)f | 2.25(1.49)e | 3.76(1.93)f | 4.55(2.12)f | 0.80(0.89)f | 1.10(1.04)e | 16.92(4.09)e | 11.95(3.43)f | 11 | 41 |
| CD (0.05) | 0.08 | 0.03 | 0.13 | 0.10 | 0.06 | 0.06 | 0.21 | 0.21 | - | - |
| SEm | 0.02 | 0.06 | 0.08 | 0.04 | 0.01 | 0.02 | 0.20 | 0.21 | - | - |
| CV(%) | 2.82 | 1.34 | 2.85 | 2.18 | 2.70 | 4.09 | 3.90 | 4.70 | - | - |

Figures in the parentheses are subjected to square root transformation.

**Effect of plant spacing on sucking pest population:**

The sucking pest data was recorded throughout crop growth period starting from 45 DAS to 150 DAS.

**Leaf hopper:**

 The leaf hopper population was significantly impacted by plant spacing. The data revealed that leaf hopper population was ranged from 1.03 to 4.95 number per three leaves in closer spacing and 1.70 to 3.25 nos/3 leaves in normal spacing. The leaf hopper population was recorded 4.95, 3.65, 3.94 and 3.32 nos/3 leaves at 45, 60, 75 and 90 DAS respectively in closer spacing and gradually declined, similar trend was observed in normal spacing also.

 The above findings are in conformity with the findings of Shwetha *et al*. (2009) who reported that higher population of leafhoppers was recorded at closer plant spacing of 90 cm × 30 cm (4.73 leaf-1 plant-1) when compared to 90 cm × 60 cm spacing (3.93 leaf -1 plant-1). Biradar (2010) who reported that in cotton, leafhopper population was higher with a plant spacing of 90 cm × 30 cm at 30 and 45 DAS (1.88 and 2.88 leafhoppers leaf-1 plant-1, respectively).

**Thrips:** Thrips population was ranged from 4.49 to 20.53 nos/3 leaves in closer spacing, whereas in normal spacing ranged from 4.55 to 15.36 nos/3 leaves.

 Thrips population was dominated the sucking pest during the early stage of the crop and recorded 20.53, 8.04, 5.27, 5.77 and 5.28 at 45, 60, 75, 90 and 105 DAS respectively in closer spacing, whereas in normal spacing recorded 15.36, 8.35, 4.95, 6.50 and 6.05 no/3 leaves on same days interval. These results are corroborate with the findings of Prasad *et al.,* 2019 who reported that highest number of thrips (6.30 and 4.89 per three leaves) was observed at 45 x10 cm, while lowest (6.20 and 4.53 per three leaves) was observed at 90 x10 cm during *kharif,* 2014 and 2015 respectively.

**Whitefly:** Whitefly population was ranged from 0.72 to 2.12 nos/3 leaves in closer spacing, whereas in normal spacing ranged from 0.60 to 1.50 nos/3 leaves.

 Whitefly population was constant throughout crop growth period 0.78nos/3leaves were observed at 45 DAS and 0.80 nos/3 leaves were observed at 150 DAS. Peak incidence was observed at 60 DAS (2.12 nos/3 leaves). Similar trend was noticed in normal spacing also. Present findings are in conformity with the results of Desai *et al*., 2019 who reported that Whitefly population remains below ETL throughout crop growth period from first fortnight of September both in HDPS and normal spacing. Rajasekhar and Durga Prasad (2018) also did not find above ETL populations of whitefly either sown at normal or closer spacing. These findings are not coincide with the findings of Pandagale *et al.,* 2020 who concluded that whitefly population was increased with increasing plant density and registered 10.34, 9.043 and 8.66 whiteflies/3leaves in 45x10cm, 60x10cm and 75x10cm spacing respectively. Add one more number of supporting authors.

**Aphid Population:** Aphid population was ranged from 3.45 to 20.73 nos/3 leaves in closer spacing, whereas in normal spacing ranged from 2.92 to 13.30 nos/3 leaves. Aphid population gradually increased and attain peak at 120 DAS (20.73 nos/3 leaves). Whereas, in normal spacing sudden peak was observed at 105 DAS (13.30 nos/3 leaves) then gradually decline. Similar findings were observed by the Bhanderi *et al*., 2024 who found that, the highest number of aphids were observed 38.26 and 32.39 per three leaves at closer (60 cm× 15 cm) spacing respectively, while the lowest 19.24 and 24.41 per three leaves was observed at wider (120 cm × 45 cm) spacing

 **Pink bollworm:** Pink bollworm damage (% green boll damage) was observed at 120 DAS (4%) in closer spacing, whereas in normal spacing observed at 90 DAS (5%). Fag end stage of the crop closer spacing recorded 11% green boll damage, whereas in normal spacing it is 41%. These findings are in close conformity with the findings of Gohil *et al*., 2019 who reported that the technological intervention (Closer spacing 90x30cm) recorded significantly lower pink bollworm damage 14.01% and 13.96% during 2017-18 and 2018-19, respectively while the farmer’s practice registered 30.76% and 33.00% during 2017-18 and 2018-19, respectively. These findings are contradictory with the findings of Desai *et al.,* 2019 who reported 4.41 larva/20green bolls in closer spacing (70x10cm) and whereas, 2.51 larva/20green bolls in insecticide resistance management (IRM) plots of normal spacing (120x45cm). Early sowing of cotton in closer spacing aid to complete the crop 10-15 days early compared to normal spacing which helps the crop to escape pink bollworm attack by one picking.

 After developing resistance of pink bollworm for BG-II Garg *et al.,* 2022 suggested certain possible reasons for PBW management strategies, such as understanding life history, non-compliance of bio-safety laws, crop mangement practices, hybrid seed technology and refugia strategy.

**Yield:**

Average yield of 15.3 and 11.5q/acre was recorded in closer and 8.3 and 6.8q/acre was recorded in normal spacing during 2024 and 2025 respectively. Lower yields were recorded during 2025 due to unceasent rains. Even though pest population recorded more in closer spacing higher yields were noticed in closer spacing because of more plant population (14,814 plants/acre) in closer spacing compared to normal spacing (8888 plants/acre). Similar findings were observed by the Dilip 2025 who reported 9q/acre in HDPS (90x18cm) high density planting system and 4.5q in normal spacing (90x60cm).

**Conclusion:**

Closer spacing has the potential of increased yields with reduced cost of cultivation and widely suitable in upland areas especially in redsoils. This technology along with appropriate agronomic and plant protection practices fortify the indias cotton production capacity. Farmers gradually realizing the importance of the closer spacing with respect to higher yields and crop escape from the incidence if pink bollworm, as these two were major constrains of cotton.

Give the proper reasons or justification that eventhough insect population is more in closer spacing but the yield was more.

In article mentioned that nutritional and high density planting data is scanty but no data or table on nutritional status of plants in closer and normal spacing before starting the experiment and after pests data collection

Reasons behind the high incidence of pink bollworm in normal spacing as compared to closer spacing

**Disclaimer (Artificial intelligence)**

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

**References:**

Anjum, S. A., Saleem, M. F., Wang, L., Xue, L., Shahid, M. Q. and Ali, S 2010. Growth, lint yield and earliness index of cotton (Gossypium hirsutum L.) Cultivars under varying row spacing. Cotton Sci., 22(6): 611- 616.

Anonymous. 2023. ICAR-AICRP (Cotton) Annual Report (2022- 23) ICAR–All IndiaCoordinated Research Project on Cotton, Coimbatore 641 003. Pp A-1 toA-4 ([www.cicr.org.in](http://www.cicr.org.in)).

Balkcom, K. S., Price, A. J., Santen, E. V., Delaney, D. P., Boykin, D. L., Arriaga, F. J., Bergtold, J. S., Kornecki, T. S and Raper, R. L. (2010). Row spacing, tillage system and herbicide technology affects cotton plant growth and yield. Field Crops Res., 117: 219-225.

Basanagouda and Patil, C. (2007). Performance of compact cotton genotypes (Gissypium hirsutum) at three spacing and two moisture levels. *Proceedings of The World Cotton Research Conference-4,* September 10- 14. Lubbock.

Bhanderi, G.R., Patel, R.D., Desai, H.R., Patel, M.M., Sankat, K.B and Patel, M.C 2024. Incidence of insect-pests in response to plant density and nutrient levels inDesi cotton (Gossypium arboreum)under rainfed condition. *Indian Journal of Agronomy:* 69 (2): 158-165.

Biradar V 2010 Sucking pests and bollworm studies of late sown Bt cotton (Gossypium hirsutum L.) as influenced by different plant spacings, fertilizer levels and NAA applications under irrigation. *International Journal of Agricultural Sciences,* 6(2): 497-500.

Briggs, R. E., Patterson, L. L and Massey, G. D. (1967). Within and between-row spacing of cotton. Arizona Annual Report. pp: 6-7. University of Arizona Agricultural Extension Service, Arizona.

Desai H.R, Bhanderi G.R, Patel R.D, Sankat K.B and Patel R.K 2019. High density planting with insecticide resistance management approach for sustainable and profitable cotton production in rain fed region. *Journal of Entomology and Zoology Studies*; 7(5): 453-458.

Dilip, M 2025. Cotton crop high density planting system in india – inretrospect and prospects. Cotton Statistics and News. *Weekly Publication of Cotton Association of India*. 29th April 2025: 1-8.

Garg, R., Bishan, S., Raveena, K., Sangeeta, T.,Sunita, Y., Anil, J., Dalip, K and Bajrang, L. S 2022. Resistance in Pink Bollworm Pectinophora gossypiella(Saunders) against Bt Cotton, a Major Threat to Cotton in India: A Brief Review. *International Journal of Plant & Soil Science:* 34(22): 248-261.

Gohil, P. J., Savaliya, S. G., Bharadiya, A. M., Patel, P. V., Kavar, N. R and Varia, M. V 2019. Dissemination of impproved production technologies of cotton through farerms first programme in saurashtra region of Gujarat. *Gujarat Journal of Extension Education*. Special Issue on National Seminar:112-115.

Jost, P. H and Cothren, J. T. (2001). Phenotypic alterations and crop maturity differences in ultra-narrow row and conventionally spaced cotton. *Crop Science*., 41: 1150- 1159.

Pandagale, A.D, Baig, K.S., Telang, S.M., Dhoke, P.K., Rathod, S.S and Namde, T.B 2020. Influence of high density planting and genotypes on major pests and diseases in rainfed cotton. *Journal of Entomology and Zoology Studies*; 8(3): 1916-1920.

Prasad, R.B., Sudarshanam, A., Malathi, S and Raghu Rami Reddy, P 2019 Influence of high density planting system (HDPS) on cotton sucking pests and natural enemies in rainfed alfisols. *Journal of Entomology and Zoology Studies* 2019; 7(5): 1328-1331.

Rajasekhar N and Durga Prasad N.V.V.S 2018. Incidence of Sucking Pests and Natural Enemies in Cotton under High Density Planting System (HDPS).*Current Microbiology and Applied Sciences;* 7(5):2857-2864.

Shwetha N.S, Halepyati A.S and Pujari B.T 2009 Effect of detopping, removal of monopodia and plant spacings on nutrient uptake, quality parameters and economics of Bt cotton (Gossypium hirsutum L.). *Karnataka Journal of Agricultural Sciences*, 22(4): 892-893.

Venugopalan, M.V., Kranthi, K.R., Blaise, D., Lakde, S. and Sankaranarayana, K. 2014. High density planting system incotton-The Brazil Experience and Indian Initiatives*. Cotton Research Journal* 5(2): 172–185