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RESEARCH PAPER

Impact of intercropping systems on the incidence of pink bollworm (*Pectinophora gossypiella* Saunders) in *Bt* cotton

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Abstract: A field experiment was conducted at the Agricultural Research Station (ARS), Dharwad, during the *kharif* season of 2023 to evaluate the effect of different intercropping systems on the incidence of pink bollworm in cotton. The study comprised cotton as the main crop with okra, marigold, cowpea, coriander as an intercrop. The lowest incidence of rosette flowers and larval recovery was recorded in cotton intercropped with coriander (13.00% and 13.50 larvae per 20 bolls), followed by cotton + marigold (13.25% and 14.75 larvae per 20 bolls), corresponding with reduced green boll damage. Among the intercropping systems, cotton intercropped with okra and cowpea recorded the third- and fourth-lowest levels of pink bollworm incidence, respectively. Sole cotton exhibited the highest rosette flower incidence (14.75%), green boll damage (50.00%) and larval recovery (15.75 larvae per 20 bolls). A similar trend was observed for good opened bolls, bad opened bolls and locule damage, with no significant differences among treatments. The mean population of arthropod predators, particularly coccinellids and chrysopids, was highest in cotton + cowpea, followed by cotton + okra. Cotton intercropped with coriander recorded the highest seed cotton yield (12.70 q/ha), followed by sole cotton (11.45 q/ha).

Key words: Cotton, Intercropping, Natural enemies, Pink bollworm

Introduction

Cotton (*Gossypium hirsutum* L.) is one of the commercial crops of India and referred as 'white gold' in farming community due to its high market returns. Insect pests constitute one of the major constraints in cotton production, with nearly 160 species reported to infest the crop, of which 15 are considered as major pests. With the introduction of *Bt* cotton, the problem of American bollworm, *Helicoverpa armigera* (Hubner) has been overcome, but the problem of sucking pests and pink bollworm, *Pectinophora gossypiella* (Saunders) Lepidoptera: Gelechiidae (PBW) remained as such. Farmers are heavily relied on chemical pesticides to manage pink bollworm because of their immediate effectiveness; however, their indiscriminate application has resulted in pesticide residues in the food chain, the evolution of pest resistance, pest resurgence and detrimental impacts on beneficial organisms and the environment (Patil *et al*., 2017). In recent years biological control of crop pests has received considerable attention. Crop diversification with pollen-providing plant species can suppress pest populations by enhancing predator efficiency, while increased plant diversity within the crop area supports natural enemies by offering shelter and alternative food sources such as nectar, pollen and honeydew (Landis *et al*., 2000). In addition, intercropping can increase plant diversity and lead to greater and more stable crop productivity and increased economic benefits (Singh *et al*., 2017). Therefore, taking these considerations into account, the present study was undertaken to assess the effect of intercropping on pink bollworm incidence and cotton yield under cotton based intercropping systems.

Material and methods

The field experiment was conducted in Agriculture Research Station, Dharwad during *kharif* 2023-24 season under rainfed conditions with Randomized block design varying 4 replications and 5 treatments with each plot size of 7.2 m x 5.4 m and *Bt* cotton genotype (Jadoo BGII) sown at a spacing of 120 cm between the rows and 45 cm between the plants with four different crops along with sole cotton crop. The incidence of pink bollworm was assessed based on the number of rosetted flowers on 20 randomly selected plants in each treatment. To assess green boll damage, 20 bolls were collected randomly and opened along with ridges of the locules to observe boll damage and PBW larvae and expressed as per cent green boll damage and total number of pink bollworm larvae per 20 bolls. Similarly, the extent of locules damaged, good opened bolls and bad opened bolls by PBW was assessed at the time of harvesting. The values obtained were subjected to suitable statistical analysis either arc sine or square root transformed values and presented. Natural enemies' population has been recorded by taking 10 randomly selected plants from each treatment. In case of chrysopids (green lace wing) and coccinellids (lady bird beetles), the number of eggs, grubs and adults present on plants were recorded, spiders and spiderlings were also counted. Finally, the yield of the main crop and intercrop have been recorded in terms of kg per plot and were added for computing yield on hectare basis. Meanwhile, intercrop yield was converted to cotton yield and computed as crop equivalent yield of cotton and worked out using the formula.

$$\text{Crop equivalent yield of cotton} = \text{yield of cotton} + \frac{\text{Yield of intercrop x price of intercrop}}{\text{Price of main crop}}$$

Results and discussion

Incidence of pink bollworm

Data on per cent flower damage, green boll damage, larval recovery per 20 bolls are presented in Table 1. The pink bollworm incidence was noticed on cotton flowers was from second fortnight of August and increased gradually with the advancement of crop growth reaching its peak incidence during first fortnight of October. Thereafter, the incidence of pink bollworm in rosetted flowers was declined gradually and became negligible with the formation of bolls. Cotton + coriander exhibited lowest flower damage, boll damage and larval recovery (13.00 %, 42.50 % and 13.50 larvae/20 bolls) followed by marigold (13.25 %, 43.75 % and 14.75 larvae/20 bolls) while sole cotton registered (14.75%, 50.00% and 15.75 larvae/20 bolls), respectively. Similarly, there is not much difference in case of open boll damage and locule damage among the treatments cotton + okra (34.33% and 25.14%), cotton + marigold (33.47% and 24.96%), cotton+ cowpea (35.18% and 25.71%), cotton + coriander (31.54% and 23.50%) and sole cotton (36.25% and 25.83%), respectively. These results clearly indicate that intercropping systems has no role on the incidence of pink bollworm because, PBW is a monophagous pest and it enters the boll within 2 hours of hatching. Further, it will be got rid from the environment and the predators and parasitoids which are present in the ecosystem. These findings are in concurrent with Kavitha *et al*. (2003) as they reported infestation of cotton bolls by pink bollworm did not vary significantly between cotton plants strip cropped with cowpea and sole cotton. Balakrishnan *et al*. (2010) reported that pink bollworm showed no preference to the intercrops or trap crops like okra and cowpea. This aligns with the observations of Liu *et al*. (2002), who reported that egg predation rates were not documented for the pink bollworm.

Among the intercrops studied cotton + coriander has lowest incidence followed by cotton + marigold this might be due to the presence of volatile compounds. Sujayanand *et al*. (2015) reported that coriander possesses twenty-one volatile compounds, while marigold contains seven volatile compounds, which may interfere with the behavioural responses of target insect pests. The authors further observed that these volatile emissions significantly reduced the incidence of shoot and fruit borer in brinjal, along with the lowest leafhopper infestation when brinjal was intercropped with coriander and marigold. Additionally, intercropping was found to modify the microclimate of the main crop, thereby suppressing insect pest development and promoting the proliferation of natural enemies through the provision of supplementary food sources and refugia. Satpathy and Mishra (2011) opined that coriander contains about thirty-seven volatiles where, some of them responsible for the lower fruit damage of brinjal early shoot and fruit borer (ESFB) in okra when intercropped with coriander. It also reduced egg-laying capacity as it impairs the orientation of females.

Seed cotton yield

Highest seed cotton was obtained from the cotton + coriander intercropping (12.70 q/ha) followed by sole cotton (11.45 q/ha). Whereas, Cotton + okra (11.03 q/ha) and cotton + cowpea (10.96 q/ha) and cotton + marigold with (10.72 q/ha) recorded the lower seed cotton yield, which are numerically superior but statistically on par with one another (Table 2). Various intercrops with cotton offer diverse yields, contributing to the overall productivity and sustainability of the agricultural ecosystem. Among these intercrops okra (9.38 q/ha), marigold (60.00 q/ha), cowpea (5.15 q/ha), coriander (3.10 q/ha). Higher B:C ratio has been obtained from the cotton + marigold (3.92) followed by cotton + cowpea (1.87). Cotton + coriander and cotton + okra have 1.76 and 1.69 B:C ratios, respectively. Relatively, sole cotton has lowest ratio (1.63). Cotton + coriander has highest seed cotton yield but has lowest B:C ratio this is due to reduced intercrop yield and equivalent yield. Cotton + marigold has second lowest incidence of pink bollworm but also registered lowest seed cotton yield due to allelopathic effect of marigold which influences the yield of main crop (Sujayanand *et al*., 2015) but has highest B:C ratio due to highest flower yield, equivalent yield and price. Despite these factors, sole cotton recorded the second highest seed cotton yield due to the absence of intercrops. In sole cropping, the lack of

Table 1. Effect of different intercropping systems on incidence of pink bollworm in *Bt* cotton

Treatments	Flower damage (%)	Green boll damage (%)	Larval population /20 bolls	Good opened bolls/plant	Bad opened bolls/plant	Open boll damage (%)	Locule damage (%)	Yield (q/ha)
Cotton + okra (1:1)	14.25 (22.18)	47.50 (43.57)	15.75 (4.03)	25.91 (5.14)	13.50 (3.74)	34.33 (35.87)	25.14 (30.09)	11.03 (3.40)
Cotton + marigold (1:1)	13.25 (21.35)	43.75 (41.41)	14.75 (3.91)	24.14 (4.96)	12.09 (3.55)	33.47 (35.35)	24.96 (29.97)	10.72 (3.35)
Cotton + cowpea (1:1)	14.75 (22.59)	47.50 (43.57)	15.25 (3.97)	25.50 (5.10)	13.88 (3.79)	35.18 (36.38)	25.71 (30.47)	10.96 (3.39)
Cotton + coriander (1:1)	13.00 (21.13)	42.50 (40.69)	13.50 (3.74)	26.01 (5.15)	11.99 (3.53)	31.54 (34.17)	23.50 (29.00)	12.70 (3.63)
Sole cotton	14.75 (22.59)	50.00 (45.00)	15.75 (4.03)	24.90 (5.04)	14.10 (3.82)	36.25 (37.02)	25.83 (30.55)	11.45 (3.46)
S.Em(±)	0.68	2.50	0.78	1.12	0.67	1.64	1.38	0.29
C.D @ 5%	NS	NS	NS	NS	NS	NS	NS	NS
C.V. (%)	9.78	10.81	10.39	8.91	10.27	9.66	11.05	13.42

Flower damage, green boll damage, open boll damage and locule damage are arc sine transformed values

Larval population, good opened bolls, bad opened bolls and yield are $\sqrt{x+0.5}$ transformed values

Table 2. Economics of different intercropping systems

Treatments	Seed cotton yield of sole cotton (q/ha)	Yield of an intercrop (q/ha)	Crop equivalent yield of cotton (q/ha)	Cost of cultivation (₹ /ha)	Gross returns (₹ /ha)	Net returns (₹ /ha)	B:C Ratio
Cotton + okra (1:1)	11.03	9.38	14.60	61250	103639	42389	1.69
Cotton + marigold (1:1)	10.72	60.00	36.07	65375	256112	190737	3.92
Cotton + cowpea (1:1)	10.96	5.15	16.04	60920	113866	52946	1.87
Cotton + coriander (1:1)	12.70	3.10	15.36	62000	109080	47080	1.76
Sole cotton	11.45	0.00	11.45	50000	81295	31295	1.63

Price of cotton. 7100/q; Okra. 2700/q; Marigold. 3000/q; Cowpea. 7000/q; Coriander. 6100/q

Table 3. Abundance of natural enemies in different intercropping systems

Treatments	*Chrysoperla zastrowi sillemi*		*Cheilomenes sexmaculata*		Spiders/ Spiderlings
	Adults/plant	Grubs/plant	Adults/plant	Grubs/plant	
Cotton + okra (1:1)	1.21 (1.31)[a]	1.61 (1.45)[a]	2.46 (1.72)[a]	1.83 (1.52)[a]	1.53 (1.42)[a]
Cotton + marigold (1:1)	1.15 (1.28)[a]	1.55 (1.43)[a]	2.55 (1.75)[a]	1.64 (1.46)[a]	1.49 (1.41)[a]
Cotton + cowpea (1:1)	1.25 (1.32)[a]	1.65 (1.47)[a]	2.64 (1.77)[a]	1.93 (1.56)[a]	1.78 (1.51)[a]
Cotton + coriander (1:1)	1.14 (1.28)[a]	1.48 (1.41)[a]	2.51 (1.74)[a]	1.66 (1.47)[a]	1.49 (1.41)[a]
Sole cotton	0.93 (1.19)[b]	1.08 (1.25)[b]	1.71 (1.49)[b]	0.88 (1.17)[b]	1.15 (1.28)[b]
S. Em (±)	0.06	0.07	0.07	0.10	0.09
C. D @ 5%	0.20	0.22	0.24	0.31	0.29
C.V (%)	11.63	9.71	6.56	12.75	12.89

Fig in parenthesis are $\sqrt{x}+0.5$ transformed values;
Means showing same alphabets do no differ significantly by DMRT (p=0.05)

competition between the main crop and intercrops allows cotton plants to grow more vigorously and densely, ultimately resulting in higher yield.

Incidence on natural enemies

The data on natural enemies in various intercrops in cotton are presented in Table 3. In a study on abundance of green lace wing, *Chrysoperla zastrowi sillemi* adults and grubs per plant in a cotton ecosystem, various companion crops were evaluated for their impact. Among the different crops, cotton + cowpea had on an average of 1.25 and 1.65 followed by cotton + okra 1.21 and 1.61 adults and grubs per plant, respectively. Sole cotton exhibited the lowest densities of just 0.93 and 1.08 adults and grubs while except sole cotton all other treatments are showing on par with one another. In the case of the coccinellid predator, *Cheilomenes sexmaculata*, the cotton + cowpea intercropping system attracted the highest number of adults and grubs (2.64 and 1.93 per plant, respectively), followed by cotton + marigold (2.55 and 1.64 per plant, respectively). In contrast, sole cotton had the lowest adults and grubs (1.71 and 0.88/plant). While, except sole cotton all other treatments are showing on par with one another. *Four spider species predominated in the cotton ecosystem, viz., Neoscona mukerjei* Tikader, 1980; *Oxyopes hindostanicus* Pocock, 1901; *Thomisus projectus* Tikader, 1960; *and Meotipa picturata* Simon, 1895. Cotton + cowpea had highest (1.78/plant) followed by cotton + okra (1.53/plant). Sole cotton had the lowest spiders (1.15/plant) where except sole cotton all other treatments are showing on par with one another. The fluctuation in densities of natural enemies may be due to continuous availability of pollen and nectar. These results corroborated with the findings of Chakravarthy *et al*. (1997) that due to the availability of nectar, pollen and existence of favourable microclimate in intercropped zones of agro-ecosystem and increased natural enemies *viz.*, coccinellids and chrysopids by conservation. Similar, results were obtained by Kavitha *et al*. (2003) as they reported growing of cowpea in cotton may help in enhancing the population of arthropod predators and in reducing the insect-pest population in cotton.

Vaiyapuri *et al*. (2010) told that cotton + cowpea intercropping had maximum number of predators. Similarly, present findings are in line with Praharaj *et al.* (2010) they specify that cowpea helps in colonization of coccinellid predators and increases the natural parasitization of *Earias vitella.* The earlier reports by Patel *et al*. (2012) confirmed that cotton + cowpea exhibited higher population of chrysopids, coccinellids and spiders. Coriander supported good activity of predators *viz*., coccinellids and chrysopid, *C. zastrowi sillemi* (Sujay and Giraddi, 2015).

Conclusion

Cotton-based intercropping studies revealed that intercropping systems had no significant effect on pink bollworm incidence, as neonate larvae rapidly enter cotton bolls after hatching. Consequently, infestation levels remained above the Economic Threshold Level (ETL) across treatments, as indicated by rosette flowers, green boll damage and locule damage, confirming pink bollworm as a highly destructive

and persistent pest in *Bt* cotton. The lack of significant variation among intercropping systems suggests that intercropping alone is inadequate for pink bollworm management. However, intercropping significantly enhanced populations of natural enemies, particularly coccinellids and chrysopids, by providing a favorable microclimate and continuous pollen and nectar resources, which may aid in suppressing sucking pests. Among the systems evaluated, cotton + marigold (1:1) was economically superior, recording a high benefit–cost ratio (3.92). Thus, it can be recommended as an ecologically sustainable IPM component for conserving natural enemies and managing secondary pests, rather than for direct pink bollworm control.

References

Balakrishnan N, Baskaran R K and Mahadevan N R, 2010, Influence of intercrops or trap crops on the preference of major pests of cotton in different IPM modules under rainfed condition. *Journal of Biopesticides*, 3(1): 373-378.

Chakravarthy A K, Prasad R, Mallikarjuna G B and Prasad R, 1997, Intercropping in cotton (*Gossypium hirsutum*) checks insect pests build up. *Insect Environment*, 2(4): 131-132.

Kavitha G, Ram P and Saini R K, 2003, Impact of strip crops on the population of arthropod predators and insect-pests in cotton. *Journal of Biological Control*, 17(1): 17-21.

Landis D A, Wratten S D and Gurr G M, 2000, Habitat management to conserve natural enemies of arthropod pests in agriculture. *Annual Review of Entomology*, 45(1): 175-201.

Liu Y, Tabashnik B E, Dennehy T J, Carriere Y, Sims M A and Meyer S K, 2002, Oviposition on and mining in bolls of *Bt* and non-*Bt* cotton by resistant and susceptible pink bollworm (Lepidoptera: Gelechiidae). *Journal of Economic Entomology*, 95(1): 143-148.

Patel B H, Godhani P H, Patel R M, Patel H M, Patel B K and Korat D M, 2012, Impact of habitat manipulation on insect pests infesting *Bt* cotton and their natural enemies. *Karnataka Journal of Agricultural Sciences*, 25(3): 336-339.

Patil S B, Goyal A, Satish S, Chitgupekar, Kumar S and Mustapha B, 2017, Sustainable management of chickpea pod borer. *Agronomy Sustainable Development*, 37(20): 1-17.

Praharaj C S, Sankaranarayanan K and Gopalakrishnan N, 2010, Role of improved agronomy in integrated pest management in cotton (*Gossypium* spp.)-An overview. *Journal of Cotton Research*, 24(1): 29-40.

Satpathy S and Mishra D S, 2011, Use of intercrops and antifeedants for management of eggplant shoot and fruit borer, *Leucinodes orbonalis* (Lepidoptera: Pyralidae). *International Journal of Tropical Insect Science*, 31(1-2): 52-58.

Singh A, Weisser W W, Hanna R, Houmgny R and Zytynska S E, 2017, Reduce pests, enhance production: Benefits of intercropping at high densities for okra farmers in Cameroon. *Pest Management Science*, 73(10): 2017-2027.

Sujay Y H and Giraddi R S, 2015, Role of intercrops for the management of chilli pests. *Karnataka Journal of Agricultural Sciences*, 28(1): 53-58.

Sujayanand G K, Sharma R K, Shankarganesh K, Saha S and Tomar R S, 2015, Crop diversification for sustainable insect pest management in eggplant (Solanales: Solanaceae). *Florida Entomological Society*, 98(1): 305-314.

Vaiyapuri K, Amanullah M M, Rajendran K and Sathyamoorthi K, 2010, Intercropping unconventional green manures in cotton: An organic approach for multiple benefits: A review. *Asian Journal of Plant Sciences*, 9(4): 223-226.