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MANAGEMENT OF WHITEFLY (*Bemisia tabaci*) IN BRINJAL THROUGH INTERCROPPING

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Abstract

In Bangladesh, brinjal (Solanum melongena L.) is suffering from a huge loss of yield caused by whitefly (Bemisia tabaci) which sucks the sap from the plant and transmits viruses. Farmers often use chemical insecticides which leads to pest resistance and harm to the environment. Intercropping is another sustainable alternative that can control pest spread and benefit the ecosystem. An experiment was carried out at the Regional Agricultural Research Station (RARS), Bangladesh Agricultural Research Institute (BARI), Jamalpur during three winter seasons (2022-2025) involving brinjal intercropped with onion, calendula, coriander, garlic, chilli and a control with brinjal only. Research findings revealed that intercropping significantly suppressed the population of whiteflies in comparison to the control. The brinjal-coriander intercropping showed the greatest efficacy against whiteflies, reducing the pest count by 58-59%. Moreover, the intercropping significantly augmented the yield by 64-66%. The lowest whitefly density was recorded at 13.3-14.2 per leaf. Chilies were the least effective on whitefly incidence whereas onion, calendula and garlic slightly reduced it. Regression analysis showed that there was a strong negative correlation between the whitefly population with yield (R^2 = 0.94). Intercropping of brinjal with coriander is a low-cost and sustainable management measure to control whitefly and enhance brinjal yield.

Key words: *brinjal, increased yield, intercrop, reduction over control, whitefly.*

INTRODUCTION

Brinjal (*Solanum melongena L.*), also called eggplant, is a solanaceous vegetable, grown widely and with high economic potential in Bangladesh. The Brinjal, known locally as Begun in Bangladesh, is grown throughout the country in both the summer and winter seasons (Rahman et al., 2016). It is the second most popular vegetable in Bangladesh (Bushra et al., 2022). Brinjal is grown over 7,127.69 ha during the winter season in 2022-23; the total production during the winter season was 71872.8 metric tons (BBS, 2023). This vegetable is high in essential vitamins, minerals and nutrients (Quamruzzaman et al., 2020). Nevertheless, it faces many antagonistic factors, including attacks by numerous insect pests, which is a significant concern for brinjal cultivation. Brinjal Shoot and Fruit Borer is considered the most destructive among them (Prashanth et al., 2024). Furthermore, various hemipteran pests, such as whiteflies, aphids, leafhoppers, thrips, mealybugs, and scale insects, cause damage and significantly reduce crop yield (Shahi et al., 2024). Depending on the level of infestation, 10 to 15% yield losses can be caused by sucking pests (Chatterjee et al., 2018).

Brinjal is affected by several sucking pests, among which whitefly (Bemisia tabaci Gennadius) (Hemiptera: Aleyrodidae) is one of the most obnoxious. Whiteflies are among the major pests worldwide due to the extensive damage they cause (Sani et al., 2020). The cell fluid of brinjal is sucked by both adults and nymphs and other host plants, leading to physiological stress and yield loss (Gangwar & Charu, 2018). Whiteflies are very polyphagous and feed on various plant species, including tomato, cassava, pepper, sweet potato, melons, lettuce, cucumber, bean, okra, potato, peanut, soybean, tobacco, cotton, watermelon, field crops, and weeds (Ghosh, 2022). Their food is cell sap, which damages plants. Honeydew is also released by these insects, which promotes the growth of sooty mold fungus, which in turn helps sooty mold fungus grow. This mold also impairs plant photosynthesis. Apart from the direct damage that they cause through feeding, whiteflies are also the vectors of many economically important plant viruses. They also transmit pathogens such as Eggplant Mottle Leaf Virus (EMLV), Tomato Yellow Leaf Curl Virus (TYLCV), and Tomato Torrado Virus (ToTV), which infect tomato and brinjal, respectively (Amari et al., 2008; Lapidot et al., 2014). Whiteflies are responsible for other viral diseases, like yellow mosaic virus and leaf curl virus, which are known to affect a broad variety of crops (Kumar et al., 2023).

Traditional insecticides are often used by farmers to control whitefly, and therefore, an exorbitant number of pesticides is used. These practices have multiple adverse effects, including the potential for pesticide resistance, pest resurgence, and health risks. Intercropping has become one of the emerging, sustainable, and effective alternative insect management systems through increased system diversity (Altieri & Letourneau, 1982). This cultural strategy is important for ensuring sustainable pest control and efficient resource use, as it helps control whitefly without toxic chemicals and in a way that is good for the environment (Mir et al., 2022). The use of intercropping systems is known to improve crop productivity compared to monoculture and to help balance vegetation encroachment in several other studies (Li et al., 2020; Verret et al., 2017). With these observations, the present study aims to evaluate an economical and environmentally friendly intercropping system for the management of whitefly (Bemisia tabaci) in brinjal cultivation.

MATERIAL AND METHODS

Location of the study and time

The experiment was conducted at the Regional Agricultural Research Station (RARS) of the Bangladesh Agricultural Research Institute (BARI), located in Jamalpur, Bangladesh. The station is situated at approximately 24°56' N latitude and 89°55'54" E longitude, at an elevation of 16.46 m. It lies about 200 km northwest of Dhaka, the capital city.

Duration of the study

The investigation was carried out during the winter season, spanning November to April, over the period 2022–2025.

Planting of crops

This experiment focused on selecting the BARI Begun-8 brinjal variety. Seeds were sown in the seedbed during the third week of November and the seedlings were transplanted to the main field in the first week of December. The dimensions of the plot measured 4.8m by 3.2m, with a distance of 50cm by 50cm between plots, and the sowing distance for brinjal seedlings was set at 80cm by 60cm. Each intercrop was properly positioned between two brinjal shoots. Garlic cloves were carefully planted at intervals of 10cm x 10cm, while coriander seeds were sown between two rows of brinjal at a spacing of 30cm x 40cm. One month old chilli seedlings were planted at 50cm x 50cm spacing, onion seedlings were set at a distance of 15cm x 10cm, and calendula seedlings were transplanted between two brinjal rows at 20cm x 10cm spacing.

Experimental design and treatments

A Randomized Complete Block Design (RCBD) with four replications was adopted, consisting of six treatments. The following intercrops were used: garlic, coriander, onion, calendula (plant marigold), and chilli. The treatments were as follows:

T1= One row of onion between two lines of brinjal
T2= One row of calendula flowers between two lines of brinjal
T3= One row of coriander between two lines of brinjal
T4= One row of garlic between two lines of brinjal
T5= One row of chilli between two lines of brinjal
T6= Brinjal monoculture (Untreated control)

Data collection

Five brinjal plants were randomly selected from each plot. During the study period, the number of whiteflies on the leaves of these chosen plants was counted and recorded every seven days.

Data analysis

Data on whitefly population and brinjal production were analyzed statistically using the STAR (version 2.0.1, IRRI) software and Microsoft Excel (version 2013). Based on a Randomized Complete Block Design (RCBD), a one-way analysis of variance (ANOVA) was conducted to evaluate the effects of the treatments. Upon finding significant differences between treatments in the ANOVA results, mean separation was performed using Tukey's Honest Significant Difference (HSD) at the 5% level of significance ($p < 0.05$).

$$\% \text{ Reduction over control} = \frac{X2-X1}{X2} \times 100$$

Here,

X1= The mean value of the treated plot
X2= The mean value of the untreated plot

For calculation of increased yield over control following formula was used:

$$\text{Increased yield over control (\%)} \quad \frac{X1-X2}{X2} \times 100$$

Here,

X1= Yield of the intercropped plot
X2= Yield of sole brinjal cropped plot

To assess the relationship between whitefly population and brinjal yield, the strength of relationship was assessed using the coefficient of determination (R2) in a linear regression analysis.

RESULTS AND DISCUSSION

Population density of the whitefly among the intercrops

Details of population density of whitefly on brinjal leaves as influenced by various intercrop treatments over the years (2022-23, 2023-24 and 2024-25) are summarized in Table 1. The treatments (T1–T6) differ in the mean number of whiteflies per leaf. All treatments except for T6 (control) showed lower average whitefly densities than the control treatment, which resulted in the highest mean number of whiteflies per leaf over the years. The control (T6), which received no intercrop treatment, had 33–34 whiteflies per leaf, suggesting greater infestation. In contrast, the treatments for T3 (coriander), which had the fewest number of whiteflies (mean numbers of Whiteflies per leaf ranged from 13.30 to 14.19), showed an effective decrease in whitefly population density. The other treatments (T1, T2, and T4) showed intermediate control of whitefly populations, with mean densities ranging between 17.30 and

21.50 whiteflies per leaf. These findings indicate that the intercrop treatments significantly decrease whitefly density compared to the control, with T3 (coriander) being the most effective intercrop.

Razzak et al. (2015) examined the development of brinjal under a polyculture system and also found out that a significant reduction of whitefly infestation was observed in brinjal partly cropped with coriander but the highest level was monocropped brinjal. Likewise, Sujayanand et al. (2015) demonstrated the effectiveness of intercropping brinjal with coriander and marigold to control the population of whiteflies. Maurya et al. (2020) also reported that intercropping brinjal with garlic, onion, fenugreek, and coriander reduced infestation by leafhoppers, a Hemipteran pest, compared with monocropped brinjal. Such findings support the findings of the current study. In the experimental study under analysis, brinjal intercropped with chilli had a much lower level of whiteflies than the other types of intercrops, which may be explained by the fact that the two crops are in the Solanaceae family and are equally vulnerable to whiteflies (Kumawat & Ram, 2019).

Table 1. Effect of different intercrops against whitefly of brinjal.

Year	2022-23		2023-24		2024-25	
Treatments	Mean No of whitefly/ leaf	Reduction over control (%)	Mean No of whitefly/ leaf	Reduction over control (%)	Mean No of whitefly/ leaf	Reduction over control (%)
T1	21.50c	35.50	22.10c	34.90	22.35c	34.86
T2	17.90cd	46.30	18.50cd	45.90	18.64cd	45.67
T3	13.30d	59.40	14.00d	58.50	14.19d	58.64
T4	17.30cd	48.50	18.20cd	47.10	17.99cd	47.57
T5	26.10b	20.10	27.30b	19.60	27.71b	19.24
T6	33.00a	-	33.20a	-	34.31a	-
CV (%)	9.10	-	9.20	-	9.30	-
Lsd	1.53	-	1.54	-	1.56	-

Means with same letter were not significantly different among the treatments by Tukey test (P < 0.05). CV= Coefficient of Variance, LSD= Least Significant Difference **T1**=One row onion between two lines of brinjal, **T2**=One row of calendula flower between two lines of brinjal, **T3**= One row of coriander between two lines of brinjal, **T4**=One row of garlic between two lines of brinjal, **T5** =One row of chilli between two lines of brinjal, **T6** =Sole brinjal/untreated control.

Whitefly percentage reduction over control

The percent reduction of whitefly population over control, as shown in Table 1, indicates variation in the effectiveness of different intercrops. Generally, the lower whitefly densities were treated, the greater the percentage reduction in their populations. For instance, T3 (coriander) exhibited the greatest decrease in percentage (58.50–59.40) over the three years, suggesting that coriander was very effective in reducing the number of whiteflies. Treatments T1 (onion), T2 (calendula flower) and T4 (garlic) also exhibited a reduction between 34.86 to 48.50%, confirming the relevance of the choice of intercrop to decrease whitefly populations as well. T5 (Chilli), on the other hand, showed the least significant reduction (19.24%–20.10%) in whitefly population, indicating that it was less effective than the others. These results indicate that the biocontrol effect of intercropping plants on whiteflies differs, and an appropriate intercropping mixture is needed to achieve control and reduce crop damage. The control (T6), as anticipated, showed no population reduction, supporting the provenance of these intercrops in this study.

Several earlier studies support these findings. Coriander has excellent insect-repelling effects that help decrease the population of insect pests (Khan et al., 2012), the pungent odor of calendula has been demonstrated to be a good insect-pest repellant (Medhini et al., 2012). Afrin et al. (2017) also discovered that intercropping with mustard with onion, garlic, radhuni, and coriander has a strong effect of reducing pest densities. In intercrop use or pest control, garlic has been found to be effective in the control of sucking insects like aphids (Zhou et al., 2013). Onion, similarly, has been found to potentially be used in management of insect pests when planted together with cabbage (Baidoo et al., 2012). Together, these studies support the conclusion that intercropping is an effective measure for reducing insect pest infestation.

Yield of brinjal

The marketable yields of brinjal over a period of 3 years (2022 -23, 2023-24 and 2024-25) under different intercropping systems are presented in Table 2. T3 (one row of coriander between two rows of brinjal) produced the highest marketable yield for brinjal, ranging from 14.80 to 14.98 t/ha. This treatment actually produced the maximum per cent increase in yield over the control, at 64.44, 66.48, and 66.08 per cent during 2022-23, 2023-24, and 2024-25, respectively. The performance of T3 in enhancing brinjal output may be due to coriander as an intercrop, which had a positive effect on brinjal growth by reducing whitefly infestation.

Onion (T1), calendula (T2), and garlic (T4) treatments also significantly increased yield, but yields were lower than in T3. The marketable yield of T1, T2 and T4 was about 13.20 to 13.80 t/ha and increased by 46.67-53.07%. These intercrops are repellent in nature, especially onion and garlic, known for pest repelling, which could have contributed to brinjal growing better by minimizing damage from pests. Their impact on yield was significantly less than corianders, however.

In contrast, T5 (chilli) produced the lowest yield among the intercrop treatments (12.05–12.15 t/ha), increasing yield by only 33.59–35.75%. While chilli helped reduce pests to some extent, its effect was not as strong as that of the other intercrops. Eventually, the least marketable yield was obtained in the control (T6), with 8.95 to 9.02 t/ha, and no linear response in yield was observed across all three years when brinjal was grown was grown solely as a monoculture. The results support the effect of intercropping on improving brinjal yield and highlight that selecting certain intercrops, such as coriander, could be a key approach for maximizing brinjal production.

Intercropping brinjal with coriander, onion, radish, palak and chilli gave more benefits than those of solo crops. It has been found that intercropping can act synergistically with host-plant resistance and biological control, which leads to greater yield stability, averts crop failure, enhances soil fertility, and protects soil health, reduces pesticide use, and minimizes environmental effects (Mir et al., 2022). These benefits were established by the observed increased yield of brinjal as comparing with control treatment of this study.

Table 2. Effect of different intercrops on the yield of brinjal.

Year	2022-23		2023-24		2024-25	
Treatments	Marketable yield of brinjal (t/ha)	Increase yield over control (%)	Marketable yield of brinjal (t/ha)	Increase yield over control (%)	Marketable yield of brinjal (t/ha)	Increase yield over control (%)
T1	13.20d	46.67	13.30d	48.60	13.32d	47.67
T2	13.80b	53.33	13.90b	55.30	13.97b	54.88
T3	14.80a	64.44	14.90a	66.48	14.98a	66.08
T4	13.60c	51.11	13.70c	53.07	13.78c	52.77
T5	12.10e	34.44	12.15e	35.75	12.05e	33.59
T6	9.00f	-	8.95f	-	9.02f	-
CV (%)	6.38	-	6.50	-	6.51	-
LSD	0.60		0.62	-	0.62	-

Means with same letter were not significantly different among the treatments by Tukey test ($P < 0.05$). CV= Coefficient of Variance, LSD= Least Significant Difference **T1**=One row onion between two lines of brinjal, **T2**=One row of calendula flower between two lines of brinjal, **T3**= One row of coriander between two lines of brinjal, **T4**=One row of garlic between two lines of brinjal, **T5** =One row of chilli between two lines of brinjal, **T6** =Sole brinjal/untreated control.

Relationship between whitefly and brinjal yield

The regression analysis (Figure 1) revealed a strong negative linear relationship between the mean number of whiteflies per leaf and the total marketable yield of brinjal over three years. The fitted equation, $y = -0.2784x + 18.903$ ($R^2 = 0.9411$), indicates that each additional whitefly per leaf reduced yield by approximately 0.28 t ha^{-1}. The high coefficient of determination ($R^2 = 0.94$) demonstrates that variations in whitefly incidence accounted for most of the observed yield decline. This inverse association suggests that increased whitefly infestation significantly impairs plant vigor, likely through sap depletion and transmission of viral diseases such as leaf curl. When the whitefly population exceeded 30 insects per leaf, yields dropped below 10 t/ha, whereas lower infestations (< 15 insects per leaf) maintained yields around 15 t/ha.

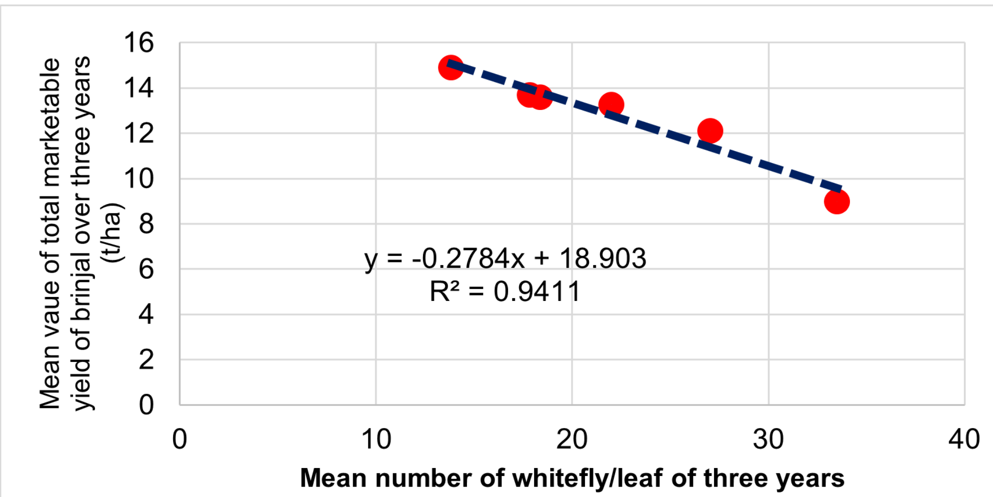

Figure 1. Relationship between number of whitefly and brinjal yield during the study period.

Whiteflies were found in brinjal crops between the times of transplanting to their maturity (Bhowmik et al., 2018). The experiment found an adverse relationship existing on the brinjal production and whiteflies number, which was in line with other solanaceous crops like tomato (Rashid et al. 2008). Islam et al. (2009) also indicated that the effective leaf area is decreased due to the whitefly infestation resulting in reduced photosynthetic activities and yield. The current study confirms that the rise in the population of whiteflies directly correlates with the fall in the yield of brinjal. The infestation of the whitefly decreases the chlorophyll levels in brinjal leaves, thus limiting the extent of photosynthetic activity and eventually the yield (Raed et al., 2022). The current observation findings support the fact that the higher the density of whiteflies, the lower the yield of brinjal.

CONCLUDING REMARKS

This research shows that intercropping could be an environmentally sustainable strategy for controlling whitefly in brinjal crops. Brinjal–coriander intercropping recorded the maximum suppression (58–59%) of whitefly populations and yield enhancement (64–66%) over sole crop among other treatments. Moderate control was found with onion, calendula and garlic whereas chill was less successful. The high negative correlation between whitefly densities and yield (R^2 = 0.94) illustrates the potential of the pest to limit yields. The results demonstrate that coriander-based intercropping is a practicable low input and environmentally friendly replacement for chemical insecticidal usage in IPM of brinjal ecosystems.

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УПРАВУВАЊЕ СО БЕЛОКРИЛКА (*Bemisia tabaci*) КАЈ ПАТЛИЏАН ПРЕКУ ИНТЕРКРОПИНГ

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Резиме

Во Бангладеш, патлиџанот (*Solanum melongena L.*) страда од огромна загуба на принос предизвикана од белокрилката (*Bemisia tabaci*) која го цица сокот од растението и пренесува вируси. Земјоделците често користат хемиски инсектициди, што доведува до отпорност на штетници и штети на животната средина. Интеркропингот е уште една одржлива алтернатива што може да го контролира ширењето на штетниците и да му користи на екосистемот. Експеримент беше спроведен во Регионалната земјоделска истражувачка станица (RARS), Институт за земјоделски истражувања во Бангладеш (BARI), Џамалпур во текот на три зимски сезони (2022-2025), вклучувајќи интеркропинг на патлиџан со кромид, невен, коријандер, лук, чили и контрола само со патлиџан. Резултатите од истражувањето покажаа дека интеркропингот значително ја намалува популацијата на белокрилки во споредба со контролата. Интеркропингот кај патлиџан и коријандер покажа најголема ефикасност против белокрилките, намалувајќи го бројот на штетници за 58-59 %. Покрај тоа, интеркропингот значително го зголеми приносот за 64-66 %. Најниската густина на белокрилки беше забележана од 13,3-14,2 по лист. Чили пиперките беа најмалку ефикасни врз инциденцата на белокрилки, додека кромидот, невенот и лукот малку ја намалија. Регресионата анализа покажа дека постои силна негативна корелација помеѓу популацијата на белокрилка и приносот (R2 = 0,94). Интеркропингот кај патлиџан со коријандер е нискобуџетна и одржлива мерка за управување за контрола на белокрилка и зголемување на приносот на патлиџан.

Клучни зборови: *патлиџан, зголемен принос, интеркроп, намалување пред контрола, белокрилка.*