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Influence of different companion crops on major sucking pests in the brinjal ecosystem

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ABSTRACT

Cultivating companion crops with the main crop is comparatively more striking to the pests and serves to amuse them from the main crop. Biological pest control and nutrient content of the soil may also be enhanced by companion cropping. Accordingly, an experiment was conducted to evaluate the role of field boundary-based companionship cropping including (T_1- sweet potato, T_2- marigold, T_3-brinjal itself, T_4-cowpea, T_5-maize, and T_6- sole crop without any border crop) in brinjal ecosystem for population build-up of major sucking pests (whitefly and jassid). A significantly lesser population of sucking pests was observed in treated plots (T_1-T_5) with companion crops in comparison to sole crop (T_6) throughout the cropping season. Jassid population was lowest with marigold (T_2) during the 39th to 6th standard week of 2018-19 and it was highest in sole crop (T_6). The average whitefly population was also lowest in T_2 and highest in (T_6) throughout the crop season.

***Keywords*:** Brinjal, companion crops, main crop, sucking pests

Brinjal (*Solanum melongena* L.) under the Solanaceae family is grown well in sub-tropics and tropics with various names *viz*., eggplant, baingan, aubergine, etc. and having around 2450 varieties under 95 genera (Mabberley, 2008). As the most preferred vegetable in India, it is sprayed most frequently with insecticides to eradicate the pests for enough quantity of marketable yield. It yields 12399.9 thousand million tonnes of brinjal from an area of about 668.7 thousand hectares having a productivity of 18.5 MT per hectare in India (Anonymous, 2018). We get calories (25 g), total fat (0.2 g), sodium (2 mg), potassium (229 mg), carbohydrate (6 g), dietary fiber (3 g), sugar (3.5 g), protein (1 g), vitamins (B6, B12, and C), iron, magnesium, phosphorus, etc. as the nutritive value from 100 g of brinjal (USDA, 2013).

Many insects attack brinjal in the nursery as well as in the main field up to the harvesting stage. Sucking insect pests like whitefly, jassid, etc. cause remarkable yield loss and act as a vector to transmit viral diseases. The role of pesticides has become critically vital with the modernization of agriculture. Modernization of agriculture implies increased use of chemical fertilizers and trendy seeds, which gives a favorable climate for the rising of pests. In India, the farmer uses 6000 tons of active ingredients to manage pests in vegetables and fruits (Mohan and Gujar, 2003). However, an environment-friendly crop ecosystem may be helpful for pest suppression. Accordingly, the locally available 5 companion crops at border rows were evaluated to control the sucking pest problems in the brinjal ecosystem, which may reduce the use of toxic molecules in the environment to control the insect pests and also conserve the natural enemies and beneficial insects without hampering ecosystem.

Companion planting relies on the principle that certain plants can attract or repel insects or offer beneficial support to other plants. Various crops are grown in proximity targeting pest reduction, pollination, habitat creation for natural enemies, space maximization, and ultimately increased productivity. Such crops are comparatively more attractive to pests and facilitate repelling them from the core crop. They also improve the nutrient content of the soil, especially legumes used as companion crops like beans, cowpea, and peas. Keeping all these views in mind, the current research was conducted to examine the influence of some companion crops on major sucking pests (jassid & whitefly) in the brinjal ecosystem.

The investigation was carried out at Gayeshpur (Latitude 23°N, Longitude 89°E, Altitude 9.75m MSL),

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Research farm of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal from September to February of 2018-2019. Transplanting of brinjal (variety: Muktakeshi) was done on 27th September 2018 along with different companion crops of 2 rows in the border. Here, adopting local recommended horticultural practices, the crop was raised in a randomized block design with 6 treatments (T_1- sweet potato, T_2- marigold, T_3-brinjal itself, T_4-cowpea, T_5-maize, and T_6- sole crop without any border crop) and 4 replications having each plot size of 5 m × 4m. Maize (T_5) and cowpea (T_4) were sown 15 days before the transplanting of brinjal as the main crop. Whereas, other companion crops (i.e. marigold, sweet-potato, and brinjal) were transplanted at the same transplanting time as the main crop. No insecticides were used for pest management. In case of treatment (T_3) with brinjal itself as a companion crop, somewhat excess (1.5 times) fertilizer was used in border rows than the main crop. Whereas, fertilizer used in the main crop was the same for all other companion crops.

Using magnifying glass (10x) during morning hours, the population of jassid and whitefly were counted from each treatment starting at 7 days after transplanting of brinjal to its final harvesting at an interval of each meteorological week. Three leaves (each one from top, middle, and bottom) of five randomly selected plants per replicated plot were considered for both the insects to express each of their average number leaf^{-1} plant^{-1}. All these data on insect populations were transformed into angular forms which were used for statistical analysis using Excel tool.

Jassid population (Table 1, 3 and Fig. 1) appeared within the first week after transplanting (WAT) coincided with the vegetative stage of the crop. This pest remained active till the last picking of brinjal fruits. The lowest population of jassid (1.55 insects per plant) was recorded in brinjal + sweet potato combination (T_1) during the 1st - 4th WAT (39th SW to 42th SW) under the phenological regime of 20.24°C - 33.16°C temperature, 65.57% -97.07% relative humidity and 21.50 mm of rainfall. It was highest with 5.00 insects per plant in the sole brinjal (T_6) (control plot) during the 17th-20th WAT when the other plant combinations like brinjal+sweet potato (T_1), brinjal+marigold (T_2), brinjal+brinjal (1.5 times of recommended fertilizer dose) (T_3), brinjal+cowpea (T_4) and brinjal+maize (T_5) nurtured the insects population per plant to the tune of 3.20, 1.77, 2.72, 2.69 and 1.75 respectively under a corresponding temperature of 8.82°C -26.11°C, relative humidity ranged from 45.46% - 94.28% and precipitation being nil.

Throughout the crop period, a significantly lesser population of jassid was recorded in all companion crop (T_1-T_5) combinations than untreated control as a sole crop (T_6). Further, it was noticed that the cumulative mean of jassid (1.98 insects plant^{-1}) was lowest in T_2 during the entire crop season resulting in the highest percent population reduction (47.70%) over control. Such best treatment T_2 was followed by T_5, T_4, T_3, and T_1 with respective reductions of 43.65%, 36.85%, 32.53%, and 27.97 %.

Various croppings cause lesser outbreak of pests due to the natural own-sustaining mechanism of plant protection by enhancing the population and function of natural enemies (Scherr and McNeely, 2008). The overall average number of jassid throughout the cropping season was smallest in treatment brinjal+marigold (T_2) followed by brinjal+maize (T_5), brinjal+cowpea (T_4), brinjal+brinjal (T_3),brinjal+sweet potato (T_1), sole crop control (T_6). The border crop modifies the specific abiotic environment of the key crop, which successively prevents pest population build-up, but increases natural enemy population by supplying required food and refugia (Staver *et al.,* 2001). Furthermore, 7 kinds of volatiles were present in the flower specifically Allylisothiocyanate, Butane-4-isothiocyanate, Cinnamaldehyde, Phenol m-tert-butyl, Chrysanthenone, Piperitenone. Piperitenone compound. (Bruce and Cork, 2001). The volatiles from the marigold flower might repel leafhoppers, resulting in lesser populations in brinjal+ marigold (T_2) than the lone crop brinjal (T_6). Releasing volatiles of intercrops and border crops could mask or repel insect pests to locate their host plants (Goel and Tiwari, 2004). The current finding of the odoriferous nature of marigold as a companion crop is in agreement with Dethier *et al.* (1960). They also highlighted the odoriferous effect of companion crops to deter the recognition, feeding, and reproduction of insect pests on their host plants. Treatment with maize as a companion crop on the periphery of the main crop field recorded a lesser jassid population than cowpea, sweet potato, and brinjal (as border crop). Such effect corrugates with the findings of Fereres (2000) who proved the barrier role of maize in the association of leaf hoppers with the main crop.

The collected data on the whitefly population per plant throughout the crop growing season has been disclosed in Table 2, 3 and Fig. 2. This pest remained active within the entire cropping season. The lowest mean population of the insect was 1.75 insects per plant recorded throughout the 13th - 16th WAT under the phonological regime of 7.74^0 C – 24.14^{0}C

Table 1: Variation of the jassid population in brinjal under the influence of different companion crops during the crop season (2018-19)

Treatments	1st - 4th WAT*	5th -8th WAT	9th -12th WAT	13th -16th WAT	17th -20th WAT	Mean	Reduction over control (%)
T_1	1.55 (1.43)**	2.94 (1.85)	2.84 (1.83)	3.09 (1.90)	3.20 (1.92)	2.72 (1.80)	27.97
T_2	1.61 (1.45)	2.66 (1.78)	1.98 (1.58)	1.88 (1.54)	1.77 (1.51)	1.98 (1.57)	47.70
T_3	1.56 (1.44)	3.23 (1.93)	2.63 (1.77)	2.63 (1.77)	2.72 (1.79)	2.55 (1.75)	32.53
T_4	1.61 (1.45)	2.69 (1.79)	2.48 (1.72)	2.48 (1.73)	2.69 (1.79)	2.39 (1.70	36.85
T_5	1.88 (1.54)	2.84 (1.83)	2.11 (1.62)	2.08 (1.61)	1.75 (1.50)	2.13 (1.62)	43.65
T_6	3.25 (1.94)	3.62 (2.03)	3.05 (1.88)	4.00 (2.12)	5.00 (2.35)	3.78 (2.07)	—
SEm(±)	**0.04**	**0.03**	**0.05**	**0.05**	**0.05**	—	—
LSD(0.05)	**0.11**	**0.10**	**0.15**	**0.15**	**0.14**	—	—
CV (%)	**4.98**	**3.50**	**5.85**	**6.49**	**6.26**	—	—

*Mean population of four standard weeks.WAT- Weeks After Transplanting

**Data in parentheses indicate √(x+0.5) transformation

Maincrop – Brinjal

Companion crop -sweet potato, marigold, brinjal (1.5x more fertilizer dose),cowpea, maize T_1=brinjal+sweetpotato,T_2=brinjal+marigold,T_3=brinjal+brinjal(1.5 times more fertilizer dose), T_4=brinjal+cowpea,T_5=brinjal+maize,T_6=sole brinjal(control plot).

Table 2: Variation of the whitefly population in brinjal under the influence of different companion crops during the crop season (2018-19)

Treatments	1st - 4th WAT*	5th -8th WAT	9th -12th WAT	13th -16th WAT	17th -20th WAT	Mean	Reduction over control (%)
T_1	2.06 (1.60)**	3.36 (1.96)	3.27 (1.94)	1.86 (1.54)	2.75 (1.80)	2.66 (1.78)	19.64
T_2	1.77 (1.51)	3.15 (1.91)	2.94 (1.85)	1.75 (1.50)	1.95 (1.57)	2.31 (1.68)	30.19
T_3	2.20 (1.64)	3.27 (1.94)	3.59 (2.02)	3.56 (2.02)	3.32 (1.95)	3.19 (1.92)	3.67
T_4	2.13 (1.62)	3.25 (1.94)	3.10 (1.90)	3.31 (1.95)	3.27 (1.94)	3.01 (1.87)	9.03
T_5	1.80 (1.52)	3.44 (1.98)	2.97 (1.86)	2.33 (1.68)	2.63 (1.77)	2.63 (1.77)	20.49
T_6	2.77 (1.81)	4.02 (2.13)	3.84 (2.08)	2.86 (1.83)	3.06 (1.89)	3.31 (1.95)	—
SEm(±)	0.02	0.08	0.05	0.07	0.06	—	—
LSD(0.05)	0.06	0.23	0.14	0.20	0.19	—	—
CV (%)	2.27	6.63	4.32	6.49	6.16	—	—

*Mean population of four standard weeks. WAT- Weeks After Transplanting

**Data in parentheses indicate√(x+0.5) transformation

Maincrop – Brinjal

Companion crop -sweet potato, marigold, brinjal (1.5x more fertilizer dose),cowpea, maize T_1=brinjal+sweetpotato,T_2=brinjal+marigold,T_3=brinjal+brinjal(1.5 times more fertilizer dose), T_4=brinjal+cowpea,T_5=brinjal+maize,T_6=sole brinjal(control plot).

Table 3: Temperature, relative humidity and rainfall data during crop season (2018-19)

Standard weeks after transplanting(WAT)	Temperature (°C)		Relative humidity (%)		Total rainfall (mm)
	Max.	Min.	Max.	Min.	
1st -4th WAT	33.16	20.24	97.07	65.57	21.50
5th – 8th WAT	30.05	15.81	95.39	56.35	5.9
9th - 12th WAT	27.95	11.19	96.03	47.75	0
13th -16th WAT	24.14	7.74	97.92	52.17	13.8
17th-20th WAT	26.11	8.82	94.28	45.46	0

Source- Department of Agrometeorology, BCKV, Mohanpur, Nadia, W.B., 741252
N.B.: Max. = Maximum, Min. = Minimum and mm. =Millimeter; WAT=Weeks after transplanting.

temperature, 52.17% - 97.92 % relative humidity, and 13.8 mm rainfall in brinjal + marigold combination (T_2). This crop combination efficiently maintained the smallest cumulative mean value (2.31 insects per plant) throughout the crop growing periods (39 SW of 2018 to 6 SW of 2019), the percentage of reduction over control being, 30.19%, followed by the other efficient companion crop combinations; T_5, T_1, T_4, and T_3 respectively. On the contrary, the population was highest in the plot with T_6, having brinjal only (i.e. 4.02 insects per plant), during the 5th - 8th WAT temperature, ranging from 15.81^{0}C to 30.05^{0}C, relative humidity of 56.35% - 95.39%, and precipitation of 5.9 mm. The seasonal mean population was also highest in T_6 which was 3.31 insects plant^{-1}. However, among all the treatments the best border crop marigold resulted in an effectively reduced whitefly population in brinjal.

The lesser whitefly population in T_2 may be due to its repellency from main crop brinjal by releasing volatiles from border crop marigold. Such great information was also shared earlier by Zavaleta-Mejía and Gomez (1995). The volatiles emitting from intercrops or border crops create masking or repellency of insect pests to detect their host plants (Goel and Tiwari, 2004). There was a reduced population of whitefly in tomato intercropped with marigold (Abid and Magbool, 1990). Marigold was the most efficient companion crop in diverting the whitefly population followed by maize as the companion crop grown with the main crop brinjal. The colonization and mobility of whitefly could be prevented in the main crop by growing good barrier crop maize. Hence, after marigold, the treatment T_5 with border maize got a lower population of whitefly than the other treatments brinjal + brinjal (T_3), brinjal +cowpea (T_4), and sole crop control (T_6). The population of *Bemisia tabaci* in beans was maintained below economic threshold levels by the presence of maize as a barrier crop (Smith and McSorley, 2000).

Going through the current result, it is clear that during the entire cropping season the jassids and whitefly population was appreciably lesser in all companion crop combinations (T_1-T_5) than in untreated control (T_6). Further, the cumulative mean of jassid was lowest in T_2 and it was the best treatment followed by T_5, T_4, T_3, and T_1. However, the population of whitefly in the T_2 crop combination efficiently maintained the smallest cumulative mean value (2.31 insects per plant) throughout the crop growing period and it was the best treatment followed by the other efficient companion crop combinations: T_5, T_1, T_4, and T_3 respectively.

Therefore, it is recommended that the crop brinjal may be cultivated with suitable companion crops for eco-friendly pest reduction without the use of synthetic chemical toxicants. Moreover, pest diversion might be considered as an important powerful tool for sustainable integrated pest management.

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