Influence of Adjacent and Border Crops on the Incidence of Fall Armyworm *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) in Maize

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**ABSTRACT**

Background: Maize is one of the predominant millets cultivated in an area of 6500 ha both under drip and open irrigation systems in Dharmapuri district. The infestation of invasive insect pest *Spodoptera frugiperda* poses major threat to maize cultivation and increased the cost towards plant protection since 2018. In the integrated pest management strategies, the benefits of growing border and intercrop has been studied in detail but least emphasis was given to the crops grown in adjacent fields to the main crop. The cropping pattern in Dharmapuri district is highly diversified and the farmers prefer to grow more number of crops across the seasons compared to other maize growing areas.

**Methods:** The present survey envisages the influence of adjacent and border crops on the incidence of fall armyworm in maize. The field incidence of fall armyworm in maize crop surrounded by other crops such as tapioca, nerium, cotton and maize fields with blackgram, cowpea and sesamum as border crops were studied during *kharif* season of 2018 and 2019.

**Result:** The maize fields surrounded by tapioca and nerium crop recorded lower fall armyworm incidence (3.00 - 10.00%) followed by field surrounded by tapioca on either side of maize (4.50 - 14.50%) during 15 to 60 days after emergence. Growing of border crops such as blackgram, sesame and cowpea recorded 24.50, 23.50 and 16.50% incidence at 60 DAE, respectively. With regard to grain yield, no marked variation was observed in different crop combination. The higher return (Rs. 86040/ha) and benefit cost ratio (2.65) was observed in maize crop adjacent to tapioca and nerium crop. The lower net return (Rs. 75360/ha) and benefit cost ratio (2.36) was realized in maize crop adjacent to maize crop. In most of the management strategies pulses have been inducted either border or intercrop to attract natural enemies and thwart the host insects. In the present survey, tapioca and nerium crop combination reduces the fall armyworm incidence. Hence tapioca and nerium crop combinations can be tried as border crop to push the fall armyworm away from the maize crop. The days required for advanced planting and crop combinations should be studied in detail to devise effective fall armyworm management strategies.

**Key words:** Adjacent crop, Border crops, Cowpea, Fall armyworm, Maize, Nerium, Tapioca.

**INTRODUCTION**

Maize is one of the predominant millet crops grown in Dharmapuri district in an area of 6500 ha both in irrigated and rainfed conditions in Dharmapuri district. Both drip and open irrigation systems have been widely adopted by the farmers for maize cultivation. More than 141 insect species causes damage to maize from sowing to harvest (Reddy and Trivedi, 2008). Though many insect species are reported to cause damage in maize the farmers gave less attention to plant protection until the infestation of invasive insect pest fall armyworm (*Spodoptera frugiperda*), *Cowpea*. The invasive fall armyworm incidence in Dharmapuri district was first noticed in Morappur block during May 2018 and from there it spread to all the maize growing area with

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20-30% average yield loss in the district. Immediately after noticing the incidence of FAW on maize, farmers resorted to application of chemical insecticides for its management. Though chemical insecticides provided good control, cases of resistance have been reported against some insecticides (Yu, 1992; Al-Sarar et al. 2006). The dispersion pattern of fall armyworm to the lower canopy parts and inside the whorls makes the insecticide application a difficult task (Cook et al. 2004).

The management strategies involving growing of border and intercrops will be the best option to attract natural enemies and reduce incidence on main host crop. Many studies revealed that diversification at farm level resulted in an increased abundance of natural enemies and their improved effectiveness in managing insect pests (Harrison et al. 2019). Midega et al. 2018 revealed that push pull strategies can be integrated with other measures to control pests, including soil fertility management and habitat diversification at field level. The cropping pattern in Dharmapuri district is highly diversified and the farmers preferring to grow more number of crops across the seasons in their fields compared to other maize growing districts where diversified farming is less.

Conducting the preliminary survey will be useful to find out the suitable adjacent and border crop to reduce the incidence of fall armyworm in the maize crop. Hence, Krishi Vigyan Kendra, Dharmapuri has conducted an extensive survey to find out the effect of adjacent and border crops on the incidence of fall armyworm in the maize growing areas of the district.

**RESULTS AND DISCUSSION**

The results of the field survey indicated that lower incidence of fall armyworm in the fields surrounded by tapioca and Nerium (Table 2). The incidence was 3.00, 5.50, 8.00 and 10.00% respectively on 15, 30, 45 and 60 days after emergence (DAE). The fields surrounded by tapioca alone also witnessed low incidence of fall armyworm i.e 4.50, 8.00, 10.50 and 14.50% on 15, 30, 45 and 60 DAE respectively. It was followed by sorghum and cotton grown as an adjacent crop which recorded 15.00 and 25.00% incidence at 60 DAE, respectively. The higher incidence of 28.00% at 60 DAE was recorded where maize was grown as an adjacent crop.

Growing of border crops such as blackgram, sesame and cowpea recorded 24.50, 23.50 and 16.50% incidence at 60 DAE, respectively. Tapioca, nerium, cotton and...
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Table 1: Details of field survey and cropping pattern.

| Details of the farmer | Geo-coordinates | Variety/Hybrid | Season | Crop associated with Maize | Type of association |
|-----------------------|-----------------|----------------|--------|---------------------------|---------------------|
| V. Arulkumar S/o.     | 12.0333’N       | Co(HM)6        | Kharif 2018-19 | Tapioca | Adjacent crop |
| Velu Nathamedu         | 78.2788’E       |                |        | (Manihot utilissima Crantz.) | |
| Mottangurichi post Morappur block |   |                |        | |                |
| P. Madhu S/o.        | 12.0328’N       | Co(HM)6        | Kharif 2018-19 | Nerium | Adjacent crop |
| Pachiappan Gandipuram Mottangurichi post Morappur block | 78.2757’E | | (Nerium oleander L.) | |
| N. Manivannan S/o.   | 12.0328’N       | Co(HM)6        | Kharif 2018-19 | Cotton | Adjacent crop |
| Nanjappan Gettur Morappur block | 78.2757’E | | (Gossypium spp) | |
| V. Narayanan S/o.    | 12.0328’N       | Co(HM)6        | Kharif 2018-19 | Sorghum | Adjacent crop |
| Vedi Gettur Mottangurichi post Morappur block | 78.2757’E | | [Sorghum bicolor (L.) Moench] | |
| Mr. J. Suresh S/o.   | 11.9975’N       | CP818          | Kharif 2019-20 | Blackgram | Border crop |
| Jayaraj Parayapattipudur, Harur | 78.4068’E | | [Vigna mungo (L.) Hepper] | |
| Mr. C.Kumaresan S/o. | 11.9975’N       | CP818          | Kharif 2019-20 | Sesame | Border crop |
| Chinnagounder Parayapattipudur, Harur | 78.4068’E | | (Sesamum indicum L.) | |
| Mr. K. Venkatesan S/o | 11.9975’N      | CP818          | Kharif 2019-20 | Cowpea | Border crop |
| Krishnan Parayapattipudur, Harur | 78.4068’E | | (Vigna unguiculata L.) | |
| Mr. M.Srinivasan S/o | 11.9578’N       | CP 818         | Kharif 2019-20 | Cowpea | Border crop |
| Muthu Alapuram, Pappireddipatti | 78.3441’E | | (Vigna unguiculata L.) | |
| Mr. A. Chinnasamy S/o | 11.9578’N      | CP 818         | Kharif 2019-20 | Sesame | Border crop |
| Ariyagounder Alapuram, Pappireddipatti | 78.3441’E | | (Sesamum indicum L.) | |
| Mr. K. Palanivel S/o | 11.9975’N       | CP 818         | Kharif 2019-20 | Cowpea | Border crop |
| Kullugounder Parayapattipudur, Harur | 78.4068’E | | (Vigna unguiculata L.) | |

Sorghum were grown three months, one year and one month earlier than the maize sowing in the adjacent fields. The height of nerium and tapioca was 2m and 1m respectively at the time of maize sowing in the respective fields. The emerging maize plants were effectively protected from fall armyworm by these two adjacent fields. One critical observation was that one side of the field which doesn’t have any adjacent crop recorded more damage than the other sides of the field.

The results of the natural enemies population showed that growing of cowpea and black gram as border crop recorded more natural enemies populations compared to all other combinations (Table 3). The maize and black gram combination recorded 12.00, 13.00, 10.00 and 11.50% natural enemies and cowpea combination recorded 13.00, 15.00, 12.00% natural enemies during 15, 30, 45 and 60 DAE respectively. The maize and gingelly combination recorded 10.00, 9.50, 7.00 and 9.00 % natural enemies at 15, 30, 45 and 60 DAE respectively. Though tapioca and nerium as adjacent crops recorded less fall armyworm incidence, the natural enemies’ population was less. The tapioca and nerium on either side of maize field
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recorded more number of natural enemies compared to fields where tapioca alone served as adjacent crop. The cotton and maize adjacent crops recorded lower numbers of natural enemies population compared to other crop combinations. The crop canopy of black gram and gingelly attracts more number of natural enemies compared to other crop combinations in the study. Hailu et al. 2018 revealed that intercropping of maize with leguminous crops provided significant reduction of stem borers and fall armyworm compared to the mono cropped maize especially in the early growth phases and up to tasseling stage of maize.

Hailu et al. 2018 revealed that choice of companion crop, ratio of intercropping and time of sowing enhanced the fall armyworm control in maize. In the present investigation also the tapioca and Nerium are cultivated much earlier than maize sowing and thus favours the reduction in fall armyworm damage. Moreover, both are not preferred hosts for the FAW. In the climate adapted push pull strategy 82.7% reduction in average number of per plant and 86.7% in plant damage per plant were recorded compared to maize monocrop plots (Midega et al., 2018). The white African black pepper extract and beans push cropping systems were suggested as an effective alternative management measure against the fall armyworm (Tanyi et al. 2020). Whenever the choice of border or intercrop arises the researchers mostly focus on pulse crops whereas in the present survey tapioca and nerium are providing good control of fall armyworm as adjacent crops.

The results on the yield parameters indicated that maize grain yield was higher (76.8 q/ha) in maize crop adjacent to tapioca and nerium crop and it was followed by maize field adjacent to tapioca crop (76.2 q/ha) (Table 4). The lower maize grain yield (72.7 q/ha) was recorded in the maize crop grown adjacent to maize crop. Though, considerable difference was not observed in grain yield, the net return (Rs. 86040/ha) and benefit cost ratio (2.65) was higher in maize crop adjacent to tapioca and nerium crop. The lower net return (Rs. 75360/ha) and benefit cost ratio (2.36) was realized in maize crop adjacent to maize crop. It might be due to the higher cost involved in managing the fall armyworm incidence in maize under maize crop adjacent to maize crop. Daizy Sarma et al. 2018 also reported that intercropping of mustard and cowpea in cabbage reduced the diamondback moth population and increased the yield of cabbage.

The tapioca and nerium along with other crop combinations can be tried for the effective fall armyworm management. The major concern will be the planting of tapioca setts or nerium seedlings in and around the maize crop much earlier than the maize sowing. The days required for advanced planting and crop combinations should be

### Table 2: Incidence of fall armyworm in maize under different crop combinations.

| Crops with maize                  | 15 DAE | 30 DAE | 45 DAE | 60 DAE | Cob damage |
|-----------------------------------|--------|--------|--------|--------|------------|
| Adjacent crop - Tapioca (both sides) | 4.50   | 8.00   | 10.50  | 14.50  | 9.50       |
| Adjacent crop - Tapioca and Nerium (on either side) | 3.00   | 5.50   | 8.00   | 10.00  | 8.00       |
| Adjacent crop - Cotton (both sides) | 17.50  | 14.50  | 20.50  | 25.00  | 16.00      |
| Adjacent crop - Sorghum (both sides) | 13.00  | 13.00  | 17.00  | 15.00  | 14.50      |
| Border crop - Blackgram           | 19.00  | 16.00  | 22.50  | 24.50  | 15.00      |
| Border crop - Sesame              | 18.50  | 17.00  | 23.50  | 23.50  | 14.00      |
| Border crop - Cowpea              | 14.50  | 11.00  | 15.50  | 16.50  | 13.00      |
| Maize crop adjacent maize         | 28.00  | 25.50  | 25.00  | 28.00  | 17.00      |

Average of infestation in twenty plants*.

DAE – days after emergence.

### Table 3: Abundance of natural enemies in maize in maize under different crop combinations.

| Crops with maize                  | 15 DAE | 30 DAE | 45 DAE | 60 DAE |
|-----------------------------------|--------|--------|--------|--------|
| Adjacent crop - Tapioca (both sides) | 7.00  | 7.50   | 6.50   | 7.50   |
| Adjacent crop - Tapioca and Nerium (on either side) | 9.50  | 8.50   | 10.50  | 9.50   |
| Adjacent crop - Cotton (both sides) | 4.50  | 4.00   | 9.50   | 6.00   |
| Adjacent crop - Sorghum (both sides) | 6.50  | 5.50   | 6.00   | 6.00   |
| Border crop - Blackgram           | 12.00  | 13.00  | 10.00  | 11.50  |
| Border crop - Sesame              | 10.00  | 9.50   | 7.00   | 9.00   |
| Border crop - Cowpea              | 13.50  | 15.00  | 13.50  | 12.00  |
| Maize crop adjacent maize         | 4.00   | 5.00   | 4.00   | 4.00   |

Abundance in twenty plants*.

DAE - days after emergence.
studied in detail to devise effective fall armyworm management strategies in the new invaded areas.

CONCLUSION
The preliminary survey to study the impact of adjacent and border crops on the incidence of fall armyworm in maize clearly indicated that the crops grown adjacent to the maize crop clearly influences the fall armyworm incidence in the maize crop than the border crops. The tapioca and nerium on either side of the maize and tapioca alone on both sides of maize reduces the fall armyworm incidence than the other combinations surveyed. Among the border crops cowpea and backgarm recorded lower fall armyworm incidence in the present survey carried out in the farmer fields. The tapioca and neriou can be better alternate crops along with pulses to devise a sound ecological engineering technique against fall armyworm in maize.

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Table 4: Yield parameters of maize under different crop combinations.

| Crops with maize | Cost of plant protection (Rs. / ha) | Yield (q/ha) | Net Return (Rs. / ha) | BCR |
|------------------|------------------------------------|-------------|----------------------|-----|
| Adjacent crop - Tapioca (both sides) | 6700 | 76.2 | 85160 | 2.64 |
| Adjacent crop - Tapioca and Nerium (on either side) | 6900 | 76.8 | 86040 | 2.65 |
| Adjacent crop - Cotton (both sides) | 8000 | 73.4 | 78820 | 2.48 |
| Adjacent crop - Sorghum (both sides) | 8200 | 75.6 | 82580 | 2.54 |
| Border crop - Blackgram | 8750 | 74.3 | 79690 | 2.47 |
| Border crop - Sesame | 8400 | 73.0 | 77700 | 2.45 |
| Border crop - Cowpea | 7800 | 75.4 | 79920 | 2.49 |
| Maize crop adjacent maize | 10200 | 72.7 | 75360 | 2.36 |