International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 10-08-2021, Accepted: 24-08-2021, Published: 10-09-2021
Volume 6, Issue 5, 2021, Page No. 26-30

Management of thrips, *Scirtothrips dorsalis* hood in chilli through ecological engineering methods

Archunan K[1], Pazhanisamy M[2]
[1] Ph.D. Scholar, Deptartment of Entomology, Faculty of Agriculture, Annamalai University, Tamil Nadu, India
[2] Assistant Professor, Deptartment of Entomology, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

Abstract
Ecological engineering is a relatively new concept of environmental manipulation for the benefit of humans and the environment. Field study involved habitat manipulation based on growing nectar producing flowering plants (preferably alfalfa, cowpea and marigold) combined with border plants on the chilli bounds, reducing the intensity of pesticide use against thrips, *Scirtothrips dorsalis* in chilli crop. Studies were conducted in two consecutive seasons for kharif 2020 to rabi 2020-21. Results of the field trial indicated that the lowest thrips population and high natural enemies were recorded in model 4 comprising the basal application of FYM + vermicompost + neem cake, chilli + marigold intercropping (5:1) on par with model2 (no./leaf) [FYM + vermicompost + neem cake, chilli + Alfalfa, sorghum (border crop)] followed by model 2 [FYM + vermicompost + neem cake, chilli + Alfalfa, sorghum (border crop)], sorghum (border crop) and in model 8 (chilli alone planted plot) observed maximum population of *S. dorsalis* and less natural enemies presented. Finally, the research concluded habitat manipulation is not a 'high-tech' approach so is simple and practical for vegetable farmers to implement and reduce the pesticides risk.

Keywords: ecological engineering, chilli, *Scirtothrips dorsalis*, intercropping, marigold, neem cake

Introduction
Chilli or red pepper (*Capsicum annuum* L.) is an important spice crop as well as a vegetable crop grown all over India. It is grown for the demand of its pungent fruits, both green and ripe (dried form) to add pungency to the food. As a condiment, it has become indispensable in every Indian home. It is also used for medicinal purpose, chutneys and pickles (Das, 2013; Saleh *et al*., 2018) [3, 13]. India is the world's largest producer, consumer and exporter of chilies and it's cultivated in an area of 7.67 lakh hectares and the production is estimated to be 12.34 lakh tones (Priyadarshini *et al*., 2018) [10] and in Tamil Nadu, an area covered by chilli is 2160 hectares with a production of 21350 tones during 2016-17 (NHB, 2017) [7]. The sustainability of chilli production is threatened by many biotic stresses such as several insect pests and diseases (Hanumanthappa *et al*., 2018). Among the different insect pests, thrips, *Scirtothrips dorsalis* Hood (Thripidae: Thysanoptera) is referred to as the most serious and important pest. Both adults and nymphs of *S. dorsalis* are caused the damage by scraping the epidermis and suck the cell sap from the chilli leaves resulting in the tip of the leaves rolled upwards and reduction in the leaf size (Shivalingaswamy and Satpathy, 2007; Shankar and Raju, 2012) [16, 15]. Chilli thrips *S. dorsalis* is regarded to be one of the most damaging insect pests and causes lose range between 30 to 50 % of the plant under severity and its life-cycle is completed between 14 to 21 days depending on climate condition as many as 25 overlapping generations in a year (Paul, 2007; Bhede *et al*., 2008; Kumar *et al*., 2019) [8, 2, 4]. Natural enemies are playing an important role in the management of chilli thrips. Chilli sucking pest management using the non-chemical approaches leading to economic and environmental benefits. Hence, this study was to determine the role of habitat manipulation on the incidence of *S. dorsalis* and their natural enemies in chilli. This will facilitate to execution of a basal application of bio agents with intercropping in chilli crop and other control strategies for the *S. dorsalis* in chilli.

Materials and Methods
Studies were conducted in 25 cents at Pennagaram Taluk, Dharmapuri (12º 05'10.4" N 77º 57' 00.6"E) during kharif 2020 and rabi 2020-2021 in a Randomized Block Design (RBD) to assess the ecological engineering on the incidence of *S. dorsalis* in chilli. The chilli variety CO 2 was raised in the protected nursery and 30 days after seedlings were transplanted in main the field at the spacing of 45×30 cm. Normal agronomic practices are followed without pesticides applied to the entire cropping period of chilli.

Table 1: Details of ecological engineering implemented chilli ecosystem

Model	Treatments
Model 1	FYM + *P. florescence* + neem cake, chilli + Alfalfa, sorghum (border crop)
Model 3	FYM + vermicompost + neem cake, chilli + Alfalfa, sorghum (border crop)
Model 4	FYM + *P. florescence* + neem cake, chilli + marigold, sorghum (border crop)
Model 5	FYM + vermicompost + neem cake, chilli + marigold, sorghum (border crop)
Model 6	FYM + *P. florescence* + Neem cake, chilli + cowpea, sorghum (border crop)

Model 5	FYM + vermicompost + neem cake, chilli + cowpea, sorghum (border crop)
Model 7	Chilli + weeds
Model 8	Chilli alone (control).

Below ground treatments include basal application of Farm Yard Manure (FYM) @ 300 kg/plot, vermicompost @ 2 kg/plot, neem cake @1 kg/plot and *Pseudomonas florescence* @250 g/plot were applied before planting of chilli seedling/ last ploughing based on model details given in Table 1.Chilli intercropped with the marigold seedling, Alfalfa and cowpea seeds sowed at 10 Days before planting of chilli plant @ 4:1 ratio of alfalfa, marigold and cowpea. In each model, sorghum used as border crop sowed at 10 days before planting of Chilli in above ground level treatments. Weeds were allowed up to entire cropping periods in Model 7.

Thrips population of both nymphs and adults stages were counted in the morning before 9 am when the pests were not much active by using a hand lens (3x). During the population count, the leaves were carefully handled to prevent the escape of adult thrips. Three replications were maintained and in each replication five plants were tagged and the thrips populations were counted in three leaves (top, middle and bottom) of chilli plant modified for Ravikumar and Rafee, 2018 [12] Kumar *et al*., 2020 [4]. The natural enemies (Coccinellids, Spider, Mirid bug) were also observed by visual counting in tagged five plants. Observations were taken from 15 DAT till the end of the crop period. The population data was further subjected to statistical analysis to transfer the square root, ranked by DMRT and the per cent reduction over the control was calculated in both the first and second season (Pazhanisamy and Archunan, 2019) [9].

$$\% \text{ reduction over the control} = \frac{\text{Population in control (model 8)} - \text{population in treated}}{\text{Population in control}} \times 100$$

Results and Discussion

Influence of habitat manipulation against *S. dorsalis*

Efficacy of field experiments of habitat manipulation against thrips of chilli is presented in Tables 2 & 3. The average number of chilli thrips/ leaf in each model varied between 0.40-12.53. It was evident that on the 15 days after planting (DAP), the lowest thrips population recorded in model 4 comprising the basal application of FYM + vermicompost + neem cake, chilli + marigold intercropping (5:1), sorghum (border crop) and in model 8 (chilli alone planted plot) observed maximum population of *S. dorsalis* (1.73 no./leaf). Lowest population of *S. dorsalis* observed in model 4 (1.07, 1.80, 2.50, 3.77 & 5.37 no./leaf) on par with model 2 (1.30, 1.77, 3.10, 4.07 & 6.27 no./leaf) [FYM + vermicompost + neem cake, chilli + Alfalfa, sorghum (border crop)] followed by model 3 (1.60, 2.77, 3.40, 4.87 & 7.40 no./leaf) [(FYM + *P. florescence* + neem cake, chilli + marigold, sorghum (border crop)] at 30, 45, 60, 90 and 120 DAP of chilli during kharif 2020. Intercrop as marigold and border crop such as Sorghum, maize and bajra against small soft bodied flying insects which migrate from one field to another field such as whiteflies, hoppers, aphids, mealybugs and thrips in chili and cotton (Samal *et al*., 2020) [14].

The moderate populations of *S. dorsalis* (1.70, 2.80, 5.67, 6.43 & 9.00 no./leaf) were recorded in model 7 comprising the chilli with weeds. The highest population of *S. dorsalis* (2.20, 5.40, 8.20, 11.37 & 12.53 no./leaf) also observed in chilli alone growing plot at 30, 45, 60, 90 and 120 days after planting of chilli field during the kharif 2020 (Table 2). The present finding was foloowing Tatagar *et al*. (2011) stated that sorghum border crop can reduce the incidence of chilli leaf curl caused due to thrips and mites. The flowering plants provide food and shelter for natural enemies to increases life span and the efficiency of predatory activity.

The results of secondary confirmatory field experiments of habitat manipulation against *S. dorsalis* conducted during rabi season 2020-21 are presented in Table 3, the lowest population of thrips were model 4 (0.47, 1.13, 1.80, 2.63, 3.63 & 5.20 nos. /leaf) on par with model 2 (0.87, 1.50, 1.77, 3.60, 4.23 & 5.46 no./ leaf) followed by model 3 (1.13, 1.47, 2.27, 4.57, 5.37 & 6.23 no./ leaf), model 6 (1.67, 1.81, 2.33, 3.00, 5.13 & 5.77 no./ leaf) and model 5 (1.43, 1.93, 3.30, 4.00, 5.33 & 6.17 no./ leaf) and highest population was observed in Model 8 (chilli alone) (2.83, 3.77, 4.03, 6.50, 9.23 &12.30 no./ leaf) and model 7 (chilli + weeds) (1.57, 2.15, 3.07, 4.80, 6.33 & 6.83 no./ leaf) at 15, 30 45, 60, 90 and 120 days after planting of chilli. Major weeds such as *Trianthema portulacastrum, Acalypha indica, Cynodon dactylon* and *Cyperus rotundus* presented in model 7.

Per cent reduction comparison with control of *S. dorsalis* population was maximum in model 4 (65. 67 & 61.31 %) and model 2 (60.31 & 54.82 %) followed by model 3 (53.04 & 45.57 %) and model 6 (48.81 & 48.20 %) during kahrif 2020 and rabi 2020-21.Veena *et al.* observed the chilli amended at planting with neem cake (250 kg/ha) and vermicompost (1t/ha) were effective in keeping the chilli thrips (*S. dorsalis*) and mite (*Polyphagotarsonemus latus*) density in check, being comparable to recommended insecticides. Organic amendments (neem cake, pungam cake, vermicompost) relatively increased the phenols in the plant and also the activity of enzymes *viz.*, polyphenol oxidase and peroxidase, which might be responsible for the reduced pest incidence (Ravi *et al*., 2006) [11].

Influence of habitat manipulation in natural enemies in chilli

The population of natural enemies on habitat manipulation in chilli during kharif 2020 and 2020-21 is shown that Tables 4 & 5. The natural enemies were observed in all the experimental plots, during the trial period and the observation showed statistically there no significant differences among the model at 15 & 45 DAP. The mean number of natural enemies maximum presented in model 4 (3.13 & 2.94 nos./ plant) and model 2 (2.90 &3.04 nos./ plant) followed by model 5 (2.20 & 2.06), model 3 (2.09 & 2.54 nos./ plant) and model 6 (2.12 & 2.03 nos./ plant). Matintarangson (2018) [5] reported that Intercropping of marigold and yardlong beans can reduce pest populations and way to increase diversity in an agricultural ecosystem to reduce the use of chemicals and environmentally friendly aphid control. Similarly, Muthukumar and Sridharan (2017) [6] who evaluated the bitter gourd with sorghum as a border crop were found to be conserved and enhance the natural enemies population. The lowest population was recorded in model 8 (Chilli alone) (1.14 & 1.09 nos. /plant) followed by model 7 (chilli+ weeds) (1.69 & 1.73 nos./plant). (1.14 & 1.09 nos./plant). The weed plants resources provided less

nutritional benefit to the natural enemies compared to flowering plants. The present finding was supported by Amaral *et al. (*2013) [1] who suggested that management of specific weed species may provide an optimal strategy for the conservation of beneficial insects that utilize non-prey foods in chilli ecosystem. Finally, the research concluded that habitat manipulation is not a 'high-tech' approach and it is a simple method and practical for vegetable farmers to implement and reduce the pesticides risk and increase the economic returns.

Table 2: Ecological engineering model against *S. dorsalis* in chilli during kharif 2020

Model	Treatments	Thrips population/ leaf*						Over all mean	% reduction over the control
		15 DAP	30 DAP	45 DAP	60 DAP	90 DAP	120 DAP		
1	FYM + *P. florescence* + neem cake, chilli + Alfalfa, sorghum (border crop)	1.33 (1.53)^{c}	2.33 (1.83)^{c}	3.20 (2.05)^{b}	5.00 (2.44)^{b}	6.27 (2.69)^{b}	8.37 (3.05)^{b}	4.82	39.15
2	FYM + vermicompost + neem cake, chilli + Alfalfa, sorghum (border crop)	0.87 (1.36)^{b}	1.30 (1.51)^{a}	1.77 (1.66)^{a}	3.10 (2.02)^{a}	4.07 (2.24)^{a}	6.27 (2.69)^{a}	3.14	60.31
3	FYM + *P. florescence* + neem cake, chilli + marigold, sorghum (border crop)	0.60 (1.25)^{ab}	1.60 (1.61)^{b}	2.27 (1.80)^{an}	3.40 (2.09)^{ab}	4.87 (2.41)^{ab}	7.40 (2.89)^{ab}	3.72	53.04
4	FYM + vermicompost + neem cake, chilli + marigold, sorghum (border crop)	0.40 (1.18)^{a}	1.07 (1.44)^{a}	1.80 (1.67)^{a}	2.50 (1.86)^{a}	3.37 (2.09)^{a}	5.77 (2.59)^{a}	2.72	65.67
5	FYM + *P. florescence* + Neem cake, chilli + cowpea, sorghum (border crop)	1.57 (1.60)^{cd}	1.80 (1.67)^{b}	3.03 (2.01)^{b}	4.43 (2.32)^{b}	4.90 (2.42)^{ab}	7.27 (2.87)^{ab}	4.18	47.27
6	FYM + vermicompost + neem cake, chilli + cowpea, sorghum (border crop)	1.40 (1.55)^{c}	1.81 (1.67)^{b}	2.33 (1.82)^{ab}	4.27 (2.28)^{b}	5.10 (2.45)^{ab}	7.3 (2.87)^{ab}	4.05	48.81
7	Chilli + weeds	1.23 (1.49)^{bc}	1.70 (1.64)^{b}	2.80 (1.95)^{b}	5.67 (2.58)^{bc}	6.43 (2.72)^{b}	9.00 (3.16)^{b}	4.86	38.67
8	Chilli alone (control)	1.73 (1.65)^{d}	2.20 (1.79)^{c}	5.40 (2.46)^{c}	8.20 (3.02)^{c}	11.37 (3.50)^{c}	12.53 (3.63)^{c}	7.92	0.00
	Sed	0.108	0.089	0.118	0.201	0.233	0.217		
	CD (0.05 %)	0.235	0.193	0.255	0.435	0.506	0.469		

DAP = Days after Planting, * Mean of three replications,

Figures in parentheses are square root transformed values, means in column followed by a common letter are not significantly different at the 5 per cent level (DMRT)

Table 3: Ecological engineering model against *S. dorsalis* in chilli during rabi 2020-21

Model	Treatments	Thrips population/ leaf						Over all mean	% reduction over the control
		15 DAP	30 DAP	45 DAP	60 DAP	90 DAP	120 DAP		
1	FYM + *P. florescence* + neem cake, chilli + Alfalfa, sorghum (border crop)	1.57 (1.60)^{b}	2.13 (1.77)^{b}	3.20 (2.05)^{b}	4.93 (2.43)^{c}	5.50 (2.55)^{b}	6.37 (2.71)^{ab}	3.95	38.66
2	FYM + vermicompost + neem cake, chilli + Alfalfa, sorghum (border crop)	0.87 (1.34)^{a}	1.50 (1.56)^{a}	1.77 (1.66)^{a}	3.60 (2.14)^{b}	4.23 (2.29)^{a}	5.46 (2.54)^{a}	2.91	54.82
3	FYM + *P. florescence* + neem cake, chilli + marigold, sorghum (border crop)	1.13 (1.45)^{ab}	1.47 (1.56)^{a}	2.27 (1.80)^{ab}	4.57 (2.35)^{bc}	5.37 (2.51)^{b}	6.23 (2.68)^{ab}	3.51	45.57
4	FYM + vermicompost + neem cake, chilli + marigold, sorghum (border crop)	0.47 (1.20)^{a}	1.13 (1.45)^{a}	1.80 (1.67)^{a}	2.63 (1.89)^{a}	3.63 (2.15)^{a}	5.20 (2.50)^{a}	2.49	61.31
5	FYM + *P. florescence* + Neem cake, chilli + cowpea, sorghum (border crop)	1.43 (1.55)^{b}	1.93 (1.70)^{ab}	3.03 (2.01)^{b}	4.00 (2.23)^{b}	5.33 (2.51)^{b}	6.17 (2.67)^{ab}	3.65	43.32
6	FYM + vermicompost + neem cake, chilli + cowpea, sorghum (border crop)	1.67 (1.63)^{b}	1.81 (1.67)^{ab}	2.33 (1.82)^{ab}	3.00 (2.07)^{ab}	5.13 (2.47)^{b}	5.77 (2.59)^{a}	3.34	48.20
7	Chilli + weeds	1.57 (1.60)^{b}	2.15 (1.77)^{b}	3.07 (2.01)^{b}	4.80 (2.41)^{c}	6.33 (2.70)^{c}	6.83 (2.80)^{b}	4.13	35.94
8	Chilli alone (control)	2.83 (1.96)^{c}	3.77 (2.18)^{c}	4.03 (2.24)^{c}	6.50 (2.73)^{d}	9.23 (3.20)^{d}	12.30 (3.64)^{c}	6.44	0.00
Sed		0.161	0.165	0.132	0.156	0.166	0.158		
CD (0.05 %)		0.349	0.357	0.285	0.310	0.359	0.342		

DAP = Days after Planting, * Mean of three replications,

Figures in parentheses are square root transformed values, means in column followed by a common letter are not significantly different at the 5 per cent level (DMRT)

Table 4: Effect of Ecological engineering model on natural enemies in chilli during kharif 2020

Model	Treatments	NE population/ plant						Mean
		15 DAP	30 DAP	45 DAP	60 DAP	90 DAP	120 DAP	
1	FYM + *P. florescence* + neem cake, chilli + Alfalfa, sorghum (border crop)	0.33 (1.14)	1.27 (1.50)	1.73 (1.65)^{bc}	2.33 (1.82)^{b}	2.37 (1.81)^{b}	3.43 (2.10)^{b}	1.91
2	FYM + vermicompost + neem cake, chilli + Alfalfa, sorghum (border crop)	0.83 (1.35)	1.87 (1.68)	3.03 (2.00)^{ab}	3.30 (2.07)^{a}	3.70 (2.17)^{a}	4.67 (2.38)^{a}	2.90
3	FYM + *P. florescence* + neem cake, chilli + marigold, sorghum (border crop)	0.50 (1.21)	1.27 (1.50)	2.13 (1.77)^{b}	2.67 (1.91)^{b}	2.70 (1.91)^{b}	3.27 (2.06)^{b}	2.09
4	FYM + vermicompost + neem cake, chilli + marigold, sorghum (border crop)	0.50 (1.21)	2.07 (1.74)	3.67 (2.16)^{a}	3.70 (2.16)^{a}	4.03 (2.24)^{a}	4.83 (2.42)^{a}	3.13
5	FYM + *P. florescence* + Neem cake, chilli + cowpea, sorghum (border crop)	0.58 (1.25)	1.5 (1.58)	2.53 (1.87)^{b}	2.70 (1.92)^{b}	2.97 (1.98)^{ab}	2.90 (1.97)^{bc}	2.20
6	FYM + vermicompost + neem cake, chilli + cowpea, sorghum (border crop)	0.67 (1.27)	1.33 (1.52)	2.50 (1.87)^{b}	2.37 (1.82)^{b}	2.59 (1.89)^{b}	3.23 (2.06)^{b}	2.12
7	Chilli + weeds	0.33 (1.15)	1.03 (1.41)	1.90 (1.07)^{d}	2.10 (1.75)^{bc}	2.3 (1.81)^{bc}	2.47 (1.86)^{c}	1.69
8	Chilli alone (control)	0.50 (1.21)	0.73 (1.31)	1.03 (1.42)^{c}	1.23 (1.49)^{c}	1.47 (1.57)^{c}	1.87 (1.69)^{d}	1.14
Sed		0.172	0.158	0.124	0.161	0.105	0.12	
CD (0.05 %)		N/A	N/A	0.268	0.351	0.237	0.26	

DAP = Days after Planting, * Mean of three replications,

Figures in parentheses are square root transformed values, means in column followed by a common letter are not significantly different at the 5 per cent level (DMRT)

Table 5: Effect of Ecological engineering model on natural enemies in chilli during rabi 2020-21

Model	Treatments	NE population/ plant						Mean
		15 DAP	30 DAP	45 DAP	60 DAP	90 DAP	120 DAP	
1	FYM + *P. florescence* + neem cake, chilli + Alfalfa, sorghum (border crop)	0.43 (1.19)	1.00 (1.41)^{b}	1.70 (1.64)^{b}	2.23 (1.80)^{b}	2.90 (1.97)^{ab}	3.20 (2.04)^{d}	1.91
2	FYM + vermicompost + neem cake, chilli + Alfalfa, sorghum (border crop)	0.53 (1.23)	2.03 (1.73)^{a}	2.87 (1.96)^{a}	3.90 (2.20)^{a}	4.43 (2.32)^{a}	4.50 (2.34)^{b}	3.04
3	FYM + *P. florescence* + neem cake, chilli + marigold, sorghum (border crop)	0.60 (1.26)	1.53 (1.59)^{ab}	2.43 (1.89)^{ab}	3.47 (2.11)^{a}	3.63 (2.15)^{a}	3.60 (2.14)^{c}	2.54
4	FYM + vermicompost + neem cake, chilli + marigold, sorghum (border crop)	0.50 (1.21)	2.23 (1.78)^{a}	3.03 (2.01)^{a}	3.03 (2.01)^{a}	3.13 (2.03)^{a}	5.73 (2.59)^{a}	2.94
5	FYM + *P. florescence* + Neem cake, chilli + cowpea, sorghum (border crop)	0.41 (1.18)	0.97 (1.39)^{b}	2.50 (1.86)^{ab}	2.57 (1.88)^{b}	2.67 (1.91)^{b}	3.23 (2.06)^{d}	2.06
6	FYM + vermicompost + neem cake, chilli + cowpea, sorghum (border crop)	0.17 (1.08)	1.50 (1.58)^{ab}	2.23 (1.72)^{b}	2.13 (1.76)^{b}	2.70 (1.91)^{b}	3.43 (2.10)^{cd}	2.03
7	Chilli + weeds	0.43 (1.19)	0.70 (1.30)^{bc}	1.60 (1.60)^{b}	2.30 (1.81)^{b}	2.37 (1.83)^{b}	2.97 (1.99)^{d}	1.73
8	Chilli alone (control)	0.13 (1.06)	0.47 (1.21)^{c}	0.93 (1.39)^{c}	1.33 (1.53)^{c}	1.60 (1.61)^{c}	2.07 (1.75)^{e}	1.09
Sed		0.132	0.152	0.154	0.159	0.14	0.082	
CD (0.05 %)		N/A	0.330	0.334	0.345	0.304	0.179	

DAP = Days after Planting, * Mean of three replications,

Figures in parentheses are square root transformed values, means in column followed by a common letter are not significantly different at the 5 per cent level (DMRT)

References

1. Amaral DS, Venzon M, Duarte MV, Sousa FF, Pallini, A, Harwood JD. Non-crop vegetation associated with chili pepper agroecosystems promote the abundance and survival of aphid predators. Biological Control, 2013:64(3):338-346.
2. Bhede BV, Suryawanshi DS, More DG. Population dynamics and bioefficacy of newer insecticide against chilli thrips, *Scirtothrips dorsalis* (Hood). Indian Journal of Entomology,2008:70(3):223-226.
3. Das G. Efficacy of imidacloprid, a nicotinoid group of insecticide against the infestation of chilli aphid, *Myzus persicae* (Hemiptera: Aphididae). International Journal of Biology and Biological Sciences,2013:2:154-159.
4. Kumar S, Awasthi AK, Kerketta A, Shyam R. Seasonal incidence of chilli thrips (*Scirtothrips dorsalis*) on chilli& its correlation with different abiotic factors. Journal of Entomology and Zoology Studies, 2020:8(5):779-782.
5. Matintarangson N. Effects of intercropping of marigold and yardlong bean on Population of cowpea aphid Aphis Craccivora, Science & Technology Asia, 2018:23(2):12-18. Retrieved from https://ph02.tci-thaijo.org/index.php/SciTechAsia/article/view/131196.
6. Muthukumar M, Sridharan S. Engineering sorghum as border crop to manage bitter gourd gall midge *Lasioptera* spp. International Journal of Chemical Studies,2017:5(6):1153-1156.
7. NHB. Horticultural Statistics at a Glance 2017. Horticulture Statistics Division, GOI, Controller of Publication, 2018, 510.
8. Paul AVN. Insect pests and their management (online), Indian Agricultural Research Institute, New Delhi, 2007. Available at: https://www.hrsacademy.in/wp-content/uploads/2016/11/Agriculture-Entomology-Insect-Pest-and-their-Management.pdf
9. Pazhanisamy M, Archunan K. Efficacy of botanical extracts and panchagavya against bhendi shoot and fruit

borer, *Earias vittella* (Fab.). Journal of Biological Control,2019:33(4):372-377.
10. Priyadarshini S, Mishra A, Nayak AK, Thakoor P. Seasonal Incidence of Different Sucking Pests of Chilli and their Natural Enemies under West Bengal Condition. International Journal of Current Microbiology and Applied Sciences,2018:7(10):2936-2948. doi: https://doi.org/10.20546/ijcmas.2018.710.341.
11. Ravi M, Dhandapani N, Sathiah N, Murugan M. Influence of organic manures and fertilizers on the incidence of sucking pests of sunflower, *Helianthus annuus* L. Annals of Plant Protection Sciences,2006:14(1):41-44.
12. Ravikumar H, Rafee CM. Management of insect pests of chilli through sequential spray schedules. Journal of Experimental Zoology, India,2018:21(2):1213-1218.
13. Saleh BK, Omer A, Teweldemedhin B. Medicinal uses and health benefits of chili pepper (*Capsicum* spp.): a review. MOJ Food Processing & Technology,2018:6(4):325-328.
14. Samal I, Bhattacharjee J, Bhattacharjee D. Ecological Engineering for Pest Management. Biotica Research Today,2020:2(5):100-102.
15. Shankar U, Raju SVS. Integrated pest management in vegetable eco-system. Ecologically Based Integrated Pest Management, New India Publishing House, New Delhi, India, 2012, 619-650.
16. Shivalingaswamy TM, Satpathy S. Integrated pest management in vegetable crops. Entomology: Novel Approaches, Jain, PC and Bhargava, MC (Eds.), New India Publishing Agency, New Delhi, India, 2007, 353-375.
17. Tatagar MH, Awaknavar JS, Giraddi RS, Mohankumar HD, Mallapur CP, Kataraki PA. Role of border crop for the management of chilli leaf curl caused due to thrips, *Scirtothrips dorsalis* (Hood) and mites, *Polyphagotarsonemus latus* (Banks). Karnataka Journal of Agricultural Sciences,2011:24(3):294-299.
18. Veena SK, Giraddi RS, Bhemmanna M, Kandpal K. Effect of pongamia cake, neem cake and vermicompost on sucking insect pests of chilli. Journal of Entomology and Zoology Studies,2017:5(4):775-778.