Original Research Article

Seasonal incidence of insect pest and natural enemies in foxtail amaranthus and spinach and efficacy of dimethoate against insect-pests infesting leafy vegetables

ABSTRACT

An investigation was made to study the efficacy of dimethoate against sucking and defoliator pest infesting foxtail amaranths and spinach. Apart from dissipation study of dimethoate in foxtail amaranths and spinach, the efficacy of dimethoate was studied at two doses, one at recommended dose of 200g a.i. ha^{-1} and other at double the recommended dose of 400 g a.i ha^{-1}along with control and three replication each.The incidence of leaf webber, *Hymenia recurvalis*, ear-head bug, *Cletus pugnator*, Thrips, *Thrips tabaci*and leaf *miner Liriomyzatrifoli* were also observed in foxtail amaranth. In spinach, leaf eating caterpillar, *Spodoptera litura*, cut worm, *Agrotisipsilon*and Thrips, *Thrips tabaci*were recorded. In spinach at 3th leaf stage, nearly 9.20% leaf defoliation, 10.34% leaf damage and mean thrips population of 3.48/5 plants with mean predator population of 0.32/ 5 plants was recorded.In efficacy study,dimethoate was efficient in reducing the infestation of leaf webber population with pre-mean count of 4.4± 0.87 in control and 1.2± 0.03 in X dose and 0.0± 0.0 in 2X dose after 1 DAT in foxtail amaranths. In efficacy study of dimethoate on thrips in spinach, the pre-mean thrips population was 6.6± 0.17in control and 5.4± 0.41 in X dose and 7.9± 0.57in 2X dose plots and subsequent increase in population was recorded in control from 17.1± 2.12on 3 DAT to 22.5± 3.37on 5 DAT, while complete reduction in thrips population was observed 3 DAT in all treatments.

Keywords: Spinach, Foxtail amaranths, Dimethoate, efficacy, seasonal incidence

1. INTRODUCTION

Vegetables plays a vital role in dietary requirement of human of which leafy vegetable reserves a unique spot in providing all the essential nutrients, vitamins and minerals. The consumption of leafy vegetables was followed from ancestor and collection from wild sources were stills a major practice in all parts of the world (Turner *et al.*, 2011). Leafy vegetables were eaten raw or cooked by many tribal and millions of rural communities as a traditional food (Bharucha andPretty,2010). Leafy vegetables are rich in antioxidants, flavenoids, beta-carotene and minerals like Zn, Na, Fe and Ca which serve as a wholesome meal apart from cereals and millets (Di Carlo et al., 1999; Bartlett and Eperjesi, 2004; Misra and Misra, 2013).The change in climate have resulted in shift in pest distribution and occurrence in all cultivated and arable crops especially vegetables, especially protected cultivation (Pandey*et al*., 2006). Recent incidence of chilli gall midge (*Asphondyliacapparis*), solenopsis mealy bug (*Phenacoccussolenopsis*),Hadda beetle (Henosepilachnavigitioctopunctata) and plume moth (*Sphenaechescaffer*) in bottle gourd were reported in India on major vegetables (Rai *et al*., 2014). The insect pest causes30-40%yield loss in vegetables in India and also reduce the marketability and value of the produce (Rai *et al*., 2014; Bhat*et al*., 2018).

Among the major pest infesting the vegetables, Lepidopteran insect pests viz.*Helicoverpaarmigera*, *Pieris brassicae*, *Leucinodesorbonalis*, *Phthorimaeaoperculella*, *Plutellaxylostella*, *Spilosomaobliqua*, *Spodoptera litura* and Hemipteran insect pest viz.*Aphis gossypii*, *Bemisiatabaci*, *Brevicorynebrassicae*,*Myzus persica*,*Dysdercuscingulatus*, *Lipaphiserysimi*and non-insect pests like spider mites, slugs and snails were the predominant one attacking vegetable in northern regions of India (Tripathi *et al*., 2021). The major insect pest attacking spinach were leaf miners, *Liriomyza spp*.; green peach aphid,*Myzuspersicae*; loopers worms,*Trichoplusiani*; beet armyworm, *Spodoptera exigua*; whiteflies, *Bemisiaargentifolii*; thrips, *Frankliniella occidentalis*and mites, *Rhizoglyphus spp*.(Koike *et al*., 2011; Simko *et al*., 2014). The impact of insect-pests in leafy vegetables not only reduces the yield but also reduces the marketability and quality of vegetables.

2. MATERIALS AND METHODS

A field experiment was laid out during October - November 2017 to study dissipation study and efficacy study of dimethoate and to record the seasonal incidence of insect pests of foxtail amaranthus and spinach in Coimbatore, Tamil Nadu, India. Observation on insect pest and natural enemy population was made at regular interval and the insect specimens collected from foxtail amaranthus and spinach fields were identified in the biosystematics unit of Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore.

Efficacy of broad spectrum insecticide, dimethoate 30EC was studied under field condition. Pre-count of insect pest population in foxtail amaranth and spinach was recorded and first spray of dimethoate was applied using knapsack sprayer at the recommended dose of 200g a.i. per ha and double the dose of 400g a.i. ha^{-1} with three replicates. Second spray with same recommended dose was applied 10 days after first spray. The data on insect pest and natural enemy population was recorded per 5 plants at regular intervals. Apart from dissipation study of dimethoate in foxtail amaranth and spinach, efficacy study was carried to find the toxicity of dimethoate against insect pest of foxtail amaranth and spinach. The data collected during the course of study was recorded and mean data on pest population in different treatment were calculated along with standard error value.

3. RESULT AND DISCUSSION

The seasonal incidence of insect pest profile in foxtail amaranth was discussed in the table 1. In foxtail amaranths, the incidence of insect pest was negligible till 10 DAS lie up to 3rd leaf stage. At 5th leaf stage, nearly 6.28% leaf mining and 8.18% leaf damage was recorded with mean predator population of 0.4/ 5 plants was observed. At 8th leaf stage, 5.43% of defoliation, 1.36% of leaf mining followed by mean sting bug (0.20), stem weevil (0.08) and thrips population (0.52) was recorded per five plants. At 10th leaf stage, 11.15% of defoliation, 1.12% leaf mining followed by mean stem weevil (1.50) and thrips population (1.20), predator(1.33) was recorded per five plants.Amaranthus stem weevil, *Hypolixustruncatulus*(Boheman), leaf webber, *Hymenia recurvalis* (Fabricius), leaf caterpillar, *Erectmoceraimpactella* (Walker) and ear-head bug, *Cletus pugnator* (Fabricius) was prevalent in the field. Damage by ash weevil, *Myllocerusundecimpustulatus* (Marshall), Thrips, *Thrips tabaci*Lindeman, grasshopper, *Attractomorphacrenulata* (Fabricius) and leaf miner *Liriomyzatrifoli* (Burgess) were also observed in foxtail amaranth. A constant increase in coccinellid, spiders and rove beetle population was observed in unsprayed area followed by raise in insect pest population in foxtail amaranths.

The perusal of data of seasonal incidence of insect pest profile in spinach was discussed in the table 2. At 3th leaf stage, nearly 9.20% leaf defoliation, 10.34% leaf damage and mean thrips population of 3.48/5 plants with mean predator population of 0.32/ 5 plants was recorded.

Table 1. Seasonal incidence of pest in foxtail amaranthus in first season 2017-18

DAS	No. of leaves*	No of leaves defoliated*	Percent leaf defoliated **	No of leaves mined	Percent leaf mined **	No of leaves webbed 8	No. of stem with galls*	Ear-head bug*	Leaf webber *	Stem weevil*	Thrips*	Predators *	Parasitoids *	Inference
10	2.84± 0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	No pest incidence in 2-3 leaf stage
15	6.36± 0.25	0.52± 0.20	8.18	0.40± 0.09	6.29	0.00	0.00	0.00	0.00	0.00	0.00	0.04± 0.04	0.00	at 5-8 leaf stage leaf miner and defoliator were recorded
20	8.84± 0.26	0.48± 0.17	5.43	0.12± 0.06	1.36	0.00	0.00	0.20± 0.08	0.00	0.08± 0.05	0.52± 0.13	0.24± 0.08	0.00	Increase in coccinellid, spiders and rove beetle population was observed
25	10.76± 0.32	2.14± 0.18	11.15	1.00± 0.00	1.12	0.00	1.00± 0.00	0.00	0.00	1.50± 0.1	1.20± 0.08	1.33± 0.09	0.00	

*Mean number of individuals observed in 5 plants
** Percent leaf defoliated/leaf mined
DAS- Days After Sowing

Table 2. Seasonal incidence of pest in spinach in 2017-18

DAS	No. of leaves *	No of leaves defoliated *	Percent leaf defoliated **	No of leaves mined	Percent leaf mined **	No of leaves webbed 8	No. of stem with galls*	Ear-head bug*	Leaf webber *	Stem weevil*	Thrips *	Predators *	Parasitoids *	Inference
10	2.44± 0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	No pest incidence in 2-3 leaf stage
15	3.48± 0.10	0.32± 0.14	9.20	0.36± 0.10	10.34	0.00	0.00	0.00	0.00	0.00	3.48± 0.07	0.32± 0.04	0.00	at 2.4 leaf stage leaf miner and defoliator were recorded

*Mean number of individuals observed in 5 plants
** Percent leaf defoliated/leaf mined
DAS- Days After Sowing

20	5.8± 0.17	0.64± 0.18	11.03	0.24± 0.09	4.14	0.00	0.00	0.00	0.00	0.00	0.72± 0.12	0.32± 0.09	0.00	Increase in natural enemy population was observed
25	8.2± 0.16	1.38± 0.24	16.10	0.32± 0.08	2.93	0.00	0.00	0.00	0.00	0.00	8.2± 0.12	1.38± 0.11	0.00	

At 5^{th} leaf stage, 11.03% of defoliation, 4.14% of leaf mining followed by mean thrips population (6.72) was recorded per five plants. At 8^{th} leaf stage, 16.10 % of defoliation, 2.93% leaf mining followed by mean thrips population (8.2), predator (1.38) was recorded per five plants.Severe damage by leaf eating caterpillar, *Spodoptera litura*(Fabricius), cut worm, *Agrotisipsilon*(Hufnagel) and Thrips, *Thrips tabaci* Lindeman were recorded in spinach. Leaf webber, *H. recurvalis*, leaf miner, *L. trifoli*, and tortoise beetle, *Aspidomorphaexilis*(Boheman) infestation were alsoobserved feeding on spinach. Simko *et al*. (2014) also reported that *Spodoptera littoralis* was the major pest attacking spinach in Italy while in our study *Spodoptera litura* was recorded as minor pest while *L. trifoli* and *Thrips tabaci* were the predominant one.Mou *et al*. (2008) reported in their study that leafminer, *Liriomyzaspp.*was the major pest of spinach in USA and Kirisik*et al*. (2018) stated that mite *Tyrophagusneiswanderi* was the major pest of spinach under greenhouse condition.

The perusal of results of efficacy study of dimethoate on amaranths leaf webber in foxtail amaranths was given in the table 3. The results revealed that dimethoate was efficient in reducing the infestation of leaf webber population in both X and 2X dose. Before first spray, the pre-mean leaf webber population was 3.1± 0.12 in control and 4.3±0.32 in x dose and 3.5± 0.41 in 2X dose plots.The mean leaf webber population was 4.4± 0.87 in control and 1.2± 0.03 in X dose and 0.0± 0.0 in 2X dose of dimethoate after 1 DAT. Subsequent increase in population was recorded in control from 7.6± 0.92 on 3 DAT to 8.3± 0.45 on 5 DAT. Further incidence of leaf webber population was recorded 10 DAT and second spray was applied with same recommended dose of X and 2X with control. Before secondspray, the pre-mean leaf webber population was 2.6±0.39in control and 1.1± 0.19in x dose and 1.8± 0.22in 2X dose plots.The mean leaf webber population was 3.2± 0.09in control and 0.0± 0.0in both X dose and 2X dose of dimethoate after 1 DAT. Subsequent increase in population was recorded in control from 3.6± 0.18on 3 DAT to 4.0±0.87on 5 DAT, while complete reduction in population was observed in treatments.

Table 3. Efficacy of dimethoate against leaf webber, *Hymenia recurvalis*in foxtail amaranthus during 2017-18.

Treatment	Chemical Name	Dose a.i./ha	Pre Treatment count	Mean population after 1^{st} spray*			Pre Treatment count	Mean population after 2^{st} spray*		
				1 DAT	3 DAT	5 DAT		1 DAT	3 DAT	5 DAT
T1	Control	-	3.1± 0.12	4.4± 0.87	7.6 0.92	8.3± 0.45	2.6± 0.39	3.2± 0.09	3.6± 0.18	4.0± 0.87

T2	Dimethoate X dose	200	4.3±0.32	1.2± 0.03	0.0± 0.0	0.0± 0.0	1.1± 0.19	0.0± 0.0	0.0± 0.0	0.0± 0.0
T3	Dimethoate 2X dose	400	3.5± 0.41	0.0± 0.0	0.0± 0.0	0.0± 0.0	1.8± 0.22	0.0± 0.0	0.0± 0.0	0.0± 0.0

*Mean number of leafwebbers observed in 5 plants
DAT- Days After Treatment

The perusal of results of efficacy study of dimethoate on thrips in foxtail amaranths was given in the table 4. The results revealed that dimethoate was efficient in reducing the infestation of thrips population in both Xand 2X dose. The Before first spray, the pre-mean thrips population was 5.4±0.82in control and 4.8± 0.74in X dose and 6.1±1.02 in 2X dose plots.The mean thrips population was 4.2±1.12in control and 2.6± 0.93in X dose and 1.3± 0.09in 2X dose of dimethoate after 1 DAT. Subsequent increase in thrips population was recorded in control from 8.5±1.24on 3 DAT to 11.3±2.28on 5 DAT. Further incidence of thrips population was recorded 10 DAT and second spray was applied with same recommended dose of X and 2X with control. Before second spray, the pre-mean thrips population was 8.8±1.24in control and 4.4±0.92in x dose and 4.9±0.86in 2X dose plots.The mean thrips population was 12.3±2.34in control and 2.5± 0.92in both X dose and 0.0 ± 0.0in 2X dose of dimethoate after 1 DAT. Subsequent increase in population was recorded in control from 15.7±3.49on 3 DAT to 19.8±3.14on 5 DAT, while complete reduction in thrips population was observed in treatments.

Table 4. Efficacy of dimethoate against thripsin foxtail amaranthsduring 2017-18.

Treatment	Chemical Name	Dose a.i./ha	Pre Treatment count	Mean population after 1st spray*			Pre Treatmen tcount	Mean population after 2nd spray*		
				1 DAT	3 DAT	5 DAT		1 DAT	3 DAT	5 DAT
T1	Control	-	5.4± 0.82	4.2± 1.12	8.5± 1.24	11.3± 2.28	8.8± 1.24	12.3± 2.34	15.7± 3.49	19.8± 3.14
T2	Dimethoate X dose	200	4.8± 0.74	2.6± 0.93	0.0 ± 0.0	0.0 ± 0.0	4.4± 0.92	2.5± 0.92	0.0 ± 0.0	0.0 ± 0.0
T3	Dimethoate 2X dose	400	6.1± 1.02	1.3± 0.09	0.0 ± 0.0	0.0 ± 0.0	4.9± 0.86	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0

*Mean number of thrips observed in three leafs per plant
DAT- Days After Treatment

The perusal of results of efficacy study of dimethoate on thrips in spinach was given in the table 5. The results revealed that dimethoate was efficient in reducing the infestation of thrips population in both X and 2X dose. The Before first spray, the pre-mean thrips population was 6.6± 0.17in control and 5.4± 0.41in X dose and 7.9± 0.57in 2X dose plots.The mean thrips population was 8.5± 0.34 in control and 2.3±0.09in X dose and 1.7±0.17in 2X dose of dimethoate after 1 DAT. Subsequent increase in thrips population was recorded in control from 24.1± 3.14on 3 DAT to 27.4± 5.67 on 5 DAT. Further incidence of thrips population was recorded 10 DAT and second spray was applied with same recommended dose of X and 2X with control.

Table 5. Efficacy of dimethoate against thripsin spinachduring 2017-18.

Treatment	Chemical Name	Dose a.i./ha	Pre Treatmen tcount	Mean population after 1st spray*			Pre Treatmen tcount	Mean population after 2st spray*		
				1 DAT	3 DAT	5 DAT		1 DAT	3 DAT	5 DAT
T1	Control	-	6.6± 0.17	8.5± 0.34	24.1± 3.14	27.4± 5.67	9.6± 2.34	13.2± 3.10	17.1± 2.12	22.5± 3.37
T2	Dimethoate X dose	200	5.4± 0.41	2.3± 0.09	0.0 ± 0.0	0.0 ± 0.0	6.0± 1.78	2.4± 0.14	0.0 ± 0.0	0.0 ± 0.0
T3	Dimethoate 2X dose	400	7.9± 0.57	1.7± 0.17	0.0 ± 0.0	0.0 ± 0.0	5.3± 1.90	1.3± 0.10	0.0 ± 0.0	0.0 ± 0.0

*Mean number of thrips observed in three leafs per plant
DAT- Days After Treatment

Before second spray, the pre-mean thrips population was 9.6±2.34in control and 6.0± 1.78in x dose and 5.3± 1.90in 2X dose plots.The mean thrips population was 13.2± 3.10in control and 2.4± 0.14in both X dose and 1.3± 0.10 in 2X dose of dimethoate after 1 DAT. Subsequent increase in population was recorded in control from 17.1± 2.12on 3 DAT to 22.5± 3.37on 5 DAT, while complete reduction in thrips population was observed in treatments.Kachot*et al*. (2021) also reported in their study that dimethoate in combination withfo*Beauveria bassiana* 1.15% WP resulted in 95% reduction in thrips population in onion, at 5 DAT.

4. CONCLUSION

The efficacy study of dimethoate against sucking and defoliator infesting foxtail amaranths and spinach revealed that the both the recommended and double the recommended dose were effective in controlling the incidence level. This part of work was the continuation of the previous study Gopalakrishnan *et al*. (2018) on dissipation pattern of dimethoate in foxtail amaranths and spinach and during the course of study the efficacy of dimethoate on different sucking and defoliator pest were evaluated and they were found effective. Based on our study we conclude that the incidence of sucking and defoliator pest were controlled at the recommended dose of 200g a.i ha^{-1} and the dissipation pattern data (Gopalakrishnan *et al*., 2018) showed that the safe waiting period of dimethoate was 3.99 day in foxtail amaranths and 7.02 day in spinach. Hence, pest management in leafy vegetables needs integration of biological and chemical control measures to curb the off-target effect and pesticide residues in food stuffs.

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