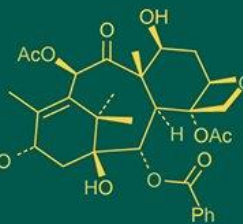
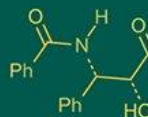


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
 ISSN Online: 2617-4707
 NAAS Rating (2026): 5.29
 IJABR 2026; 10(6): 1191-1196
www.biochemjournal.com
 Received: 10-03-2026
 Accepted: 13-04-2026

GP Shetty
 Multiplex Group of Companies,
 Bengaluru, Karnataka, India

A Meghana
 Multiplex Group of Companies,
 Bengaluru, Karnataka, India

Mahesh G Shetty
 Multiplex Group of Companies,
 Bengaluru, Karnataka, India

HG Niranjana
 Multiplex Group of Companies,
 Bengaluru, Karnataka, India

Bio-efficacy and phytotoxic evaluation of multiplex Dummar against major sucking pests of chilli (*Capsicum annuum* L.)

GP Shetty, A Meghana, Mahesh G Shetty and HG Niranjana

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i6o.8867>

Abstract

A field experiment was conducted during Rabi 2024 to evaluate the bio-efficacy and phytotoxic effect of Multiplex Dummar 20% EC (Avermectin + Spinosad) against major sucking pests of chilli. The experiment was laid out in a Randomized Block Design with seven treatments and three replications. Multiplex Dummar @ 3000 ml/ha recorded the lowest populations of aphids, thrips, and yellow mites with 76.65%, 86.38%, and 86.59% reduction over control, respectively. The highest yield (18.65 q/ha) was recorded in the 3000 ml/ha treatment compared to the untreated control (11.54 q/ha). No phytotoxic symptoms were observed. The study confirms that Multiplex Dummar is an effective and eco-compatible option for managing sucking pests in chilli under IPM programmes.

Keywords: Chilli, Avermectin, Spinosad, bio-rational insecticide, Thrips, aphids, and yellow mite

Introduction

Chilli (*Capsicum annuum* L.) is one of the most important spices and vegetable crops cultivated worldwide and plays a significant role in the agricultural economy of India. India is the largest producer, consumer, and exporter of chilli, contributing substantially to farmer income and foreign exchange earnings (FAOSTAT, 2023) [4]. Besides its culinary importance due to pungency and colour, chilli is also valued for its nutritional and medicinal properties, particularly capsaicinoids, vitamins A and C, and antioxidant compounds (Bosland and Votava, 2012) [1]. However, despite its economic importance, chilli productivity remains constrained by several biotic stresses, especially insect and mite pests.

Among the major sucking pests, aphids (*Aphis gossypii*), thrips (*Thrips parvispinus*), and yellow mites (*Polyphagotarsonemus latus*) cause severe yield losses in chilli-growing regions. Thrips infestation leads to leaf curling, flower drop, fruit deformation, and acts as a vector of viral diseases, while mites cause downward leaf curling, bronzing, and stunted growth. Aphids not only weaken plants by sap feeding but also transmit viral pathogens and promote sooty mould development through honeydew secretion (Capinera, 2008; Seal *et al.*, 2020) [2, 10]. Under favourable environmental conditions, these pests multiply rapidly, resulting in significant quantitative and qualitative yield losses.

Farmers traditionally rely on repeated applications of synthetic insecticides to manage these pests. In intensive chilli-growing ecosystems, 15-25 chemical sprays per season are common practice. Such indiscriminate use has led to pesticide resistance, resurgence of secondary pests, destruction of natural enemies, environmental contamination, and residue-related export rejections (Desneux *et al.*, 2007) [3]. Therefore, there is an urgent need to identify safer, effective, and environmentally compatible alternatives that can be integrated into Integrated Pest Management (IPM) strategies.

In this context, new-generation bio-rational molecules such as avermectins and spinosyns have gained prominence. Avermectins are macrocyclic lactones derived from the soil actinomycete *Streptomyces avermitilis* and act primarily on glutamate-gated chloride channels, leading to paralysis and death of target pests (Lasota and Dybas, 1991) [6]. Spinosad, a fermentation product of *Saccharopolyspora spinosa*, is a mixture of spinosyn A and D that affects nicotinic acetylcholine receptors and GABA receptors, resulting in rapid excitation of the insect nervous system (Salgado, 1998) [8].

Corresponding Author:
 GP Shetty
 Multiplex Group of Companies,
 Bengaluru, Karnataka, India

These molecules are considered bio-insecticides due to their microbial origin, novel mode of action, reduced mammalian toxicity, and relative safety to beneficial arthropods.

The combination of avermectin and spinosad in a single emulsifiable concentrate formulation represents a promising approach for managing complex pest infestations in chilli. Such combinations may provide broader spectrum control, delay resistance development, and reduce the frequency of chemical applications. However, systematic evaluation of bio-efficacy against major sucking pests and assessment of phytotoxicity under field conditions are essential before recommending such formulations to farmers.

Therefore, the present study was undertaken to evaluate the bio-efficacy and phytotoxic effect of a new combination molecule, Multiplex Dummar 20% EC (Avermectin + Spinosad), against aphids, thrips, and mites in chilli under field conditions during Rabi season. The findings of this study will contribute to the development of sustainable pest management strategies by promoting bio-based molecules as viable alternatives to conventional synthetic insecticides.

Materials and Methods

Experimental Site

The field experiment was conducted during Rabi season 2024 at the Department of Entomology, College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences (KSNUAHS), Shivamogga, Karnataka, India. The experimental site is located in the Southern Transition Zone of Karnataka and is characterized by humid tropical climatic conditions. Meteorological data during the crop growth period were recorded from the university observatory.

Experimental Design and Layout

The experiment was laid out in a Randomized Block Design (RBD) with seven treatments replicated thrice. Each experimental plot measured 25 m² (5 m × 5 m). Standard agronomic practices recommended for chilli cultivation were followed uniformly in all plots except for plant protection measures.

Crop Establishment

Healthy chilli seedlings were transplanted on 15 October 2024 at recommended spacing. The crop was maintained under irrigated conditions throughout the experimental period. All recommended fertilizer doses and intercultural operations were carried out as per university package of practices.

Treatments

The treatments consisted of three doses of the test molecule Multiplex Dummar 20% EC (Avermectin + Spinosad) along with standard chemical checks and an untreated control.

Treatment details:

- T₁-Multiplex Dummar @ 1500 ml/ha (3 ml/L)
- T₂-Multiplex Dummar @ 2500 ml/ha (5 ml/L)
- T₃-Multiplex Dummar @ 3000 ml/ha (6 ml/L)
- T₄-Difenthiuron @ 375 ml/ha
- T₅-Imidacloprid 200 SL @ 250 ml/ha
- T₆-Chlorfenapyr 24% SC @ 1000 ml/ha
- T₇-Untreated control

Methods of Application

The insecticidal treatments were applied as foliar sprays using a knapsack sprayer fitted with a hollow cone nozzle. A spray volume of 500 L of water per hectare was used to ensure uniform coverage.

Two sprays were imposed

- **First spray:** 30 October 2024
- **Second spray:** 15 November 2024

The interval between sprays was 15 days.

Observations Recorded

1. Pest Population

Observations were recorded on the following target pests

- Aphids (*Aphis gossypii*)
- Thrips (*Thrips parvispinus*)
- Yellow mites (*Polyphagotarsonemus latus*)

From each plot, five plants were randomly selected. On each plant, observations were taken from four leaves each from the top, middle, and bottom canopy, constituting 20 leaves per treatment per replication.

Observations were recorded at

- One day before spraying (DBS)
- 5 days after spray (5 DAS)
- 10 days after spray (10 DAS)

Aphids and thrips were counted as number per leaf, while mites were counted per cm² leaf area using appropriate magnification methods.

2. Phytotoxicity Assessment

Phytotoxicity observations were recorded at 0, 3, 5, and 10 days after spraying as per standard phytotoxicity evaluation protocols. The following symptoms were observed:

- Wilting
- Vein clearing
- Necrosis
- Epinasty
- Hyponasty
- Chlorosis
- Scorching

Visual scoring was carried out and recorded for each treatment.

3. Yield

Harvesting was done at maturity. Yield from each plot was recorded and converted into quintals per hectare (q/ha).

Statistical Analysis

The data on pest population were subjected to appropriate statistical analysis. The count data were transformed ($\sqrt{x} + 0.5$ transformation) before analysis to normalise variance. The treatment means were compared using Analysis of Variance (ANOVA), which is appropriate for a Randomised Block Design. The significance of treatment differences was tested at the 5% probability level ($p = 0.05$). Standard error of mean ($SEm \pm$), Critical Difference (CD), and Coefficient of Variation (CV%) were calculated

Results and Discussion

The bio-efficacy of Multiplex Dummar against major sucking pests of chilli was evaluated under field conditions, and the results clearly demonstrated significant suppression of aphids, thrips, and yellow mites compared to the untreated control. All insecticidal treatments significantly reduced pest populations, but the magnitude of reduction varied depending on the treatment and dosage.

Among the treatments, Multiplex Dummar @ 3000 ml/ha (T_3) recorded the lowest aphid population with a mean of 3.65 aphids per leaf after the second spray, resulting in the highest reduction over control (76.65%). This treatment was statistically superior to most of the treatments and was closely followed by Multiplex Dummar @ 2500 ml/ha (T_2), which recorded a mean aphid population of 3.86 aphids per leaf with 75.31% reduction over control. The standard check Difenthiuron @ 375 ml/ha (T_4) recorded a mean aphid population of 4.40 aphids per leaf with 71.88% reduction, while Chlorfenapyr 24% SC @ 1000 ml/ha (T_6) and Imidacloprid 200 SL @ 250 ml/ha (T_5) recorded mean populations of 4.76 and 4.90 aphids per leaf, respectively. The untreated control recorded the highest aphid population (15.63 aphids per leaf). The reduction of aphid population in the present study can be attributed mainly to the avermectin component of Multiplex Dummar. Avermectins act by stimulating glutamate-gated chloride channels in invertebrates, leading to neuromuscular paralysis and death of the insect (Lasota and Dybas, 1991) [6]. Due to their translaminar movement and stomach toxicity, they are particularly effective against sap-feeding insects such as aphids. Similar observations were reported by Zanwar *et al.* (2016) [12], who observed significant suppression of sucking pests in chilli with avermectin-based insecticides. Spinosad may also contribute to aphid suppression through its action on nicotinic acetylcholine receptors and GABA receptor sites, causing rapid excitation of the insect nervous system (Salgado, 1998) [8].

A similar trend was observed in the management of thrips. All treatments significantly reduced the population of thrips compared to the untreated control. Multiplex Dummar @ 3000 ml/ha (T_3) recorded the lowest thrips population (1.93 thrips per leaf) with the highest reduction over control (86.38%), followed by Multiplex Dummar @ 2500 ml/ha (T_2), which recorded 2.10 thrips per leaf with 85.21% reduction. The standard insecticide Difenthiuron @ 375 ml/ha (T_4) recorded a mean population of 3.07 thrips per leaf with 78.40% reduction, whereas Chlorfenapyr 24% SC @ 1000 ml/ha (T_6) and Imidacloprid 200 SL @ 250 ml/ha (T_5) recorded 3.33 and 3.70 thrips per leaf, respectively. The untreated control recorded the highest population (14.20 thrips per leaf). The strong suppression of thrips observed in the present investigation is supported by earlier studies on both avermectin and spinosad. Spinosad has been widely reported as highly effective against chilli thrips, and Seal *et al.* (2023) [9] documented significant reduction of thrips populations under field conditions following spinosad application. The mode of action of spinosad involves disruption of nicotinic acetylcholine receptors, resulting in paralysis and mortality of the insect (Salgado, 1998) [8]. Similarly, avermectins such as abamectin have shown strong efficacy against thrips species. Suresh *et al.* (2017) [11] reported effective suppression of *Scirtothrips dorsalis* in capsicum with abamectin treatments, while Lahiri (2023) [5] confirmed significant control of chilli thrips under field conditions. Earlier, Ryckewaert (1988) [7] also reported effective management of *Thrips palmi* in vegetable crops

using avermectin-based insecticides. These studies suggest that the combination of avermectin and spinosad in Multiplex Dummar provides complementary action and enhanced control of thrips.

The bio-efficacy of Multiplex Dummar was also evident in the management of yellow mites (*Polyphagotarsonemus latus*). All treatments significantly reduced mite populations compared to the untreated control. Multiplex Dummar @ 3000 ml/ha (T_3) recorded the lowest mite population (1.90 mites/cm²) with 86.59% reduction over control, followed by Multiplex Dummar @ 2500 ml/ha (T_2), which recorded 2.07 mites/cm² with 85.42% reduction. The standard insecticide Imidacloprid 200 SL @ 250 ml/ha (T_5) recorded 2.87 mites/cm², followed by Difenthiuron @ 375 ml/ha (T_4) with 3.43 mites/cm². Chlorfenapyr 24% SC @ 1000 ml/ha (T_6) recorded 3.63 mites/cm², whereas the untreated control recorded the highest mite population (14.17 mites/cm²). The superior performance of Multiplex Dummar against yellow mites may be attributed to the well-known acaricidal properties of avermectins. Abamectin and related compounds are widely used for mite control in vegetable crops due to their high potency and selective toxicity (Lasota and Dybas, 1991) [6]. Field studies have demonstrated effective suppression of mite populations in chilli and other vegetable crops with avermectin treatments (Suresh *et al.*, 2017) [11]. Spinosad has also shown some activity against certain mite species, and Seal *et al.* (2023) [9] reported reduced pest incidence in chilli production systems treated with spinosad-based formulations. The combination of avermectin and spinosad in Multiplex Dummar may therefore enhance mite suppression through complementary modes of action.

Phytotoxicity observations revealed that no symptoms such as wilting, vein clearing, necrosis, epinasty, hyponasty, chlorosis, or scorching were observed in any of the treatments throughout the observation period, indicating that Multiplex Dummar is safe for chilli plants at the tested concentrations. Similar crop safety of spinosad-based formulations has been reported in chilli and capsicum production systems (Seal *et al.*, 2023) [9]. The microbial origin and selective toxicity of avermectin and spinosad make them comparatively safer alternatives to conventional broad-spectrum insecticides.

Significant differences in yield were also observed among the treatments. The highest yield (18.65 q/ha) was recorded in Multiplex Dummar @ 3000 ml/ha (T_3), followed by Multiplex Dummar @ 2500 ml/ha (17.20 q/ha). Moderate yields were recorded in Difenthiuron (16.05 q/ha) and Chlorfenapyr (15.60 q/ha) treatments, while lower yield was observed in Imidacloprid-treated plots (14.25 q/ha). The untreated control recorded the lowest yield (11.54 q/ha). The increase in yield in Multiplex Dummar treatments can be attributed to effective suppression of sucking pests such as aphids, thrips, and mites. Severe infestation of thrips and mites is known to cause leaf curling, flower drop, reduced photosynthesis, and yield loss in chilli (Capinera, 2008) [2]. Effective pest management improves plant vigour, enhances fruit set, and increases marketable yield. Similar yield benefits from bio-rational insecticides have been reported in chilli by Zanwar *et al.* (2016) [12].

Overall, the results of the present study clearly indicate that Multiplex Dummar (Avermectin + Spinosad) provides effective and broad-spectrum control of major sucking pests in chilli and can serve as a promising option in integrated pest management programmes.

Table 1: Bio efficacy of Multiplex Dummar against Aphids (*Aphis gossypii*) in Chilli

Treatments	Number of Aphids per leaf #						Percent reduction over control
	First spray			Second spray			
	DBS	5 DAS	10 DAS	5 DAS	10 DAS	Mean	
T ₁ -Multiplex Dummar @ 1500ml/ha	9.55	7.17	5.96	6.03	4.88	5.46 ^c	65.08
	(3.10)	(2.76)	(2.52)	(2.55)	(2.32)	(2.44)	
T ₂ -Multiplex Dummar @ 2500 ml/ha	8.53	5.23	4.25	4.53	3.18	3.86 ^b	75.31
	(2.89)	(2.38)	(2.17)	(2.21)	(1.89)	(2.07)	
T ₃ -Multiplex Dummar @ 3000 ml/ha	8.65	5.06	4.10	4.25	3.05	3.65 ^a	76.65
	(2.98)	(2.35)	(2.12)	(2.16)	(1.86)	(2.03)	
T ₄ -Difenthruron @ 375 ml/ha	9.35	6.01	4.85	5.08	3.71	4.40 ^b	71.88
	(3.08)	(2.55)	(2.30)	(2.32)	(2.03)	(2.19)	
T ₅ -Imidachloprid 200 SL @ 250 ml/ha	8.96	7.08	5.42	5.53	4.27	4.90 ^c	68.67
	(3.01)	(2.75)	(2.41)	(2.45)	(2.17)	(2.32)	
T ₆ -Chlorfenapyr 24% SC @ 1000 ml/ha	9.24	6.43	5.13	5.33	4.18	4.76 ^b	69.56
	(3.04)	(2.63)	(2.35)	(2.40)	(2.13)	(2.29)	
T ₇ -Control	9.15	11.43	13.07	15.01	16.25	15.63 ^d	
	(3.04)	(3.45)	(3.66)	(3.94)	(4.09)	(4.01)	
F	NS	*	*	*	*	*	
SEm±	0.39	0.15	0.24	0.20	0.17	0.14	
CD (p = 0.05)	1.20	0.47	0.74	0.62	0.53	0.43	
CV%	22.33	9.84	16.69	13.45	12.69	9.64	

Figures in the parentheses are $\sqrt{x+0.5}$ transformed values, DAS-days after spraying, *Significant @ 5%, # Number of Aphids(All the developmental stage) were counted on four top, middle and bottom portion of the plant in each replication. A total of 5 plants were selected in each replication thus constituting 20 leaves per treatment

Table 2: Bioefficacy of Multiplex Dummar against Thrips (*Thrips parvispinus*) in Chilli during Rabi-2024

Treatments	Number of Thrips per leaf #						Percent reduction over control
	First spray			Second spray			
	DBS	5 DAS	10 DAS	5 DAS	10 DAS	Mean	
T ₁ -Multiplex Dummar @ 1500ml/ha	6.73	6.13	3.93	4.07	4.00	4.03 ^{cd}	71.60
	(2.59)	(2.57)	(2.09)	(2.10)	(2.12)	(2.12)	
T ₂ -Multiplex Dummar @ 2500 ml/ha	6.07	4.40	2.13	2.40	1.80	2.10 ^b	85.21
	(2.49)	(2.20)	(1.59)	(1.68)	(1.50)	(1.60)	
T ₃ -Multiplex Dummar @ 3000 ml/ha	5.93	4.13	2.07	2.20	1.67	1.93 ^a	86.38
	(2.49)	(2.15)	(1.57)	(1.64)	(1.39)	(1.55)	
T ₄ -Difenthruron @ 375 ml/ha	6.27	5.07	3.00	3.27	2.87	3.07 ^b	78.40
	(2.55)	(2.34)	(1.86)	(1.91)	(1.75)	(1.87)	
T ₅ -Imidachloprid 200 SL @ 250 ml/ha	6.13	5.13	3.53	3.73	3.67	3.70 ^c	73.94
	(2.51)	(2.35)	(1.97)	(2.00)	(1.96)	(2.05)	
T ₆ -Chlorfenapyr 24% SC @ 1000 ml/ha	6.27	5.33	3.20	3.40	3.27	3.33 ^{bc}	76.53
	(2.55)	(2.40)	(1.89)	(1.93)	(1.93)	(1.96)	
T ₇ -Control	6.53	9.47	11.53	13.47	14.93	14.20 ^e	
	(2.59)	(3.13)	(3.47)	(3.72)	(3.92)	(3.83)	
F	NS	*	*	*	*	*	
SEm±	0.35	0.20	0.19	0.26	0.27	0.15	
CD (p = 0.05)	1.08	0.60	0.59	0.79	0.82	0.45	
CV%	23.84	13.80	16.16	20.82	22.84	11.77	

Figures in the parentheses are $\sqrt{x+0.5}$ transformed values, DAS-days after spraying, *Significant @ 5%, # Number of thrips (adult stage) were counted on four top, middle and bottom portion of the plant in each replication. A total of 5 plants were selected in each replication thus constituting 20 leaves per treatment

Table 3: Bioefficacy of Multiplex Dummar against Mites (*Polyphagotarsonemus latus*) in Cucumber during Rabi-2024

Treatments	Number of Mites per cm ² #						Percent reduction over control	Yield (q/ha)
	First spray			Second spray				
	DBS	5 DAS	10 DAS	5 DAS	10 DAS	Mean		
T ₁ -Multiplex Dummar @ 1500ml/ha	5.40 (2.37)	5.17 (2.38)	4.23 (2.17)	4.53 (2.23)	3.87 (2.08)	4.20 ^{cd} (2.16)	70.35	13.60
T ₂ -Multiplex Dummar @ 2500 ml/ha	5.67 (2.42)	3.70 (2.03)	2.20 (1.63)	2.40 (1.70)	1.73 (1.47)	2.07 ^b (1.60)	85.42	17.20
T ₃ -Multiplex Dummar @ 3000 ml/ha	5.40 (2.31)	3.43 (1.98)	2.00 (1.57)	2.20 (1.64)	1.60 (1.44)	1.90 ^a (1.55)	86.59	18.65
T ₄ -Difenthiuron @ 375 ml/ha	5.73 (2.44)	4.47 (2.23)	3.73 (2.02)	3.87 (2.07)	3.00 (1.78)	3.43 ^{bc} (1.97)	75.77	16.05
T ₅ -Imidachloprid 200 SL @ 250 ml/ha	5.53 (2.44)	4.03 (2.12)	3.13 (1.90)	3.20 (1.92)	2.53 (1.69)	2.87 ^b (1.82)	79.77	14.25
T ₆ -Chlorfenapyr 24% SC @ 1000 ml/ha	5.80 (2.42)	4.80 (2.30)	3.93 (2.10)	4.07 (2.09)	3.20 (1.89)	3.63 ^c (2.02)	74.36	15.60
T ₇ -Control	5.70 (2.47)	7.37 (2.8)	10.53 (3.32)	13.33 (3.70)	15.00 (3.93)	14.17 ^e (3.83)		11.54
F	NS	*	*	*	*	*		*
SEm±	0.34	0.13	0.14	0.20	0.23	0.13		0.20
CD (p = 0.05)	1.06	0.41	0.42	0.62	0.72	0.39		0.63
CV%	24.66	10.15	11.24	15.78	19.91	10.21		8.91

Figures in the parentheses are $\sqrt{x + 0.5}$ transformed values, DAS-days after spraying, *Significant @ 5%, # Number of mites (all stages) were counted on four top, middle and bottom portion of the plant in each replication. A total of 5 plants were selected in each replication thus constituting 20 leaves per treatment

Table 4: Phytotoxic effect of Multiplex Dummar in Chilli during Rabi 2024

Treatments	Observations recorded						
	Phytotoxicity Symptoms						
	Wilting	Vein clearing	Necrosis	Epinasty	Hyponasty	Chlorosis	Scorching
T ₁ -Multiplex Dummar @ 500 ml/ha	0*	0	0	0	0	0	0
T ₂ -Multiplex Dummar @ 1000 ml/ha	0	0	0	0	0	0	0
T ₃ -Control	0	0	0	0	0	0	0

*No Phytotoxicity observed (Data presented is the mean of three replications at 0, 3, 5 & 10 days after each spray)

Conclusion

The present field investigation conclusively demonstrated that Multiplex Dummar 20% EC (Avermectin + Spinosad) is highly effective in managing major sucking pests of chilli, namely aphids (*Aphis gossypii*), thrips (*Thrips parvispinus*), and yellow mites (*Polyphagotarsonemus latus*). Among the tested doses, application at 3000 ml/ha consistently recorded the lowest pest population, highest percent reduction over control, and maximum yield, followed closely by the 2500 ml/ha dose. The formulation exhibited a clear dose-dependent response and provided broad-spectrum pest suppression under field conditions. The combined presence of two bio-rational molecules with distinct modes of action—avermectin acting on glutamate-gated chloride channels and spinosad targeting nicotinic acetylcholine receptors—likely contributed to enhanced pest mortality and improved field performance. Importantly, no phytotoxic symptoms were observed at the tested concentrations, confirming the crop safety of the formulation. Effective suppression of sucking pests resulted in improved plant vigour, reduced leaf curling and flower drop, and ultimately higher marketable yield. Considering the increasing issues of pesticide resistance, environmental contamination, and residue concerns in chilli production systems, the use of bio-rational molecules such as avermectin and spinosad represents a sustainable alternative to conventional broad-spectrum insecticides. The study supports the inclusion of Multiplex Dummar as a valuable component of Integrated Pest Management (IPM) strategies in chilli cultivation.

Acknowledgement

The authors express their sincere gratitude to the Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences (UAHS), Shivamogga, for providing the necessary facilities, infrastructure, and field support to conduct the present investigation. We are especially thankful to Dr C. M. Kalleshwaraswamy, Professor, Department of Entomology, College of Agriculture, Navule, Shivamogga, for planning, executing, and supervising the field trial. His technical guidance, scientific expertise, and continuous support were instrumental in the successful completion of this study. We also acknowledge the support extended by the Department of Entomology staff for their assistance in field observations and data collection.

References

1. Bosland PW, Votava EJ. Peppers: Vegetable and Spice *Capsicums*. 2nd ed. Wallingford (UK): CABI Publishing; 2012.

2. Capinera JL. Encyclopedia of Entomology. 2nd ed. Dordrecht (The Netherlands): Springer; 2008.

3. Desneux N, Decourtye A, Delpuech JM. The sublethal effects of pesticides on beneficial arthropods. *Annu Rev Entomol*. 2007;52:81-106.

4. FAOSTAT. FAOSTAT Statistical Database. Rome (Italy): Food and Agriculture Organization of the United Nations; 2023. Available from: www.fao.org/faostat/. Accessed 2026 Mar 3.

5. Lahiri S. Field evaluation of selected insecticides against chilli thrips, *Scirtothrips dorsalis* Hood under protected cultivation. J Entomol Res. 2023;47(2):345-350.
6. Lasota JA, Dybas RA. Avermectins: A novel class of compounds: Implications for use in arthropod pest control. Annu Rev Entomol. 1991;36:91-117.
7. Ryckewaert P. Field evaluation of avermectin for control of *Thrips palmi* Karny in vegetable crops. Crop Prot. 1988;7(6):373-377.
8. Salgado VL. Studies on the mode of action of spinosad: Insect symptoms and physiological correlates. Pestic Biochem Physiol. 1998;60(2):91-102.
9. Seal DR, Kumar V, Kakkar G. Management of chilli thrips, *Thrips parvispinus*, using spinosad and other bio-rational insecticides under field conditions. J Integr Pest Manag. 2023;14(1):1-9.
10. Seal DR, Kumar V, Kakkar G, Shinde R. Biology and management of chilli thrips, *Thrips parvispinus* (Thysanoptera: Thripidae). J Integr Pest Manag. 2020;11(1):1-8.
11. Suresh M, Samiyappan R, Chinniah C. Bio-efficacy of newer insecticides against chilli thrips, *Scirtothrips dorsalis*, in capsicum. Pest Manag Horticult Ecosyst. 2017;23(1):15-20.
12. Zanwar PR, Bhede BV, Chavan AP. Evaluation of bio-rational insecticides against sucking pests of chilli. Int J Plant Prot. 2016;9(2):560-565.