Plant Archives Vol. 26, Supplement 2, 2026 pp. 2235-2241 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-2.280

FIELD EVALUATION OF NEWER INSECTICIDES AND BOTANICALS FOR MANAGEMENT OF FRUIT FLY, *Zeugodacus cucurbitae* LUCAS ON BOTTLE GOURD IN SEMI-ARID REGION OF RAJASTHAN

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(Date of Receiving : 14-04-2026; Date of Revision : 27-05-2026; Date of Acceptance : 25-06-2026)

ABSTRACT

The study assessed various treatments for fruit fly infestation, with fruit damage ranged from 7.80% to 29.78% on a number basis and 6.78% to 27.75% on a weight basis. Spinosad 45 SC was the most effective, achieving 7.80% infestation and 73.81% reduction over control on a number basis and 6.78% infestation with a 75.29% reduction on a weight basis. Cyantraniliprole 10.26% OD and flubendiamide 39.35% SC were also highly effective, with infestations of 8.44% and 8.20% and reductions of 71.66% and 70.34%, respectively, on a number and weight basis. Emamectin benzoate 5 SG showed 10.97% infestation and 63.16% reduction on a number basis and 8.17% infestation and 70.45% reduction over control on a weight basis. Neem oil 2%, azadirachtin 1500 ppm and NSKE 5% were less effective, with infestations ranging from 16.05% to 19.63% on a number basis and from 14.31% to 18.41% on a weight basis. The control plots had the highest infestations, with 29.78% on a number basis and 27.65% on a weight basis. The highest fruit yield of 333.87 q ha^{-1} was obtained in the Spinosad, followed by cyantraniliprole (331.20 q ha^{-1}), emamectin benzoate (329.60 q ha^{-1}) and flubendiamide (316.80 q ha^{-1}). In contrast, the lowest yield was recorded with NSKE and azadirachtin. Spinosad treatments showed zero avoidable losses, whereas cyantraniliprole and emamectin benzoate incurred minimal losses (2.67 and 4.27 q/ha, respectively). Conversely, flubendiamide, NSKE, and azadirachtin resulted in higher avoidable losses. The highest incremental benefit-cost ratio 1:50.53 was recorded in the emamectin benzoate 5 SG, followed by Spinosad (1:20.90) and flubendiamide (1:17.12).
***Keywords* :** Fruit fly, Spinosad, Bottle gourd.

Introduction

Bottle gourd, *Lagenaria siceraria* (Molina) Standley, is a prominent cucurbitaceous vegetable crop cultivated nearly year-round, constantly in markets. This versatile plant is commonly referred to by various names, including calabash gourd, doodhi, lauki or ghia, birdhouse gourd, trumpet gourd and white flowered gourd (Thakur *et al.*, 2015; Gajera *et al.*, 2017). Nutritionally, bottle gourd is a rich source of vitamin B complex, iron, minerals and a high amount of choline, along with fair amounts of vitamin C (Milind and Satvir, 2011). The fruit is widely used as a vegetable and in preparing sweets and pickles. Additionally, it has numerous medicinal benefits, such as diuretic and cardio-tonic properties, a cooling effect and the ability to control blood sugar levels in diabetic patients. It is also known to aid in relieving constipation, night blindness and cough while helping reduce cholesterol and triglycerides.

In India, bottle gourd is cultivated over an area of 187 thousand hectares with a total production of 3011 thousand metric tonnes (Anonymous, 2018-19). Major bottle gourd-producing states in India include Uttar Pradesh, Rajasthan, Gujarat, Punjab, Bihar, West Bengal, Madhya Pradesh and Maharashtra. Specifically, in Rajasthan, the crop covers 4.98

thousand hectares, producing 25.42 thousand metric tonnes with a productivity rate of 5.10 t/ha (Anonymous, 2021-22). Within Rajasthan, Jaipur district is notable for its 865 hectares of bottle gourd cultivation, resulting in 2026 metric tonnes of production and a productivity rate of 2342 kg/ha (Anonymous, 2021-22).

Insect pests are major limiting factors affecting the quality and quantity of cucurbitaceous crops. Yield losses due to pest's attacks ranged from 20–100%, depending upon cucurbit species and season in different parts of the world (Bhowmik and Saha, 2017; Dhillon *et al*., 2005; Rashid *et al.*, 2014 and Halder and Rai, 2021). Bottle gourd is affected by red pumpkin beetle, *Aulacophora foveicollis* Lucas; melon fruit fly, *Bactrocera cucurbitae* Coquillett; mirid bug, *Nesidiocoris cruentatus* (Ballard); Hadda beetle, *Epilachna dermurili (*Mulsant), Jassid, *Amrasca biguttula biguttula* (Ishida); aphids, *Aphis gossypii* Glower; white fly, *Bemisia tabaci* Gennadius and leaf miner, *Liriomyza trifolii* Burgess (Bhowmik and Saha, 2017; Haldhar and Maheshwari, 2018 and Halder *et al*., 2021).

Among them cucurbits fruit fly (*Zeugodacus cucurbitae*) is considered one of the most destructive pests that causing remarks reduce marketable quality and yield losses of fruits. Fruit flies have polyphagous and cosmopolitan distributions in the world's tropical, sub-tropical and temperate regions. It poses a significant threat at the fruiting stage (Ram *et al.*, 2009). Maggots feed on the internal tissues of the fruit, leading to the premature dropping of fruits, degrading the quality and making them unfit for consumption (Sarkar *et al.*, 2017). The infestation varies from 30-100% in different cucurbitaceous crops (Dhillon *et al.*, 2005). Atwal and Dhaliwal (2005) reported that fruit flies caused 50% of the damage on cucurbits in India and depending on the environmental condition and susceptibility of crop species, the extent of losses varied up to 100 per cent.

In addition to direct yield losses, fruit fly infestation also deteriorates market quality of fruits, reduce consumer acceptance, lowers farmers income and infested fruits become unfit for marketing due to internal feeding by maggots and rapid rotting (Dhillon *et al.*, 2005; Sarkar et al., 2017). The concealed feeding habit of larvae makes management difficult and necessitates timely and effective control measures.

Farmers largely depend on chemical insecticides for quick suppression of fruit fly populations. However, indiscriminate and repeated use of conventional insecticides has resulted in created problems such as development of insecticide resistance, pest resurgence, environmental pollution, harmful residues on edible portion and produce adverse effects on natural enemies and human health (Halder and Rai, 2021; Haldhar and Maheshwari, 2018). In recent years, emphasis has been given to the use of newer insecticide molecules and botanicals which are comparatively safer, target-specific and compatible with integrated pest management programs. Botanicals such as neem-based formulations are eco-friendly and reduce the risk of residue hazards while newer insecticides provide effective control at lower doses (Abrol *et al*., 2019; Sultana *et al*., 2017).

The present investigation was undertaken Field Evaluation of newer Insecticides and Botanicals for Management of Fruit Fly, *Zeugodacus cucurbitae* Lucas on Bottle Gourd in Semi-arid Region of Rajasthan.

Materials and Methods

Experimental site and location

The present investigation was carried out at the Horticulture Farm, SKN College of Agriculture, Jobner, Jaipur, Rajasthan during Kharif season 2023. Geographically, Jobner is located at a longitude of 75° 28' East and a latitude of 26° 06' North, with an elevation of 427 m^2 from mean sea level (MSL) in Jaipur district of Rajasthan. The region is located under Agrro-climate zone III-a (Semi-arid Eastern Plain).

Climate and weather conditions

The climate of region is typically semi-arid, characterized by extreme temperatures during summer and winter, low rainfall and moderate humidity. In cropping season, the maximum temperature can reach as high as 39° C, while in winter, it may fall as low as -1° C. The average annual rainfall varies from 500 mm, mostly from June to September. During the experimentation periods, the minimum and maximum temperatures ranged from 13° C to 22.8° C and 32.4° C to 37°C, respectively. The average relative humidity fluctuates between 26 to 83 per cent. Rainfall is primarily received from the South-West monsoon, from July to mid-September. Evaporation ranges between 3.4 to 5.2 mm, and sunshine hours range from 2.6 to 8.9 mm hours.

Layout and Design

The bottle gourd variety 'Pusa Naveen' was grown on plots size measuring 2.0 × 5.0 m, with row to row distance of 2.5 m and plant to plant distance of 0.5 m. All the agronomic package of practices such as irrigation, fertilization, weeding and other crop management practices were carried out uniformly in all the plots throughout the crop season. The experiment was laid out in a Randomized Block Design (RBD) comprising with eight treatments including an untreated control with three replications. Each plot was separated by a 0.50 m wide irrigation channel and two paths, each 1.0 m wide.

Preparation of Neem Seed Kernel Extract (NSKE)

Neem seed kernel extract was prepared by grinding a known weight of neem seeds into a fine powder. The resulting powder was soaked overnight in a sufficient quantity of water. The described concentration of NSKE (based on the seed weight to volume of water ratio) was obtained by filtering the extract through a fine muslin cloth with repeated washing the next morning. The volume was then adjusted by adding the required quantity of water to get a 5.0 per cent solution.

Application of treatments

Two round spraying of insecticides were applied at attained population at ETL level using knapsack sprayer. All the insecticides and botanicals were applied as foliar sprays using a hand sprayer. The first spray was given on 9th September 2023 (36th SMW), when the fruit fly was building up, and the second spray was applied three weeks later, when the population had rebuilt. The quantity of spray solution was 500 liters of water in each spray application.

Method of observations

The per cent infestation of fruit fly, *Z. cucurbitae* was counted from the fruit formation stage to the last picking stage of the bottle gourd, with assessments based on the number basis and weight basis of marketable size fruits picked. The per cent of infestation was determined using the following formula given by Preetha and Nadarajan (2006).

$$\text{Per cent infestation (Number basis)} = \frac{\text{Total number of infested fruits}}{\text{Total number of picked fruits}} \times 100$$

$$\text{Per cent infestation (Weight basis)} = \frac{\text{Total weight of infested fruits}}{\text{Total weight of picked fruits}} \times 100$$

The marketable yield of bottle gourd after each picking was recorded separately for each treatment. The yields from all pickings were pooled together for each treatment and the total yield was computed on a hectare basis.

Incremental benefit-cost ratio (IBCR)

The economic of different treatments were calculated by consideration the cost of application of different treatments and the prevailing market price of bottle gourd. Incremental benefit-cost ratio was calculated by dividing the net returns of treatments from total expenditure by returns in treatment using the following formula:

$$\text{IBCR} = \frac{\text{Net returns in treatment (Rs/ha)}}{\text{Total expenditure (Rs. /ha)}}$$

Results and Discussion

Fruit fly Infestation-Number basis

The percentage of fruit damage varied from 7.80% to 28.62%. Among the treatments, spinosad 45 SC was found most effective with 7.80 per cent infestation (lowest) and and gave a maximum reduction of 73.81% over control. Following closely, cyantraniliprole 10.26 OD resulted in a 71.66% reduction with an 8.44% fruit fly infestation, while flubendiamide 39.35 SC showed a 9.32% infestation and 68.70% reduction over control. Emamectin benzoate 5 SG showed substantial efficacy, with a 63.16% reduction and a 10.97% infestation. These treatments were statistically comparable in their effectiveness. Emamectin benzoate was found on par with neem oil 2%, azadirachtin 1500 ppm, and NSKE 5%, which exhibited fruit fly infestations of 16.05%, 17.06%, and 19.63%, respectively, and reductions over control 46.10, 42.71.and 34.08%. The highest fruit fly infestation was observed in the control plots (rate of 29.78%), which were not treated with any insecticides.

The superior performance of Spinosad may be attributed to its strong contact and stomach poison action against fruit fly. Rapid larval mortality inside fruits helped in minimizing internal feeding damage. Similar findings have been reported by earlier workers in cucurbits ecosystems.

Fruit fly Infestation-Weight basis

The percentage of fruit damage on a weight basis varied from 6.78% to 27.75%. Spinosad again proved the most effective, with a 75.29% reduction over control and a minimum fruit infestation rate of 6.78% on a weight basis. Flubendiamide resulted in a 7.50% infestation and a 73.87% reduction over control. Cyantraniliprole showed an 8.20% infestation, and emamectin benzoate had an 8.17% infestation rate, both effective treatments. These treatments were statistically on par with each other. The botanical treatments showed moderate reduction in infestation, whereas Neem oil and azadirachtin were less effective, with reductions of 48.25% and 42.39%, respectively, resulting in weight-based infestation rates of fruit flies of 14.31% and 15.93%. NSKE 5% was found to be the least effective, with a 33.43% reduction over control and an 18.41% loss on a weight basis. The unsprayed control plots had the highest mean infestation rate of fruit flies, 27.65% on a weight basis.

Lower fruit damage on weight basis indicates effective protection of marketable produce. Reduced maggot feeding inside fruit maintained fruit quality and minimized post-harvest losses.

Table 1 : Efficacy of newer insecticides and botanicals against fruit flies under field conditions

S. No.	Treatment (s)	Mean infestation of fruit flies (%)			
		Number basis	Reduction over control	Weight basis	Reduction over control
1	Spinosad 45 SC	7.80 (15.73)*	73.81	6.78 (14.52)	75.29
2	Flubendiamide 39.35 SC	9.32 (17.16)	68.70	7.50 (15.28)	73.87
3	Emamectin benzoate 5 SG	10.97 (19.11)	63.16	8.17 (16.28)	70.45
4	Azadirechtin 1500 ppm	17.06 (24.31)	42.71	15.93 (23.50)	42.39
5	Neem oil 2%	16.05 (23.61)	46.10	14.31 (22.22)	48.25
6	NSKE 5%	19.63 (24.91)	34.08	18.41 (24.42)	33.42
7	Cyantraniliprole 10.26% OD	8.44 (16.35)	71.66	8.20 (15.83)	70.34
8	Control (un-treated)	29.78 (33.07)	0.00	27.65 (31.69)	0.00
	S.Em.±	2.35		2.33	
	C.D.	7.13		7.07	

Table 2 : Effect of insecticides and botanicals on fruit yield of bottle gourd

S. No.	Treatments	Formulation	Mean yield (q/ha)
1	Spinosad	45 SC	333.87
2	Flubendiamide	39.35 SC	316.80
3	Emamectin benzoate	5 SG	329.60
4	Azadirachtin	1500 ppm	267.20
5	Neem oil	1%	287.47
6	NSKE	5%	260.27
7	Cyantraniliprole	10.26% OD	331.20
8	Control (un-treated)	--	224.00
	S.Em.±		8.75
	C.D. at 5%		26.54

Effect of newer insecticides and botanicals on fruit yield of bottle gourd under field conditions

The data presented in table2 revealed that the fruit yield of bottle gourd in all treatment plots treated with newer insecticides and botanicals was significantly higher compared to control (224 q ha^{-1}). Among the treatments, the highest fruit yield per hectare was obtained in plots treated with spinosad (333.87 q ha^{-1}), closely followed by cyantraniliprole (331.20 q ha^{-1}), emamectin benzoate (329.60 q ha^{-1}) and flubendiamide (316.80 q ha^{-1}). These treatments were statistically comparable in terms of production.

In contrast, the minimum fruit yield was recorded in the plots treated with NSKE (260.27 q ha^{-1}), followed by azadirachtin (267.20 q ha^{-1}). Both of these treatments were statistically comparable in yield outcomes and azadirachtin treatment was similar to neem oil (287.47 q ha^{-1}). The Azadirachtin, neem oil, and NSKE recorded comparatively lower yields than synthetic insecticides but remained superior to untreated control.

Higher yield in treated plots was mainly due to effective suppression of fruit fly infestation during the fruiting stage. Reduced fruit drop and better fruit retention contributed to higher marketable yield.

Table 3 : Assessment of losses caused by fruit flies on bottle gourd and increase in yield over un-treated control.

S. No.	Treatments	Conc. (%) or dose	Mean yield (q/ha)	Total avoidable loss (q ha^{-1})	Per cent avoidable loss	Total increase in yield over control (q ha^{-1})	Per cent increase in yield over control
1	Spinosad 45 SC	0.014	333.87	0.00	0.00	109.87	49.05
2	Flubendiamide 39.35 SC	0.012	316.80	17.07	5.11	92.80	41.43
3	Emamectin benzoate 5 SG	0.002	329.60	4.27	1.28	105.60	47.14
4	Azadirachtin 1500 ppm	5 ml/lit.	267.20	66.67	19.97	43.20	19.29
5	Neem oil	1.0	287.47	46.40	13.90	63.47	28.33
6	NSKE	5.0	260.27	73.60	22.04	36.27	16.19
7	Cyantraniliprole 10.26% OD	0.018	331.20	2.67	0.80	107.20	47.86
8	Control (un-treated)	-	224.00	109.87	32.91	0.00	0.00

*Average price of bottle gourd Rs. 15/kg

Table 4 : Comparative economics of different treatments

S. No.	Treatments	Conc. (%) or dose	Mean yield (q/ha)	Increased yield over control	Cost of increased yield (Rs ha^{-1})*	Total cost of management (Rs ha^{-1})	Net return (Rs ha^{-1})	IBCR
1	Spinosad 45 SC	0.014	333.87	109.87	164805	7525	157280	1:20.90
2	Flubendiamide 39.35 SC	0.012	316.80	92.80	139200	7684	131516	1:17.12
3	Emamectin benzoate 5 SG	0.002	329.60	105.60	158400	3074	155326	1:50.53
4	Azadirachtin 1500 ppm	5 ml/lit.	267.20	43.20	64800	4554	60246	1:13.23
5	Neem oil	1%	287.47	63.47	95205	10304	84901	1:8.23
6	NSKE	5%	260.27	36.27	54405	7072	47333	1:6.69
7	Cyantraniliprole 10.26% OD	0.018	331.20	107.20	160800	16526	144274	1:8.73
8	Control (unsprayed)	--	224.00	0.00	0	0	0	--

*Average price of bottle gourd Rs. 15/kg

Assessment of losses and increase in yield

The assessment of losses and increase in yield showed notable variations among different treatments (Table 3). Plots treated with spinosad demonstrated zero avoidable losses and per cent avoidable loss, highlighting its effectiveness. Cyantraniliprole and emamectin benzoate followed with total avoidable losses of 2.67 and 4.27 q ha^{-1}, and per cent avoidable losses of 0.80% and 1.28%, respectively. Flubendiamide resulted in an avoidable loss of 17.07 q ha^{-1} (5.11% avoidable loss). In contrast, NSKE (73.60 q ha^{-1} and 22.04% avoidable loss), azadirachtin (66.67 q ha^{-1} and 19.97% avoidable loss) and neem oil (46.40 q ha^{-1} and 13.90% avoidable loss) recorded the highest avoidable losses.

The treatments also varied in terms of yield increase over control. Spinosad achieved the highest per cent increase in yield at 49.05%, resulting in a total yield increase of 109.87 q ha^{-1}. Cyantraniliprole followed closely with a 47.86% increase and 107.20 q ha^{-1} total yield increases, while emamectin benzoate showed a 47.14% increase and 105.60 q ha^{-1} total yield increases. Flubendiamide, neem oil, azadirachtin and NSKE followed in decreasing order of yield increase: 41.43% (92.80 q ha^{-1}), 28.33% (63.47 q ha^{-1}), 19.29% (43.20 q ha^{-1}) and 16.19% (36.27 q ha^{-1}), respectively.

Economic of insecticidal treatments

The economic analysis of insecticidal treatments (Table 4) revealed significant net profits per hectare differences. The highest net profit Rs. 157280 ha^{-1} was obtained with spinosad, followed closely by emamectin benzoate and cyantraniliprole, recorded Rs. 155326 ha^{-1} and Rs. 144274 ha^{-1}, respectively. Conversely, NSKE showed the lowest net profit (Rs. 47333 ha^{-1}), followed by azadirachtin (Rs. 60246 ha^{-1}), neem oil (Rs. 84901 ha^{-1}) and flubendiamide (Rs. 131516 ha^{-1}).

In terms of cost-benefit ratio, emamectin benzoate 5 SG demonstrated the highest ratio at 1:50.53, followed by spinosad 45 SC (1:20.90), flubendiamide 39.35 SC (1:17.12), azadirachtin 1500 ppm (1:13.23), cyantraniliprole 10.26% OD (1:8.73), neem oil 1% (1:8.23) and NSKE 5% (1:6.69).

The study assessed various treatments for fruit fly infestation, with fruit damage ranged from 7.80% to 29.78% on a number basis and 6.78% to 27.75% on a weight basis. Spinosad 45 SC was the most effective, achieving 7.80% infestation and 73.81% reduction over control on a number basis and 6.78% infestation with a 75.29% reduction on a weight basis. Cyantraniliprole 10.26% OD and flubendiamide 39.35% SC were also highly effective, with infestations of 8.44% and 8.20% and reductions of 71.66% and 70.34%, respectively, on a number and weight basis. Emamectin benzoate 5 SG showed 10.97% infestation and 63.16% reduction on a number basis and 8.17% infestation and 70.45% reduction over control on a weight basis. Neem oil 2%, azadirachtin 1500 ppm and NSKE 5% were less effective, with infestations ranging from 16.05% to 19.63% on a number basis and from 14.31% to 18.41% on a weight basis. The control plots had the highest infestations, with 29.78% on a number basis and 27.65% on a weight basis.

The present study aligns with the findings of Hirekurubar *et al.* (2018), who evaluated various botanicals and insecticides for their effectiveness against fruit flies on ridge gourd. Spinosad 45 SC at 0.3 ml/l was the most effective, with the lowest per cent fruit damage (14.27%) and highest fruit yield (22.08 t/ha). NSKE 5% and azadirachtin 1500 ppm at 5 ml/l yielded 16.86 t/ha and 16.95 t/ha, respectively. Abrol *et al.* (2019) evaluated various insecticides, biopesticides and clay to manage fruit flies (*Bactrocera* spp.). Among the biopesticides evaluated, spinosad and azadirachtin effectively reduced fruit infestation (17.38% for spinosad). Sultana *et al.* (2017) reported that neem oil was mostly effective among tested botanicals, with a 21.64% reduction in fruit infestations.

The present study supports the findings of various researchers on the efficacy of spinosad and other treatments against fruit fly infestations in cucurbits. Abhishek *et al.* (2020) reported spinosad 45 SC at 0.3 ml /lit. was the most effective, reducing fruit infestation to 28.62% and larval population (6.53%) at the fruiting stage. Alam *et al.* (2021) found spinosad to have the lowest fruit infestation rates and highest marketable yields among biopesticides tested on bottle gourd. Solanki *et al.* (2022) achieved maximum fruit yield with flubendiamide combined with jaggery, while Srinivas *et al*. (2018) highlighted the superior efficacy of spinosad 45 SC at 0.15 ml/l in reducing fruit fly infestation. Led *et al.* (2020) confirmed spinosad high effectiveness, showing significantly lower mean fruit infestation rates than untreated controls. Spinosad 45% SC, emamectin benzoate 5% SG and chlorantraniliprole 18.5% SC are effective options for managing fruit fly infestations in cucurbit crops.

Effect of insecticides and botanicals on bottle gourd yield

The data showed that a maximum fruit yield of 333.87 q ha^{-1} was obtained in the most effective treatment, spinosad 45 SC, followed closely by cyantraniliprole (331.20 q/ha), emamectin benzoate (329.60 q ha-1) and flubendiamide (316.80 q ha^{-1}). All these treatments were statistically comparable in production. In contrast, the minimum fruit yield was recorded in the plots treated with NSKE (260.27 q ha^{-1}), followed by azadirachtin (267.20 q ha^{-1}). Both of these treatments were statistically comparable in yield outcomes, with azadirachtin treatment yield also similar to neem oil (287.47 q ha^{-1}). The control plots recorded the lowest yield at 224 q ha^{-1}.

Conclusion

The investigations on “Field Evaluation of newer Insecticides and Botanicals for Management of Fruit Fly, *Z. cucurbitae* Lucas on Bottle Gourd in Semi-arid Region of Rajasthan” were conducted at Horticulture Farm, S. K. N. College of Agriculture during Kharif 2023. Spinosad was again the most effective, reducing infestation to 7.80% by number basis and 6.78 by weight basis, followed by Cyantraniliprole and flubendiamide were highly effective, with infestation of 8.44% by number basis and 8.20% by weight basis and 9.32% by number basis and 7.50% by weight basis, respectively. Emamectin benzoate showed a 10.97% infestation by number basis and 8.17% by weight basis.

The maximum fruit yield of 333.87 q ha^{-1} was obtained in the spinosad 45 SC, followed by cyantraniliprole (331.20 q/ha), emamectin benzoate (329.60 q/ha) and flubendiamide (316.80 q/ha). In contrast, the lowest yield was recorded with NSKE and azadirachtin. Spinosad treatments showed zero avoidable losses, whereas cyantraniliprole and emamectin benzoate incurred minimal losses (2.67 and 4.27 q/ha, respectively). Conversely, flubendiamide, NSKE and azadirachtin resulted in higher avoidable losses. Spinosad also demonstrated the highest yield increase over control (49.05%), followed by cyantraniliprole (47.86%) and emamectin benzoate (47.14%). NSKE showed the least increase (16.19%).

The findings of the study will be useful for researches, extension workers and farmers in selecting suitable management practices for fruit fly control. Adoption of these recommendation can enhance productivity and profitability of bottle gourd cultivation.

Acknowledgements

The authors express their sincere gratitude to the Professor and Head, Department of Entomology, and Dean SKN College of Agriculture, Jobner, Jaipur, Rajasthan, for providing essential facilities and support during the course of the investigation.

The author are highly thankful to the major advisor and advisor committee members for valuable guidance, constant encouragement and constructive suggestions throughout the research work.

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