



RESEARCH ARTICLE

Assessment of management practices against major insect-pests in bitter gourd (*Momordica charantia* L.)

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Abstract

One field experiment was conducted for assessment of management practices against major insect pests in bitter gourd (*Momordica charantia* L.) cultivar Palee (F1) during *Kharif*, 2021 at RRTTS, OUAT, Bhubaneswar. Nine treatments comprising of para pheromone traps with cue lure and food baits along with foliar spraying of the insecticides; emamectin benzoate 5SG@220 g ha⁻¹, fipronil 5EC@1000 mL ha⁻¹, cartap hydrochloride 50% SP @1000g ha⁻¹, thiodicarb 75 WP @ 500 g ha⁻¹, abamectin 1.8 SC @300 mL ha⁻¹, spinosad 45 SC @200 mL ha⁻¹, malathion 50% EC @ 1000 mL ha⁻¹ (insecticidal check), neem oil 1500ppm@1500 mL ha⁻¹ and untreated check. The results indicated that, application of food bait @ 20 baits ha⁻¹ (cucumber fruit pulp + 100 mL cow urine + 0.5l water) + para pheromone traps @ 25 ha⁻¹ + foliar spray of spinosad 45 SC @ 200 mL ha⁻¹ thrice at 30, 45 and 60 DAS was most effective with 96.36, 81.94, 85.21, 87.03, 79.89 and 60.65% reduction in population of epilachna beetle, red pumpkin beetle, flea beetle, white fly, jassid and green stink bug, respectively over control. The fruit damage by melon fruit fly was 83.17% lower over control and maximum fruit yield (5.5 t ha⁻¹), monetary benefit (Rs.110973 ha⁻¹) and ICBR (8.20) was recorded. This management practice may be considered for the management of major insect pests in bitter gourd cultivation.

Keywords: Bitter gourd, Pheromone trap, Cue lure, Spinosad.

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Introduction

Bitter gourd (*Momordica charantia* L.) has become a crucial component of the Indian diet due to its rich content of vitamins, minerals, and dietary fiber. It is particularly known for its medicinal properties, making it a valuable resource for individuals with diabetes. India stands out as the leading producer of bitter gourd, contributing to 31% of the global production (Iqbal et al., 2018). Odisha ranks fifth in bitter gourd production, contributing 8.77% (116.95 thousand MT) of the total production in India, with Madhya Pradesh being the leading producer (229.91 thousand MT). However, bitter gourd cultivation faces significant challenges, particularly the infestation of various insect pests and diseases during both the vegetative and reproductive growth stages, exacerbated by high rainfall and humidity. Major insect pests causing damage to bitter gourd include the melon fruit fly (*Bactrocera cucurbitae* Coquillett), the red pumpkin beetle (*Aulacophora foveicollis* Lucas), the epilachna beetle (*Henos epilachna vigintiocto punctata* Fabricius) and white-spotted flea beetle (*Monolepta signata* Olivier). Besides, sucking pests like the whitefly (*Bemisia tabaci* Gennadis) and jassids (*Amrasca biguttula* Ishida) also pose serious threat to the crop. The whitefly, *Bemisia tabaci* (Gennadius) is a devastating pest of vegetables, ornamental plants and

agronomic crops throughout the tropical and subtropical regions of the world (Chandi and Kular 2015; Behera *et al.*, 2023). Similarly, Wazir *et al* 2022 also opined fruit fly as one of the major pest resulting in considerable crop damage in cucurbits.

Indian farmers have traditionally relied on insecticides for pest management due to their ease of use and quick action against target pests. However, it is now imperative to transition to newer insecticides and botanicals in a responsible manner, as the repeated use of conventional insecticides has led to the development of resistance and resurgence among target pests, while also harming beneficial insect populations. Given these challenges, the present study was conducted during the *Kharif*, 2021 to assess the efficacy of eight insecticides, in combination with food baits and pheromone traps, including a neem-based botanical, against the major insect pests of bitter gourd.

Materials and Methods

The field experiment was conducted at the Regional Research and Technology Transfer Station (RRTTS), Coastal zone (CZ), OUAT, Bhubaneswar, Odisha and was situated at an altitude of 20° 26' N and longitude of 85° 80' E with an elevation of 25.9 m (84.97 ft) above mean sea level. The objective of the study was to assess the efficacy of various chemical and bio-intensive methods for the management of major insect pests observed during the course of study, their impact on beneficial insects as well as an assessment of the Incremental Cost Benefit Ratio (ICBR). A hybrid variety of bitter gourd 'PALEE (F₁)' was used for the experiment which is highly vigorous with prolific fruit set. The fruiting starts from 45-55 days after sowing. Nine treatments constituting of Food Bait (FB)+Pheromone Trap (PT)+Foliar spray of emamectin benzoate 5 SG @ 220 g ha⁻¹ (T₁), FB+PT+Foliar spray of fipronil 5 EC @1000 mL ha⁻¹ (T₂), FB+PT+Foliar spray of cartap hydrochloride 50% SP @ 1000g ha⁻¹ (T₃), FB+PT+Foliar spray of thiodicarb 75 WP @ 500 g ha⁻¹ (T₄), FB+PT+Foliar spray of abamectin 1.8 SC @ 300 mL ha⁻¹ (T₅), FB + PT + Foliar spray of spinosad 45 SC @ 200 mL ha⁻¹ (T₆), FB + PT + Foliar spray of malathion 50% EC @1000 mL ha⁻¹ (T₇), FB +PT + Foliar spray of neem oil 1500 ppm @ 1500 mL ha⁻¹ (T₈) including an untreated check (T₉) were included in the study. The insecticides were applied in form of foliar spray thrice at 30, 45 and 60 days after sowing while the cue lure was replaced every fortnight.

Observations regarding population count of epilachna beetle, red pumpkin beetle, flea beetle, whitefly, jassid, southern green stink bug and predatory coccinellid beetles were taken at 1 day before spray (DBS) and 3 days after spray (DAS), 7 DAS and 10 DAS during each spray schedule and the average population of five randomly selected leaves from each plot was calculated to derive their mean population. The infested fruits were separated from healthy fruits during

each harvest and the percentage of fruit fly infested fruits was determined both by number and weight basis. The weight and number of both marketable as well as non-marketable bitter gourd fruits were recorded separately from each treatment plot as well as control plot during the course of eleven harvests. The total fruit yield obtained from each treatment and untreated check plot was calculated in terms of kg ha⁻¹ and was later converted into tons per hectare (t ha⁻¹) and were later economically analyzed in terms of Incremental Cost Benefit Ratio (ICBR). The values of observed data were then statistically analyzed by means of OPSTAT software.

Results and Discussion

The mean population of leaf eating insects *viz.*, epilachna beetles, red pumpkin beetles and flea beetles recorded during 1st spray, 2nd spray and 3rd spray along with the total mean of the three sprays has been illustrated in Table 1. Taking into consideration the total mean of three sprays, in case of epilachna beetle lowest mean population (0.11 and 0.14 beetles per leaf) was recorded in the plots treated with spinosad 45 SC @ 200 mL ha⁻¹ and fipronil 5 EC @ 1000 mL ha⁻¹ respectively and were statistically at par with each other with 96.36 and 95.36% reduction over control. The present finding is corroborating with the findings of Hanif *et al* (2021) who found that treatment with spinosad was the best treatment resulted in 84.1 and 67.4% mortality towards grubs and adult epilachna beetles respectively. This is also in agreement with Birjhu *et al* (2020) who reported the efficacy of spinosad 45% SC against epilachna beetles in spine gourd. According to Jamwal (2011), two sprays of fipronil 5 SC (0.005%) could reduce the epilachna beetle population. In the present experiment Cartap hydrochloride 50% SP @ 1000g ha⁻¹ recorded 0.62 beetles per leaf with 79.47% reduction over control ranked second best treatment followed by the plots treated with emamectin benzoate 5 SG @ 220 g ha⁻¹ which recorded 0.88 beetles per leaf with 70.86% reduction over control. The above treatments were found to be superior to insecticidal check malathion 50%EC @ 1000 mL ha⁻¹ which recorded 1.03 beetles per leaf and 65.89 reduction over control. Thiodicarb 75WP @ 500g ha⁻¹ and abamectin 1.8 SC @ 300 mL ha⁻¹ recorded 1.13 and 1.55 beetles per leaf with 62.58 and 48.67% reduction over control respectively. Among all the treatments, plots treated with neem oil @ 1500 mL ha⁻¹ were found to be least effective on epilachna beetle population and recorded 1.98 beetles per leaf with 34.43% reduction over control. Highest mean epilachna beetle population of 3.02 beetles per leaf was recorded from untreated check and all the treatments were found to be superior to it.

From Table 1, it is observed that lowest mean red pumpkin beetle population was recorded from plots treated with cartap hydrochloride 50%SP @ 1000 g ha⁻¹

Table 1: Effect of management practices on leaf eating beetles

Treatment details	Mean no. of epilachna beetles per leaf					Mean no. of red pumpkin beetles per leaf					Mean no. of flea beetles per leaf				
	1 st spray	2 nd spray	3 rd spray	Mean of three sprays	% Reduction over untreated check	1 st spray	2 nd spray	3 rd spray	Mean of three sprays	% Reduction over untreated check	1 st spray	2 nd spray	3 rd spray	Mean of three sprays	% Reduction over untreated check
T ₁ : FB+PT+emamectin benzoate 5 SG @220g/ha	1.14 (1.46)	0.86 (1.36)	0.64 (1.28)	0.88 (1.37)	70.86	2.46 (1.86)	1.70 (1.64)	1.42 (1.55)	1.86 (1.69)	40.00	1.24 (1.50)	1.13 (1.46)	1.05 (1.43)	1.14 (1.46)	59.86
T ₂ : FB+PT+fipronil 5 EC @1000mL/ha	0.19 (1.09)	0.15 (1.07)	0.08 (1.04)	0.14 (1.07)	95.36	1.44 (1.56)	0.74 (1.32)	0.43 (1.19)	0.87 (1.37)	71.94	1.00 (1.41)	0.72 (1.31)	0.56 (1.25)	0.76 (1.33)	73.24
T ₃ : FB+PT+cartaphydrochloride 50%SP @ 1000g/ha	0.85 (1.36)	0.62 (1.27)	0.39 (1.18)	0.62 (1.27)	79.74	0.80 (1.34)	0.44 (1.20)	0.14 (1.07)	0.46 (1.20)	85.16	0.44 (1.20)	0.24 (1.11)	0.16 (1.08)	0.28 (1.13)	90.14
T ₄ : FB+PT+thiodicarb 75 WP @500g/ha	1.32 (1.52)	1.13 (1.46)	0.95 (1.40)	1.13 (1.46)	62.58	1.52 (1.59)	0.79 (1.34)	0.44 (1.20)	0.92 (1.38)	70.32	1.70 (1.64)	1.69 (1.64)	1.47 (1.57)	1.62 (1.62)	42.96
T ₅ : FB+PT+abamectin 1.8 SC@300mL/ha	1.72 (1.65)	1.66 (1.63)	1.29 (1.51)	1.55 (1.60)	48.67	1.84 (1.68)	1.02 (1.42)	0.77 (1.33)	1.21 (1.49)	60.97	1.70 (1.64)	1.40 (1.55)	1.16 (1.47)	1.42 (1.55)	50.00
T ₆ : FB+PT+spinosad 45 SC @200mL/ha	0.23 (1.11)	0.08 (1.04)	0.02 (1.00)	0.11 (1.05)	96.36	1.02 (1.42)	0.44 (1.20)	0.22 (1.10)	0.56 (1.25)	81.94	0.70 (1.30)	0.30 (1.14)	0.26 (1.12)	0.42 (1.19)	85.21
T ₇ :FB+PT+malathion 50%EC @1000mL/ha	1.27 (1.51)	1.01 (1.42)	0.81 (1.34)	1.03 (1.42)	65.89	2.30 (1.82)	1.25 (1.50)	1.04 (1.43)	1.53 (1.59)	50.64	1.34 (1.53)	1.20 (1.48)	1.06 (1.43)	1.20 (1.48)	57.75
T ₈ : FB+PT+neem oil 1500 ppm @ 1500 mL/ha	2.14 (1.77)	2.10 (1.76)	1.70 (1.64)	1.98 (1.73)	34.43	2.76 (1.94)	2.08 (1.75)	1.61 (1.61)	2.15 (1.77)	30.64	2.10 (1.76)	1.86 (1.69)	1.68 (1.64)	1.88 (1.70)	33.80
T ₉ : Control (Untreated check)	3.09 (2.02)	3.14 (2.03)	2.82 (1.95)	3.02 (2.00)	-	3.20 (2.05)	3.24 (2.05)	3.09 (2.02)	3.10 (2.02)	-	3.08 (2.01)	2.80 (1.95)	2.64 (1.90)	2.84 (1.96)	-
SE(m)±	0.010	0.014	0.018	0.010	-	0.018	0.012	0.018	0.024	-	0.011	0.013	0.018	0.020	-
CD(p=0.05)	0.03	0.04	0.05	0.03	-	0.05	0.04	0.05	0.07	-	0.03	0.04	0.05	0.06	-

*Figures in parentheses are $\sqrt{n+1}$ transformed values
 FB: Food Bait PT- Para Pheromone Trap

followed by spinosad 45 SC @ 200 mL ha⁻¹ with 0.46 and 0.56 beetles per leaf being statistically at par with each other and resulted in 85.16 and 81.94% reduction over untreated check respectively. The results are similar with Latif *et al* (2012) and Mahato (2017) who found that, cartap hydrochloride 50 SP recorded more than 80 and 74.59% reduction in red pumpkin beetle population as compared to control plot in white gourd and cucumber respectively. In the present experiment second best treatment was found to be fipronil 5 EC @ 1000 mL ha⁻¹ followed by thiodicarb 75 WP @ 500 g ha⁻¹ which recorded 0.87 and 0.92 number of red pumpkin beetles per leaf causing 71.94 and 70.32% population reduction over untreated check respectively being statistically at par with each other. Mean population of 1.21 beetles per leaf were recorded from plots treated with abamectin 1.8 SC @ 300 mL ha⁻¹ reducing 60.97% beetle population over untreated check. These treatments were found to be superior to the insecticidal check malathion 50%EC @1000 mL ha⁻¹ which recorded 1.53 beetles per leaf along with 50.64% population reduction over untreated check. Plots treated with emamectin benzoate 5 SG @ 220 g ha⁻¹ and neem oil @1500 mL ha⁻¹ recorded 1.86 and 2.15 beetles per leaf with 40.00 and 30.64% population reduction respectively.

The effect of the treatment modules on flea beetle is presented in Table 1. It was observed that cartap hydrochloride 50% SP @ 1000 g ha⁻¹ recorded lowest mean flea beetle population (0.28 beetles per leaf) followed by spinosad 45 SC @ 200 mL ha⁻¹ (0.42 beetles per leaf) and were statistically at par with each other and caused 90.14 and 85.21% population reduction over untreated check. These findings corroborate with the results obtained by Mahato and Misra (2019) who reported that cartap hydrochloride 50% SP @375ga.i. ha⁻¹ and spinosad 45 SC @ 75 g a.i. h⁻¹ were most potent among all the treatments against flea beetles and recorded 81.02 and 66.67% population reduction respectively during *Kharif*, 2016. The third best treatment was found to be fipronil 5 EC @1000 mL ha⁻¹ with mean population of 0.76 beetles per leaf and 73.24% reduction over untreated check which is similar to the findings of Prema *et al* (2019) observed that treatment with fipronil 80 WG significantly reduced the beetle population to 82.1-86.7%. The results in the present experiment reveals that, the above mentioned treatments were found to be statistically superior to insecticidal check; malathion 50%EC @1000 mL ha⁻¹ which recorded 1.20 beetles per leaf with 57.75% population reduction and are moderately effective against flea beetles. Plots treated with emamectin benzoate 5SG @220 g ha⁻¹ recorded 1.14 beetles per leaf and was found to be statistically at par with malathion. However, plots treated with abamectin 1.8 SC @ 300 mL ha⁻¹, thiodicarb 75 WP @ 500 g ha⁻¹and neem oil @1500 mL ha⁻¹ recorded mean flea beetle population of 1.42, 1.62 and 1.88 beetles

leaf¹ with 50.00, 42.96 and 33.80% respective reduction over untreated check.

Considering the mean of the three sprays, it can be depicted that, plots treated with abamectin 1.8 SC @ 300 mL ha⁻¹ recorded mean population of 0.37 whiteflies per leaf followed by spinosad 45 SC @ 200 mL ha⁻¹ with 0.42 whiteflies per leaf which are statistically at par with each other (Table 2). Both the treatments recorded 88.58 and 87.03% population reduction over untreated check respectively. Similar efficacy of abamectin have been reported by Udhayakumar *et al.* (2020) and Zawrah *et al* (2020) who depicted that abamectin 1.8% EC was found to cause 91.5, 86.63 and 83.54% mortality of adult white fly. The efficacy of Spinosad 45 SC in the present investigation is supported by Kalyan *et al* (2012) opined that the treatment with spinosad 45 SC @ 75 a.i. ha⁻¹ could effectively reduce white fly population in cotton, Wagh *et al* (2017) also revealed that, spinosad 45 SC @ 125 g a.i. ha⁻¹ was most potent against whitefly population and recorded 0.84-2.27 whiteflies per three leaves. The result obtained from the the present study shows that, Fipronil 5 EC @ 1000 mL ha⁻¹ was found to be next best treatment and recorded 0.65 whiteflies per leaf followed by emamectin benzoate 5 SG @ 220 g ha⁻¹ which recorded 0.85 whiteflies per leaf. From both the aforementioned treatments, 79.93 and 73.76% reduction in whitefly population over untreated check was observed. The plots treated with thiodicarb 75 WP @ 500 g ha⁻¹, neem oil @ 1500 mL ha⁻¹ and cartap hydrochloride 50% SP @ 1000 g ha⁻¹ recorded 1.13, 1.39 and 1.72 whiteflies per leaf with 65.12, 57.10 and 46.91% reduction over untreated check respectively. All the above treatments were statistically superior over insecticidal check malathion 50%EC @1000 mL ha⁻¹ where 2.01 whiteflies per leaf with 37.96% reduction over untreated check was recorded.

The data on the mean population of jassids indicates that, treatment with fipronil 5 EC @1000 mL ha⁻¹ recorded lowest mean population of 0.37 jassids per leaf with 89.37% reduction over untreated check. Next best treatment was abamectin 1.8 SC @300 mL ha⁻¹ from which mean population of 0.43 jassids per leaf was observed These treatments recorded 89.37 and 87.64% reduction in jassid population over untreated check respectively. Both the treatments were statistically at par with each other. The present findings were supported by Das *et al* (2014) and Kamakshi *et al* (2021) who reported fipronil to be most potent against jassids causing 81.59 and 75.20% reduction over control. Ayyanar *et al* (2018) reported abamectin 1.8 EC @ 0.5 mL L⁻¹ to be the most potent against leaf hoppers infesting brinjal. In the present experiment spinosad 45 SC @ 200 mL ha⁻¹ recorded 0.70 jassids per leaf with 79.89% reduction over untreated check. Cartap hydrochloride 50%SP @ 1000 g ha⁻¹ recorded 0.98 jassids per leaf causing 71.84% jassid population reduction over untreated check. All these treatments were found to be statistically superior to insecticidal check malathion

50%EC @1000 mL ha⁻¹ which recorded 1.22 jassids per leaf and caused 64.94% jassid mortality. Neem oil @ 1500 mL ha⁻¹ recorded 1.46 jassids per leaf while thiodicarb 75 WP @ 500 g ha⁻¹ recorded 2.08 jassids per leaf with 58.05 and 40.23 reduction over untreated check respectively. Among the insecticidal treatments, emamectin benzoate 5 SG @ 220 g ha⁻¹ recorded highest mean population of 2.36 jassids per leaf and 32.18% reduction over untreated check. However, all the treatments were superior over untreated check which harbored 3.48 jassids per leaf.

From Table 2, the results revealed that treatment with spinosad 45 SC @ 200 mL ha⁻¹ was found to be comparatively safer towards lady bird beetles as compared to other test insecticides, recording 1.11 beetles per leaf followed by emamectin benzoate 5 SG @ 220 g ha⁻¹ causing 30.62 and 41.87% reduction in coccinellid population over untreated check respectively. The plots treated with emamectin benzoate 5 SG@220 g ha⁻¹ harboured 0.93 beetles per leaf. Spinosad 45 SC @ 56 g a.i. ha⁻¹ was reported to be safest treatment for lady bird beetles in gherkin plots by Misra and Mukherjee (2012). Khan et al (2015) reported that emamectin benzoate 1.9 EC @ 494 mL ha⁻¹ and spinosad 240 SC @ 247 mL L⁻¹ were safer towards lady bird beetles. The third position was possessed by abamectin 1.8 SC @ 300 mL ha⁻¹ from which 0.78 beetles per leaf and 51.25% reduction over untreated check were recorded. Treatment with neem oil @ 1500 mL L⁻¹ recorded 0.61 beetles per leaf with 61.87% reduction over untreated check. Plots treated with thiodicarb 75 WP @ 500 g ha⁻¹ and fipronil 5 EC @1000 mL ha⁻¹ recorded 0.50 and 0.47 beetles per leaf along with 68.75 and 70.62% reduction over untreated check respectively and were statistically at par with each other. Mean population of 0.35 beetles per leaf with 78.12% reduction over untreated check was observed from plots treated with cartap hydrochloride 50% SP @ 1000 g ha⁻¹. Plots treated with malathion 50%EC @1000 mL ha⁻¹ recorded lowest beetle population (0.24 beetles per leaf) with 85.00% reduction over untreated check, thus being most potent towards predatory lady bird beetles among test insecticides. However, untreated check plots harbored maximum population of lady bird beetles (1.60 beetles per leaf).

Table 3 indicates the efficacy of management practices on fruit fly infestation on both weight and number basis along with fruit yield from which it was revealed that treatment consisting of (FB + PT + Foliar spray of spinosad 45 SC @200 mL ha⁻¹) recorded minimum fruit fly incidence (9.43% and 83.17% reduction in fruit damage over untreated check on weight basis) and (7.87% fruit infestation with 85.57% reduction in fruit damage over untreated check on number basis) resulting in highest bitter gourd fruit yield of 5.50 t ha⁻¹. Spinosad 45% SC was found to be the best treatment against fruit fly in cucumber according to Iqbal (2018), Shinde et al (2018), Sharma (2019), Abhishek et al (2020) and Meena et al

(2022). Wazir et al (2022) reported maximum fruit yield (35 t ha⁻¹ in summer squash, where spinosad spot application was done to curb fruit fly infestation with 87% mortality. In the present experiment, the treatments (FB + PT + Foliar spray of cartap hydrochloride 50% SP @ 1000 g ha⁻¹) and (FB + PT + Foliar spray of fipronil 5 EC @1000 mL ha⁻¹) were statistically at par with each other in terms of yield (4.80 and 4.88 t ha⁻¹) and recorded 16.49 and 17.15% fruit infestation along with 70.57 and 69.40% reduction in fruit damage over untreated check respectively. Mahato and Misra (2018) opined fipronil 5% SC and cartap hydrochloride 50 % SP to be effective against melon fruit fly in cucumber which is similar to the present findings. The above treatments gave better yield with less fruit infestation as compared to insecticidal check (FB +PT + Foliar spray of malathion 50% EC @1000 mL ha⁻¹) which recorded 23.78% fruit damage and 57.57% reduction in fruit damage over untreated check along with 4.07 t ha⁻¹ on weight basis. However, on number basis, (FB + PT + Foliar spray of malathion 50%EC@1000 mL ha⁻¹) recorded 20.58% fruit damage and 62.27% reduction in fruit damage over untreated check. All the treatments were statistically superior to untreated check (56.05% fruit infestation and 1.35 t ha⁻¹). On weight basis, the treatments (FB + PT + Foliar spray of abamectin 1.8 SC @300 mL ha⁻¹), (FB +PT + Foliar spray of thiodicarb 75 WP @ 500 g ha⁻¹), (FB+PT+Foliar spray of emamectin benzoate 5 SG @220 g ha⁻¹) and (FB + PT + Foliar spray of neem oil @1500 mL ha⁻¹) provided yield of 4.55, 4.66, 4.20 and 3.20 t ha⁻¹ along with 68.68, 67.45, 64.97 and 49.90% reduction over untreated check respectively. However, on number basis, treatments (FB + PT + Foliar spray of thiodicarb 75 WP @ 500 g ha⁻¹), (FB +PT + Foliar spray of abamectin 1.8 SC @ 300 mL ha⁻¹), (FB + PT + Foliar spray of emamectin benzoate 5 SG @ 220 g ha⁻¹) and (FB + PT + Foliar spray of neem oil @ 1500 mL ha⁻¹) provided 70.41, 67.79, 66.34 and 46.21% reduction over control respectively. Hence, the treatment comprising of food bait + pheromone trap + foliar spray of spinosad 45 SC @ 200 mL ha⁻¹ was found to be the best treatment for fruit fly and was found to be superior over rest of the treatments.

Based on the data represented in Table 3, highest Incremental Cost Benefit Ratio of 8.20 was obtained from (FB +PT + Foliar spray of spinosad 45 SC @200 mL ha⁻¹) followed by the treatment constituting (FB + PT + Foliar spray of malathion 50% EC @1000 mL ha⁻¹) which recorded incremental cost benefit ratio of 6.72. The findings of the investigation carried out corroborates with Kumari et al (2020), Mawtham et al (2020) who opined that, spinosad 45 SC recorded highest incremental cost benefit ratio of 1:2.61 and 1:2.33 respectively in bitter gourd. Similar results were also reported by and Wazir et al (2022), who obtained maximum cost benefit ration of 1:3.96 in summer squash with application of spinosad. The third position was acclaimed by (FB + PT + Foliar spray of fipronil 5 EC

Table 2: Effect of management practices on whitefly, jassids and coccinellids

Treatment details	Mean no. of whitefly per leaf				Mean no. of jassids per leaf				Mean no. of coccinellids per leaf						
	1 st spray	2 nd spray	3 rd spray	Mean of three sprays	% Reduction over untreated check	1 st spray	2 nd spray	3 rd spray	Mean of three sprays	% Reduction over untreated check	1 st spray	2 nd spray	3 rd spray	Mean of three sprays	% Reduction over untreated check
T ₁ : FB+PT+emamectin benzoate 5 SG @220g/ha	0.95 (1.40)	0.80 (1.34)	0.80 (1.34)	0.85 (1.36)	73.76	2.40 (1.84)	2.36 (1.83)	2.32 (1.82)	2.36 (1.83)	32.18	1.06 (1.43)	0.90 (1.38)	0.84 (1.36)	0.93 (1.39)	41.87
T ₂ : FB+PT+flupronil 5 EC @1000 mL/ha	0.80 (1.34)	0.60 (1.26)	0.55 (1.24)	0.65 (1.28)	79.93	0.38 (1.17)	0.40 (1.18)	0.33 (1.15)	0.37 (1.17)	89.37	0.51 (1.23)	0.47 (1.21)	0.43 (1.19)	0.47 (1.21)	70.62
T ₃ : FB+PT+cartaphydrochloride 50%SP @ 1000g/ha	1.79 (1.67)	1.69 (1.64)	1.68 (1.64)	1.72 (1.65)	46.91	1.11 (1.45)	1.05 (1.43)	0.90 (1.38)	0.98 (1.41)	71.84	0.40 (1.18)	0.35 (1.16)	0.30 (1.14)	0.35 (1.16)	78.12
T ₄ : FB+PT+thiodicarb 75 WP @500g/ha	1.24 (1.50)	1.12 (1.46)	1.03 (1.42)	1.13 (1.45)	65.12	2.12 (1.77)	2.06 (1.75)	2.06 (1.75)	2.08 (1.75)	40.23	0.54 (1.24)	0.50 (1.22)	0.46 (1.21)	0.50 (1.22)	68.75
T ₅ : FB+PT+abamectin 1.8 SC@300 mL/ha	0.45 (1.20)	0.36 (1.17)	0.31 (1.14)	0.37 (1.17)	88.58	0.52 (1.23)	0.40 (1.18)	0.37 (1.17)	0.43 (1.19)	87.64	0.82 (1.35)	0.78 (1.33)	0.74 (1.32)	0.78 (1.33)	51.25
T ₆ : FB+PT+spinosad 45 SC @200 mL/ha	0.52 (1.23)	0.38 (1.17)	0.35 (1.16)	0.42 (1.19)	87.03	0.84 (1.36)	0.65 (1.28)	0.61 (1.27)	0.70 (1.30)	79.89	1.20 (1.48)	1.10 (1.45)	1.03 (1.42)	1.11 (1.45)	30.62
T ₇ :FB+PT+malathion 50%EC @1000 mL/ha	2.10 (1.76)	2.04 (1.74)	1.89 (1.70)	2.01 (1.73)	37.96	1.24 (1.50)	1.25 (1.50)	1.17 (1.47)	1.22 (1.49)	64.94	0.30 (1.14)	0.22 (1.10)	0.20 (1.09)	0.24 (1.11)	85.00
T ₈ : FB+PT+neem oil 1500 ppm @ 1500 mL/ha	1.45 (1.57)	1.40 (1.55)	1.32 (1.52)	1.39 (1.55)	57.10	1.39 (1.54)	1.56 (1.60)	1.43 (1.56)	1.46 (1.57)	58.05	0.62 (1.27)	0.60 (1.26)	0.60 (1.25)	0.61 (1.27)	61.87
T ₉ : Control (Untreated check)	3.32 (2.08)	3.26 (2.06)	3.14 (2.03)	3.24 (2.05)	-	4.02 (2.24)	3.26 (2.06)	3.16 (2.04)	3.48 (2.12)	-	1.53 (1.59)	1.57 (1.60)	1.70 (1.64)	1.60 (1.61)	-
SE(m)±	0.016	0.025	0.023	0.025	-	0.014	0.021	0.026	0.022	-	0.014	0.014	0.015	0.014	-
CD(p=0.05)	0.05	0.07	0.07	0.07	-	0.04	0.06	0.08	0.07	-	0.04	0.04	0.05	0.04	-

* figures in parentheses are $\sqrt{n+1}$ transformed values
 FB: Food Bait PT- Para Pheromone Trap

Table 3: Efficacy of management practices on fruit fly infestation, yield and ICBR

Treatments	Percent fruit fly infestation (on weight basis)	% Reduction over untreated check	Percent fruit fly infestation (on number basis)	% Reduction over untreated check	Yield (t ha ⁻¹)	ICBR
T ₁ : Food Bait (FB) + Pheromone Trap (PT) + Foliar spray of Emamectin benzoate 5 SG @220g/ha	19.63 (26.29)	64.97	18.36 (25.36)	66.34	4.20	1: 6.45
T ₂ : FB+PT+Foliar spray of Fipronil 5 EC @1000 mL/ha	17.15 (24.45)	69.40	10.72 (19.10)	80.34	4.88	1: 6.51
T ₃ : FB+PT+Foliar spray of Cartap hydrochloride 50%SP @ 1000g/ha	16.49 (23.95)	70.57	11.55 (19.86)	78.82	4.80	1: 5.50
T ₄ : FB+PT+Foliar spray of Thiodicarb 75 WP @500g/ha	18.24 (25.27)	67.45	16.14 (23.68)	70.41	4.66	1: 6.26
T ₅ : FB+PT+Foliar spray of Abamectin 1.8 SC @300 mL/ha	17.55 (24.76)	68.68	17.57 (24.77)	67.79	4.55	1: 5.26
T ₆ : FB+PT+Foliar spray of Spinosad 45 SC @200 mL/ha	9.43 (17.87)	83.17	7.87 (16.28)	85.57	5.50	1: 8.20
T ₇ : FB+PT+Foliar spray of Malathion 50%EC @1000 mL/ha	23.78 (29.17)	57.57	20.58 (26.97)	62.27	4.07	1: 6.72
T ₈ : FB+PT+Foliar spray of Neem oil @1500 mL/ha	28.08 (31.98)	49.90	29.34 (32.78)	46.21	3.20	1: 3.89
T ₉ : Control (Untreated check)	56.05 (48.45)	-	54.55 (47.59)	-	1.35	-
SE(m)±	0.079	-	0.296	-	-	-
CD _(0.05%)	0.24	-	0.90	-	-	-

*Figures in parentheses are angular transformed values

@1000 mL ha⁻¹) with an incremental cost benefit ratio of 6.51. The treatments (FB + PT + Foliar spray of emamectin benzoate 5 SG @220 g ha⁻¹), (FB + PT + Foliar spray of thiodicarb 75 WP @500 g ha⁻¹), (FB + PT + Foliar spray of cartap hydrochloride 50%SP @ 1000 g ha⁻¹) and (FB +PT + Foliar spray of abamectin 1.8 SC @300 mL ha⁻¹) with ICBR of 6.45, 6.26, 5.50 and 5.26 were recorded from the present investigation. The treatment comprising of botanical; (FB +PT + Foliar spray of neem oil @1500 mL ha⁻¹) recorded lowest ICBR of 3.89 thus being least economic among other treatments.

Conclusion

The treatment using “Food bait + Para pheromone trap with cue lure @ 25 traps ha⁻¹ + spinosad 45 SC @ 200 mL ha⁻¹” applied three times (30, 45, and 60 days after sowing) was highly effective in managing leaf-eating insects, fruit fly infestation, and sucking pests in bitter gourd. It maximized fruit yield and had the highest cost-benefit ratio. Spinosad was less toxic to predatory ladybird beetles and outperformed malathion 50% EC in pest control and profitability. Being a naturally derived product, spinosad provided prolonged pest control with low toxicity to non-

target species. The fipronil-based treatment ranked second in effectiveness.

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सारांश

करेला (मोमोर्डिका चारेंटिया एल) किस्म 'पाली' में प्रमुख कीट कीटों के खिलाफ प्रबंधन प्रथाओं के मूल्यांकन के लिए एक क्षेत्र प्रयोग किया गया था। कीटनाशकों के पत्ते के छिड़काव के साथ क्यू लूर और फूड बाइट्स के साथ पैरा फेरोमोन ट्रैप वाले नौ उपचार; इमामेक्टिन बेंजोएट 5SG@220g ha-1, फिप्रोनिल 5 EC@1000 mL ha-1, कार्ताप हाइड्रोक्लोराइड 50% SP@1000g ha-1, थियोडिकार्ब 75WP@500g ha-1, अबामेक्टिन 1.8 SC @300 mL ha-1, स्पिनोसैड 45SC@200 mL ha-1, मैलाथियन 50% EC@1000 mL ha-1 (कीटनाशक जांच) नीम का तेल 1500ppm 1500 mL ha-1 और अनुपचारित जांच। परिणामों ने संकेत दिया कि खाद्य चारा @20baits ha-1 (ककड़ी फल का गूदा + 100 मिलीलीटर गोमूत्र + 0.5 l पानी) + पैरा फेरोमोन ट्रैप्स @25 ha-1 + स्पिनोसैड 45SC@200 mL ha-1 का 30,45 और 60 DAS पर तीन बार पर्ण स्प्रे 96.36,81.94,85.21,87.03,79.89 और 60.65 के साथ सबसे प्रभावी था। तरबूज फल मक्खी से फलों का नुकसान 83.17% कम था और अधिकतम फल उपज (5.5 टन हेक्टेयर-1) मौद्रिक लाभ (Rs.110973ha-1) और आईसीबीआर (8.20) दर्ज किया गया था। करेला की खेती में प्रमुख कीट कीटों के प्रबंधन के लिए इस प्रबंधन अभ्यास पर विचार किया जा सकता है।