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BIO-RATIONAL MANAGEMENT APPROACHES OF MAJOR INSECT PESTS ATTACKING YARDLONG BEAN

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ABSTRACT

Yardlong bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Walp.) is an important leguminous vegetable crop in Bangladesh, and its productivity is severely constrained by major insect pests, including aphids, jassids, whiteflies, and the legume pod borer (*Maruca testulalis*). Excessive reliance on synthetic insecticides has resulted in resistance development and ecological disruption, highlighting the need for safer alternatives. The experiment was conducted at Gazipur Agricultural University (GAU), Gazipur using a randomized complete block design with eight treatments and three replications. The treatments included Biotrin 0.5 AS (Matrine) @ 1ml/L of water, Bio-Clean 5 SL (De- limonin) @ 1ml/L of water, Biomax M 1.2 EC (Abamectine) 1ml/L of water, mahogany Oil @ 5ml/L of water, Bio-Action 1.5 SL (Matrine) @ 1ml/L of water, Spinomax 44.3 SC (Spinosad) 1ml/L of water, neem oil @ 5ml/L of water, and untreated control. Results showed that Biomax 1.2 EC, Spinomax 44.3 SC, neem oil, and mahogany oil significantly reduced populations of aphids, jassids, whiteflies, and pod borer larvae compared with the untreated control. Spinomax 44.3 SC consistently resulted in the lowest pod infestation (9.5±0.5%) and pod borer larval density (10.3±0.4). Among all treatments, Spinomax 44.3 SC and Biomax 1.2 EC produced the highest yield (20.2±0.8 and 18.6±1.4, respectively) and marginal benefit-cost ratio (3.97 and 3.43, respectively). Botanical treatments exhibited comparatively lower adverse effects on beneficial arthropods. The findings suggest that selected bio-rational insecticides, particularly Spinomax 44.3 SC and Biomax 1.2 EC, can be effectively integrated into sustainable pest management programs for yardlong bean cultivation.

Keywords: *Maruca testulalis*, Aphid, Jassid, Whitefly, IPM, Eco-friendly pest management.

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INTRODUCTION

Yardlong bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Walp.) is an important leguminous vegetable cultivated worldwide and is particularly popular as a summer vegetable in Bangladesh due to its high market demand and profitability. In Bangladesh, the crop covered an area of 17,307 ha with a total production of 28,469 MT during the 2018–2019 growing season (BBS 2019). Yardlong bean is a rich source of essential nutrients, including vitamins, proteins, minerals, and fats. Despite its nutritional and economic importance, high incidences of insect pests significantly affect the yield and quality, limiting the crop's overall productivity. According to Mrong *et al*. (2023), 12-30% of yield loss is recorded to be occurred in yardlong bean due to insect pests. The crop is attacked by several economically important pests, including aphids (*Aphis craccivora*), jassids (*Amrasca devastans*), whiteflies (*Bemisia tabaci*), epilachna beetle (*Epilachna dodecastiga*), green stink bug (*Nezara viridula*), jute hairy caterpillar (*Spilosoma obliqua*), and red spider mite (*Tetranychus* spp.). Among these, the legume pod borer (*Maruca testulalis*) is considered the most destructive pest in Bangladesh, causing yield losses of up to 80% across various host plants (Malacrinò *et al*. 2020). The larvae bore into flowers and pods, remaining concealed within plant tissues, which makes difficult for effective control using conventional chemical insecticides.

To manage these pests, farmers predominantly rely on synthetic insecticides. However, the indiscriminate and repeated use of systemic insecticides has led to the development of insecticide resistance, pest resurgence, secondary pest outbreaks, and disruption of agro-ecosystems by adversely affecting non-target organisms (Dittrich *et al*. 1990). In contrast, bio-rational pest management approaches involve the use of pesticides that are target-specific, environmentally benign, and rapidly degradable, thereby reducing environmental persistence and exposure risks. Bio-rational products, including botanical extracts and plant-based oils, have been widely incorporated into integrated pest management (IPM) programs due to their proven efficacy against insect pests (Soares *et al*. 2019). These botanicals exert toxic, antifeedant, and growth-inhibitory effects on insect pests, ultimately suppressing their development and reproduction (Ahad *et al*. 2016; Mazumder *et al*. 2016). Considering these aspects, the present study was undertaken to evaluate the efficacy of selected bio-rational insecticides for managing major insect pests of yardlong bean, assessing their impact on natural enemy populations, and determining the marginal benefit-cost ratio (MBCR) of the tested bio-rational insecticides under field conditions.

MATERIALS AND METHODS

Design of experiment and crop production: The experiment was conducted under the Department of Entomology, Gazipur Agricultural University (GAU), Gazipur during February to May, 2022. The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. A total of 24 plots were made and the unit plot size was 3 m × 2 m. There were 10 plants planted in each plot. In total 240 plants were planted for this study. The spacing between row to row and plant to plant was 1.0 m and 0.50 m, respectively. The seed of BARI Borbati-1 variety was collected from Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh. Three-week-old seedlings were transplanted to the field on March 4, 2022, maintaining row to row distance 1 m and pit to pit distance 50 cm.

Treatments and methods of application: Seven treatments along with an untreated control were evaluated on the basis of pest's infestation in yardlong bean. During the entire cropping season, insecticide was sprayed on experimental field for six times maintaining 7 days interval. The treatments, namely, Biotrin 0.5 AS (Matrine) @ 1ml/L of water, Bio-Clean 5 SL (De- limonin) @ 1ml/L of water, Biomax M 1.2 EC (Abamectine) 1ml/L of water, mahogany Oil @ 5ml/L of water, Bio-Action 1.5 SL (Matrine) @ 1ml/L of water, Spinomax 44.3 SC (Spinosad) 1ml/L of water, neem oil @ 5ml/L of water, and untreated control (spraying of only water at the same time of other treatments application). A particular insecticide was mixed with water in the Knapsack sprayer, was shaken well and sprayed well covering the whole plant. Before spraying, the spray machine was calibrated to find out the required quantity of spray materials for three plots. The spraying was done early in the afternoon to avoid bright sunlight and drift caused by the strong wind and adverse effect on pollinating bees.

Data collection and analysis: The observation on the incident of insect pests and their natural enemies was counted from their appearance on plants till harvest. Data were collected from some pre-selected parameters such as abundance and infestation of insect pests and natural enemies with crop growing season. Sample was taken from 5 plants respectively and then converted to 10 plants (3m × 2m) for expressing the rate of plant infestation and number of pests per plot. Rate of infestation by different pest, healthy and infested pods per plot by number and weight and yield of fruit were recorded at 3 days after the spraying of selected insecticides. The weight of infested and total leaves and pods for each treated plot and untreated control plot were recorded and the percent reduction over control of leaf and infestation by weight was calculated. The cumulative yield of per plot from total harvest was calculated and it was then expressed as ton per hectare. The natural enemies found in the experimental field were lady bird beetle, black ant, bees, syrphid fly and spider. The economic analysis or Marginal Benefit Cost Ratio (MBCR) was calculated on the basis of total expenditure of the respective treatment along with the total return from that particular treatment (Ali *et al.* 1996). One-way analysis of variance followed by Tukey HSD Posthoc test (at 5% level of significance) for determining the effects of insecticides on number of pests, number of natural enemies, larval number of pod borer and yield. All the analyses were performed using IBM SPSS 20.0.

RESULTS AND DISCUSSION

Efficacy of biorational insecticides against aphid and whitefly attacking yardlong bean: The effects of tested biorational insecticides on aphid and whitefly populations and their infestation rates in yardlong bean are presented in Table 1. Significant variation was observed among the treatments for both pest density and infestation rate. The untreated control plot recorded the highest aphid population (36.8±1.7 per plot) and infestation rate (32.1±6.4%), as well as the highest whitefly population (28.7±1.7 per plot) and infestation rate (28.5±3.0%). Among the treated plots, Biomax 1.2 EC and mahogany oil resulted in comparatively lower aphid populations (13.4±0.9 and 15.4±1.2 per plot, respectively) and reduced infestation rates. For whitefly, the lowest population was recorded in mahogany oil (8.8±0.3 per plot), followed by Biomax 1.2 EC (9.9±0.5 per plot). All biorational insecticide treatments significantly reduced aphid and whitefly populations and infestation rates compared to the untreated control. In align with the present study Mollah and Khatun (2024) referred Biomax M as a non-toxic alternative to suppress aphid population in brinjal ecosystem. Similarly, Choudhury (2020) found neem and mahogany as a potential bio-rational means for suppressing whitefly population.

Table 1. Effect of different biorational insecticides on aphid and whitefly population density and infestation rate (%) in yardlong bean

Treatments	Aphid/plot	Infestation rate%	Whitefly/plot	Infestation rate%
Biotrin 0.5 AS	25.6±1.1b	21.6±6.3ab	14.8±0.4c	13.3±1.7b
Bio-Clean 5 SL	22.3±1.1c	18.3±3.5b	19.0±0.3b	12.1±1.5b
Biomax 1.2 EC	13.4±0.9d	15.8±1.9b	9.9±0.5de	11.2±2.7b
Mahogany oil	15.4±1.2d	18.3±1.3b	8.8±0.3e	13.6±1.8b
Bio-Action 1.5 SL	24.2±0.7bc	18.7±3.6b	15.7±0.6c	11.5±2.2b
Spinomax 44.3 SC	22.5±0.9c	16.1±4b	11±0.4d	10.7±1.7b
Neem oil	15.5±0.4d	18.5±3.6b	11±0.1d	10.4±2.4b
Untreated control	36.8±1.7a	32.1±6.4a	28.7±1.7a	28.5±3a

Data expressed as mean± S.E. Means within a column followed by no common letter(s) are significantly different by Tukey Post hoc statistics at $P \leq 0.05$.

Efficacy of biorational insecticides against jassid and pod borer attacking yardlong bean: Data of Table 2 show the effect of different biorational insecticides on jassid and pod borer abundance and infestation rate in yardlong bean. Significant variation was observed among treatments for both pests. The highest jassid population and infestation rate were recorded in the untreated control plot (65.2±0.7 per plot and 37.2±5.4%, respectively). Among the treated plots, Spinomax 44.3 SC resulted in the lowest jassid population (16.4±1.7 per plot), which was statistically similar to neem oil (18.0±1.1) and mahogany oil (19.8±1.6). The lowest jassid infestation rate was observed in Biomax 1.2 EC (14.2±1.3%), followed by mahogany oil (15.3±1.2%), both of which differed significantly from the untreated control. In the case of pod borer, the untreated control plot recorded the highest larval population (25.8±1.7 per plot) and infestation rate (36.6±2.1%). Spinomax 44.3 SC exhibited the lowest pod borer population (10.3±0.4 per plot) and infestation rate (9.5±0.5%), which was statistically similar to Biomax 1.2 EC (16.5±0.5 larvae per plot and 10.3±1.1% infestation). Other biorational treatments showed moderate suppression of pod borer compared to the untreated control. Therefore, the results indicate that Spinomax 44.3 SC and Biomax 1.2 EC were the most effective treatments in reducing both jassid and pod borer populations and infestation rates under field conditions. Similarly, Choudhury (2020) found neem and mahogany as a potential bio-rational means for controlling whitefly population. Ahmed *et al*. (2019) observed that BioNeem plus

Table 2. Effect of different biorational insecticides on jassid and pod borer population density and infestation rate (%) in yardlong bean

Treatments	Jassid/plot	Infestation rate%	Pod borer/plot	Infestation rate
Biotrin 0.5 AS	49.3±2.4b	26.3±2.3b	23.7±0.4a	17.3±1bc
Bio-Clean 5 SL	49.4±1.9b	23.5±2.1b	22±0.3ab	18±0.5b
Biomax 1.2 EC	22.2±2.0d	14.2±1.3cd	16.5±0.5b	10.3±1.1d
Mahogany oil	19.8±1.6de	15.3±1.2cd	15.6±0.3b	12.8±0.6cd
Bio-Action 1.5 SL	38.8±3c	19.3±3.6c	21±0.6ab	15.5±3.2bc
Spinomax 44.3 SC	16.4±1.7e	18.3±0.3c	10.3±0.4c	9.5±0.5d
Neem oil	18±1.1de	17.6±0.7c	13.3±0.1bc	15.5±1.5bc
Untreated control	65.2±0.7a	37.2±5.4a	25.8±1.7a	36.6±2.1a

Data expressed as mean± S.E. Means within a column followed by no common letter(s) are significantly different by Tukey Posthoc statistics at $P \leq 0.05$

and mahogany oil performed better against pod borer. Mrong *et al*. (2024) similarly recorded lowest pod infestation from Tracer 45 SC (Spinosad). Choudhury (2020) and Ahmed *et al*. (2020) reported neem and mahogany oil effective for reducing pod infestation.

Bio-rational management approaches on number of natural enemies: Data presented in Table 3 illustrate the effects of different eco-friendly management approaches on the abundance of beneficial and non-target arthropods in yardlong bean fields. Significant variation was observed in the population of lady bird beetles among treatments. The highest number of lady bird beetles per plot was recorded in the untreated control (20.6±4.6), which was statistically similar to Biotrin 0.5 AS (18.0±5.2). In contrast, the lowest lady bird beetle population was observed in plots treated with Spinomax 44.3 SC (10.0±0.0). These findings indicate that chemical insecticides adversely affect natural enemy populations. Similar observations were reported by FAO (2003), who documented a substantial reduction in beneficial insects, particularly spiders and lady bird beetles, following insecticide application in brinjal agroecosystems. Additionally, Tohnishi *et al*. (2005) reported that neem-based products are comparatively less toxic to predators such as lady bird beetles, spiders, and other natural enemies than synthetic insecticides.

In the case of syrphid flies, no significant variation was detected among treatments, including the untreated control. The population ranged from 1.3±0.9 to 5.7±2.9 individuals per plot. Similarly, black ant populations did not differ significantly among treatments. The highest number of black ants was recorded in the untreated control (30.3±5.1), followed by Biotrin 0.5 AS (28.6±1.3) and Bio-Clean 5 SL (28.6±0.3), while the lowest population occurred in Spinomax 44.3 SC (20.0±2.3) and Biomax 1.2 EC (20.6±0.6). Comparable trends were also reported by Roy *et al*. (2016), who observed that chemical insecticides negatively affect both pest and beneficial arthropod populations, whereas biopesticides are comparatively safer and environmentally benign.

Regarding spider populations, the highest abundance was found in the untreated control (6.0±0.6), which was statistically similar to Bio-Clean 5 SL (4.3±0.3). The lowest spider population was recorded in Spinomax 44.3 SC (1.0±0.6), which was statistically comparable to neem oil (2.0±0.6) and Biomax 1.2 EC (2.0±0.6). Supporting these findings, Efad *et al*. (2021) reported that Spinomax 44.3 SC, being a bio-rational insecticide, maintained the presence of beneficial arthropods such as lady bird beetles, syrphid flies, black ants, and spiders throughout the cropping season in brinjal. Their study showed minimal statistical variation in lady bird beetle and black ant populations between Spinomax-treated and untreated plots, while no significant differences were observed for syrphid flies and spiders across the treatments.

Table 3. Effect of different bio-rational management approaches on number of natural enemies per plot during entire cropping season

Treatments	No. of lady bird beetle	No. of black ant	No. of syrphid fly	No. of spiders
Biotrin 0.5 AS	18.0±5.2a	28.6±1.3a	2.3±1.2a	3.0±0.6bc
Bio -Clean 5 SL	16.0±2.3a	28.6±0.3a	2.3±1.2a	4.3±0.3ab
Biomax 1.2 EC	11.3±1.1a	20.6±0.6a	1.7±0.9a	2.0±0.6bc
Mahogany oil	14.6±2.9a	24.0±3.0a	2.7±0.3a	4.0±0.6ab
Bio -Action 1.5 SL	15.3±2.4a	26.6±1.6a	3.3±0.3a	3.0±0.6ab
Spinomax 44.3 SC	10.0±0.0a	20.0±2.3a	1.3±0.9b	1.0±0.6c
Neem oil	14.0±0.6a	22.6±0.6a	2.0±0.6a	2.0±0.6b
Untreated control	20.6±4.6a	30.3±5.1a	5.7±2.9a	6.0±0.6a

Data expressed as mean± S.E. Means within a column followed by no common letter(s) are significantly different by Tukey Posthoc statistics at P≤ 0.05

Effect of bio-rational approaches on yield of yardlong bean: The obtained yields of yardlong bean from plots treated with different insecticides are presented Table 4. The effects of different insecticides on yield differed significantly. Total yield of yardlong bean ranged from 10.4 to 20.2 MT/ha. The highest yield (20.2±1.2 MT / ha) was obtained in plot treated with Spinomax 44.3 SC followed by Biomax1.2 EC (18.6±1.4 MT/ha). The lowest yield (10.4±1.2 MT/ha) was obtained from untreated control plot. The highest marketable yield was obtained in Spinomax 44.3 SC (17.6±0.6) and lowest in untreated control plot (6.5±1.0). Lowest infested yield found in Bio-Action (1.0±0.6) and highest infested yield found in untreated control plot (4.9±0.6). The highest percent yield loss was observed in Bio-Action 1.5 SL treated plot and lowest percent yield loss was observed in untreated control plot. Mrong *et al*. (2024) obtained the highest yield from the plots treated with Tracer 45 SC (Spinosad).

Figure 1 illustrates the highest percent reduction in yield loss was recorded in Bio-Action 1.5 SL (84.99%) treated plot, followed by Biotrin 0.5 AS (81.85%), whereas the lowest percent reduction in yield loss was obtained in untreated control plot (15.62%). Spinomax 44.3 (72.3), neem oil (68.21%), and Biomax 1.2 EC (64.3%) showed moderate yield reduction.

Economic analysis of different bio-rational approaches: The details of the cost of pest management (Tk ha^{-1}) under tested bio-rational management approaches

Table 4. Effect of different treatments on yield per hectare of yardlong bean and yield increase over untreated control

Treatments	Total yield (MT/ha)	Marketable yield (MT/ha)	Infested yield (MT/ha)	% Yield loss
Biotrin 0.5 AS	14.6±0.3b	13.3±0.6bc	1.3±0.3a	81.85
Bio-Clean 5 SL	14.6±1.0b	12.0±0.8abc	2.6±0.2a	63.71
Biomax1.2 EC	18.6±1.4ab	15.3±1.6abc	3.3±0.6a	64.30
Mahogany Oil	13.3±0.8ab	10.0±0.3ab	3.3±0.6a	50.03
Bio-Action 1.5 SL	13.3±1.3b	12.3±1.1bc	1.0±0.6a	84.99
Spinomax 44.3 %	20.2±0.8b	17.6±0.6bc	3.0±0.3a	72.35
Neem oil	14.6±1.2a	12.3±0.8a	2.3±0.4a	68.21
Untreated control	10.4±1.2b	6.5±1.0c	4.9±0.6a	15.62

Data expressed as mean± S.E. Means within a column followed by no common letter(s) are significantly different by Tukey Posthoc statistics at P≤ 0.05

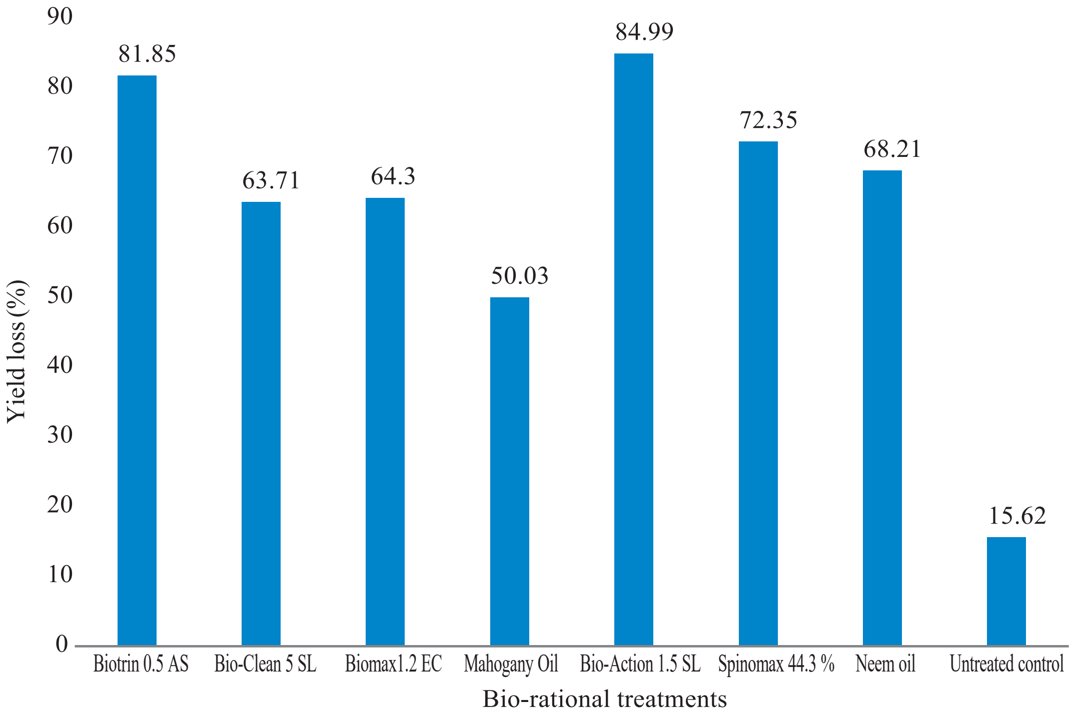

Fig. 1. Yield loss (%) assessment of yardlong bean as affected by tested bio-rational treatments.

Table 5. Marginal benefit cost ratio (MBCR) analysis of selected bio-rational management approaches against pests attacking yardlong bean (MT/ha)

Treatments	Management cost (tk)	Gross return (tk)	Net return (tk)	Adjusted net return (tk)	MBCR
Biotrin 0.5 AS	69550.0	325000.0	255450.0	99500.0	1.43
Bio-Clean 5 SL	53550.0	300000.0	246450.0	90500.0	1.69
Biomax1.2 EC	49350.0	375000.0	325650.0	169700.0	3.43
Mahogany Oil	45550.0	250000.0	204450.0	48500.0	1.06
Bio-Action 1.5 SL	56700.0	308250.0	251550.0	95600.0	1.68
Spinomax 44.3 SC	52320.0	416500.0	364180.0	208230.0	3.97
Neem oil	45550.0	308250.0	262700.0	106750.0	2.34
Untreated control	20550.0	200000.0	155950.0	0.0	

Market value of yardlong bean=25 tk/kg

against insect pests in yardlong bean was presented in Table 5. Management cost was the highest (Tk. 69550.0) with Biotrin 0.5 AS followed by Bio-Action (Tk. 56700.0). The lowest management cost (Tk. 20550.0) was found with untreated control followed by Tk. 45550.0 with neem and mahogany oil. The highest gross return (Tk. 416500.0) was found with Spinomax 44.3 SC followed by Tk. 375000.0 with Biomax 1.2 EC. The lowest gross return (Tk. 200000.0) was found with untreated control followed by Bio-Clean 5 SL (Tk. 86400.0). The highest net return (Tk.364180.0) was recorded with Spinomax 44.3 SC followed by Tk. 325650.0 with Biomax 1.2 EC, Tk. 255450.0 with Biotrin 0.5 AS, Tk. 251550.0 with Bio-Action, Tk. 246450.0 with Bio-Clean 5 SL and the lowest Tk. 155950.0 in untreated control plot. The highest adjusted net return (Tk. 208230.0) was recorded with Spinomax 44.3 SC followed by Tk. 169700.0 with Biomax 1.2 EC. The lowest adjusted net return was calculated from Mahogany oil (Tk. 48500.0) followed by Bio-Clean 5 SL (Tk. 90500.0) whereas untreated control plot had no adjusted net return. The highest MBCR of 3.97 was obtained from the plot treated with Spinomax 44.3 SC followed by 3.43 with Biomax 1.2 EC. The lowest marginal benefit cost ratio (MBCR) was found 1.06 from the Mahogany oil followed by Biotrin 0.5 AS (1.43). Our findings are supported by Mrong *et al*. (2024) who also obtained maximum marginal benefit cost ratio from the plots treated with Tracer 45 SC (Spinosad).

CONCLUSION

The findings of the present study indicate that Spinomax 44.3 SC and Biomax 1.2 EC were the most effective insecticides among the treatments evaluated for managing insect pests under field conditions. Consequently, plots treated with Spinomax 44.3 SC and Biomax 1.2 EC recorded the highest yield and marginal benefit–cost ratio (MBCR). Therefore, the application of these bio-rational insecticides is recommended for the effective management of aphids, jassids, whiteflies, and pod borers attacking yardlong bean cultivation. Future research should focus on the combination or rotation of active ingredients derived from different biological sources to enhance pest control efficiency while ensuring minimal adverse effects on non-target organisms and the environment.

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