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Efficacy of Targeted Insecticides against Major Insect Pests of Phalsa (*Grewia asiatica* Linn.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A two-year field experiment were conducted in a phalsa orchard situated at the Regional Horticulture Research Station (RHRS), Raya, District-Samba to study the efficacy of selected insecticides against major insect pests of phalsa. During the experiment, seven treatments were taken which were replicated thrice in the randomized block design. The insecticides were sprayed at the peak or ETL level of the insect problem population, insect population was noted one day before the spraying and three and ten days after the spraying. Five randomly chosen plants were subjected to pre- and post-treatment of herbicides, and insect counts was taken. Further, ten days after a second spray, 100 randomly selected fruits from each plant were examined to figure out the amount of fruits that were injured overall. Fruit damage (%) was then computed. The yield was calculated by employing the net plot area method, and the yield and cost of plant protection were utilized to calculate the monetary benefits and incremental cost-benefit ratios of the treatments. The application of imidacloprid 17.8 SL @ 0.3 ml/L was found to be the most effective method for suppressing aphids, with Fipronil 5 SC @ 1.0 ml/L, Chlorpyriphos 20 EC, and control following suit. Additionally, plots treated with imidacloprid had the highest cost-benefit ratio,

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followed by treatments with Fipronil and dichlorvos Therefore, in Jammu's subtropical climate, applying imidacloprid 17.8 SL @ 0.3 ml/L is the most efficient way to control insect pests and increase phalsa yield.

Keywords: Imidacloprid; Fipronil; phalsa; insecticides; suppression and yield.

1. INTRODUCTION

Phalsa (*Grewia asiatica* Linn.: family Tilliaceae), commonly known as star apple, holds a paramount position as an underutilized fruit crop extensively cultivated in the arid and semi-arid regions of India. The cultivation of phalsa is currently experiencing a surge in our country, owing to its abundance of bioactive compounds that augment the nutritional profile of human diets, thereby promoting overall human well-being [1]. In the state of Jammu and Kashmir, commercial cultivation of phalsa is yet to be established; however, it thrives in the Kandi and dry land areas of Kathua, Samba, Jammu, Udhampur, Rajouri, and Reasi districts, offering promising prospects for a readily accessible market. Nevertheless, the production of phalsa fruit faces diverse challenges, with insect pests emerging as a prominent hindrance, resulting in substantial losses in crop yield. A myriad of insect pests and their detrimental impacts have been reported across various regions of India [2,3,4,5]. Notably, fruit flies, primarily belonging to the *Bactrocera* genus, stand out as consequential agents causing significant damage to phalsa crops. The *Bactrocera* genus encompasses a wide spectrum of over 75 species, exhibiting broad yet primarily allopatric distributions, with regions of transition prevalent in Southeast Asia [6,7]. Extensive research has identified *Bactrocera dorsalis* as the most deleterious among these species [8,9], with discernible morphological variations observed within their populations. The damage inflicted is attributed to the maggots, which internalize within phalsa berries, leading to premature fruit detachment. Reports indicate that fruit damage can escalate up to a staggering 63% in Punjab [2], with the afflicted fruits typically hosting solitary fly pupae. The injury to the fruit transpires through oviposition punctures, followed by larval development. Monitoring and managing immature fruit fly stages within the field setting pose considerable challenges, as the maggots remain ensconced within the fruit, while pupation and overwintering transpire in the soil. Consequently, vigilant monitoring becomes imperative to gauge fluctuations in fruit fly population levels and execute appropriate control measures [10]. A significant number of insect pests attacking the crop at various phases of growth [2,3,4,5] is one of the numerous variables restricting the output of phalsa. Fruit output is lowered as a consequence of the different insecticides used to control crops that negatively impact helpful insects and hinder the pollination process. The unintentional death of bees has become a significant issue for beekeepers globally because to the amplified increase in the usage of insecticides [11,12]. Honeybees spend an extensive amount of time on the flowers collecting pollen and nectar, in addition, they take long flights transporting loads of pollen, thus, poisoning of insecticides to honeybees is typically more severe. The production of phalsa is negatively impacted by insect and mite pests, necessitating ongoing integrated pest management techniques. An integral part of an integrated pest management (IPM) program is the identification and cataloging of insect and mite pests. To maximize production, integrated pest management (IPM) strategies against these significant and prevalent phalsa insect pests are necessary (qualitative and quantitative). Phalsa growers are trending toward using fewer pesticides in order to get premium prices for organic strawberries that are free of pesticides in many regions of the world. Keeping the importance of the berry fruits in view and the problem posed by insect pests, the studies on the efficacy of selected insecticides against major insect pests of phalsa were conducted.

2. MATERIALS AND METHODS

A randomized block design field experiment comprising seven treatments and three replications was carried out at RHRS, Raya. The pesticides were sprayed at the peak or ETL level of the insect problem population. These are the pesticides that were used.

2.1 Preparation of Insecticidal Solution

The following techniques were used to assemble the spray solution intended for field application. For liquid formulations, the necessary amount of pesticides was mixed with a little amount of water and properly mixed. After that, the remaining water was added gradually while stirring continuously to achieve the appropriate spray fluid concentration. The following formula was used to determine how much pesticide (in milliliters or grams) was required for each liter of water:

Amount of insecticide (ml or g) per liter of water = [Concentration required (%)] / [Percent active ingredient] × 1000

Pre-application counts of aphids and other major insect pests on randomly selected ten plants from each plot were made. Post-treatment observation of aphid population was taken at 5 and 10 days after spraying and means population was counted accordingly. Data on percentage decline in the population of aphids due to insecticidal treatments were worked out following Henderson and Tilton [13] as given below:

2.2 Method of Insecticidal Solution Application and Timing

The investigations consisted of two foliar sprays. The insecticides were sprayed once, close to the insect pest's ETL level, and again, a quarter of a day apart. For spraying the insecticidal solution, a backpack sprayer was utilized. To guarantee full coverage of the foliage, the solution was sprayed until a gradual run-off of droplets began from the citrus trees' leaves. When every insecticidal solution was sprayed, the sprayer was thoroughly cleaned. In order to minimize damage from the local bee population, the spraying was done in the dark. A protective mask was worn to prevent unintentional inhalation of the pesticides.

2.3 Observation of Data

After insect infestations reached the ETL threshold in 2018 and 2019, a total of two insecticidal treatments were carried out. One day before the spray, a pre-count of the pest population was taken. In the instance of phalsa aphids, the population count was conducted five and ten days following insecticidal spraying. Percent reduction after single day was calculated usingformula,

Per cent reduction = (Pre spray count-post spray count) / (Pre spray count) × 100

Final Insecticidal bio-efficacy was calculated using Henderson and Tilton formula.

Corrected % = 1 - = (n in Co before treatment × n in T after treatment) / (n in Co after treatment × n in T before treatment) × 100

Where as**,**

n = Insect population,
T = treated, Co = control

The normal distribution test (also known as the Kolmogorov-Smirnov test for normalcy) was then performed on the gathered data. After that, the numbers underwent a square root transformation and were statistically examined to get the crucial difference value. This allows for an exact comparison of the bio-efficacy of various insecticidal treatments against specific insect pests.

Table 1. Insecticides to be used on phalsa against major insect pests

S. No.	Insecticide	Dose/conc.
1	Neem oil 1500ppm	3.0ml/L
2	Fipronil 5SC	1.0ml/L
3	Dichlorvos 76EC	1.5ml/L
4	Chlorpyriphos 20EC	2.0ml/L
5	Imidacloprid 17.8SL	0.3ml/L
6	Quinalphos 25 EC	2.0 ml/L
7	Control	--

For statistical analysis, the yield observations were translated from net plot area basis to kg/ha. Based on the yield and cost of plant protection, the monetary returns and incremental cost-benefit ratios of the treatments were evaluated. The analysis of variance for randomized block design was used to the data collected from field trials (Gomez and Gomez, 1984). The least significant difference at P = 0.05 was always used to identify differences between data sets after an ANOVA.

3. RESULTS AND DISCUSSION

3.1 Bio-efficacy of Insecticides against Phalsa Pest

Field trials were carried out to evaluate the bio-efficacy of selected insecticides against phalsa pest during 2018 and 2019, respectively.

3.2 Bio-efficacy of Selected Insecticides against Phalsa Pest

The pre-treatment count (mean no. of aphid per shoot) of phalsa aphid was recorded which varied from 28.67 to 24.00 /3leaves/3 plants i.e., a day prior to the insecticidal treatment (Table 2). The Imidacloprid 17.8 SL @ 0.3 ml/L treated plots showed the lowest mean population of aphids (3.64) and (5.44) following both sprays in both years. Fipronil 5 SC@ 1.0 ml/L (4.94 aphid/3leaves/3 plants) and (6.18 aphid/3leaves/3 plants) was followed by. On Phalsa, the remaining treatments—Chlorpyriphos 20 EC @ 2.0 ml/L, Quinalphos 25 EC @ 2.0 ml/L, and Dichlorvos 76 EC @ 1.5 ml/L—offered only moderate aphid control. It was discovered that Quinalphos 25 EC and Chlorpyriphos 20 EC were equally effective in decreasing the number of aphids on three leaves and three plants. The least successful treatment in lowering aphid populations (20.84 mean population of aphids) was neem oil 1500 ppm @ 3.0 ml/L, which was found to be at par with the control. The data was then subjected to the Tukey HSD test for a more accurate result, which showed that the Imidacloprid 17.8 SL @ 0.3 ml/L treated plots had the highest percentage decrease of aphids by different treatment after two sprays, followed by Fipronil 5 SC @ 1.0 ml/L. It was discovered that the treatment imidacloprid 17.8 SL differed considerably from the other treatments in that it decreased the proportion of the aphid population over control. This is because, while insecticides might offer instant relief by suppressing the population of insect pests, beneficial fauna and their natural enemies may also be a viable and efficient means of managing the problem on a natural basis. Similar findings were reported by Kacharmazov et al. (1976), who recommended using broad spectrum insecticides to manage systemic insecticides such as dimethoate (Bi-58), thiometon (Intration), pirimicarb (pirimor), or endosulfan (thionex) and spraying the plants 10–15 days after transplanting to protect the mother plants from aphid attack. Similar results were reported by Raworth and Clements [14], Raworth, et al. [15] and Lowery et al. [16] reported that the sprays of Neem seed oil and Neem seed extracts to intact plants in the laboratory resulted in significant reductions in yield.

3.3 Cost-Benefit Ratio

Cost-benefit ratio that represent the comparative economics of different insecticidal treatments used for phalsa aphid control during 2018 to 2019. The data presented in Table 3 revealed that the Plots treated with imidacloprid 17.8 SL yielded the highest net profit of Rs. 26212.00 per hectare in 2018. Fipronil 5SC, Chlorpyriphos 20 EC, and Dichlorvos 76 EC produced net profits of Rs. 25864.00, 25408.00, and 25408.00 per hectare, respectively. Regarding net profit

Table 2. Evaluation of efficacy of selected insecticides against phalsa aphid during 2018 and 2019

Treatments	Pre count (numbers per /3leaves/3 plants)		Post-treatment population of aphids (numbers per /3leaves/3 plants) After 1 and 2 spray (Mean Value)		% Reduction over control	
	2018	2019	2018	2019	2018	2019
T_1	24.00 (4.90)	23.0 (4.80)	20.84	28.42	0.00	0.00
T_2	28.67 (5.35)	24.60 (4.95)	20.84	22.84	28.90f	29.22f
T_3	26.55 (5.15)	25.70 (5.07)	4.94	6.18	83.02b	85.22b
T_4	27.88 (5.28)	23.70 (4.86)	9.90	9.95	65.93e	63.28e
T_5	28.56 (5.34)	24.30 (4.93)	6.22	8.70	78.22c	77.58c
T_6	25.99 (5.10)	25.70 (5.07)	3.64	5.44	87.16a	88.26a
T_7	26.85 (5.18)	22.10 (4.70)	6.51	8.04	78.02cd	76.15cd
SE m ±	0.26	0.25	0.19	0.22	-	-
CD at 5 %	NS	NS	0.58	0.66	-	-

**Mean of three replications,*
Figures in parentheses are square root of $\sqrt{x+0.5}$

Table 3. Cost- Benefit ration and Net Income of different insecticides on phalsa during 2018 and 2019

Insecticides	Dosage	Year 2018			Year 2019		
		Fruit yields (q/ha)	Net Profit (Rs. /ha)	Cost-Benefit Ratio	Fruit yields (q/ha)	Net Income (Rs. /ha)	Cost-Benefit Ratio
Neem oil 1500 ppm	3.0 ml/L	21.54	24268.00	1:14.84	20.75	23346.00	1:11.30
Fipronil 5SC	1.0 ml/L	23.65	25864.00	1:19.37	23.23	25352.00	1:18.76
Dichlorvos 76 EC	1.5 ml/L	22.86	25328.00	1:18.69	22.23	24580.00	1:16.84
Chlorpyriphos 20 EC	2.0 ml/L	23.17	25408.00	1:17.93	22.32	24380.00	1:15.15
Imidacloprid 17.8 SL	0.3 ml/L	24.18	26212.00	1:19.67	23.97	26018.00	1:20.45
Quinalphos 25 EC	2.0 ml/L	22.38	24806.00	1:16.35	21.80	23914.00	1:13.42
Control	-	19.59	23504.00	-	19.29	23144.00	-

returns, it was discovered that treating neem oil at a dosage of 1500 ppm (or Rs. 24268.00/ha) was the least cost-effective option. Plots treated with imidacloprid (1:19.67) had the highest cost-benefit ratio, closely followed by those treated with fipronil (1:19.37) and dichlorvos (1:18.69). Although neem oil (1:14.84) treated plots were more effective at reducing mortality than safer insecticides, the cost-benefit ratio was lowest among these plots. The cost-benefit ratios for Quinalphos (1:16.35) and Chlorpyriphos (1:17.93) were found to be moderate. Comparable outcomes were also noted for the test insecticides on phalsa in 2019 with respect to net profit and cost-benefit ratios (Table 3). In terms of rupees per hectare, imidacloprid had the highest net profit in 2019 at Rs. 26018.00, followed by fipronil at Rs. 25352.00 and dichlorvos at Rs. 24580.00. In 2019, the cost-benefit ratios of several insecticidal treatments ranged from 1:20.45 to 1:11.30, with imidacloprid showing the highest ratio and fipronil treatment followed. This is due to higher cost of insecticides and the better efficacy of these insecticides to control the pest and improve the yield of crop. Similar results were obtained by Pramanick et al. [17], Mishra et al. [18], Siswanto et al. [19].

4. CONCLUSION

The field experiments conducted over two consecutive years yielded valuable insights that the application of Imidacloprid 17.8 SL @ 0.3 ml/L recorded as most effective in aphid suppression followed by Fipronil 5 SC@ 1.0 ml/L, Chlorpyriphos 20 EC and control. Further, highest cost-benefit ratio was obtained in plots treated with Imidacloprid (1:19.67) followed by Fipronil (1:19.37) and Dichlorvos (1:18.69) treatments. Thus application of Imidacloprid 17.8 SL @ 0.3 ml/L is most effective in insect pest management and for enhancing the yield of phalsa under sub-tropics of Jammu.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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