SEASONAL INCIDENCE AND MANAGEMENT OF PESTS INFESTING JAMUN (*Syzygium cuminii* L.)

by

Mr. Raut Lalit Uttam

(Reg. No. 018/146)

A Thesis submitted to the

MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI-413 722, DIST- AHMEDNAGAR,
MAHARASTRA, INDIA.

In partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE

in

AGRICULTURAL ENTOMOLGY

DEPARTMENT OF AGRICULTURAL ENTOMOLOGY

POST GRADUATE INSTITUTE
MAHATMA PHULE KRISHI VIDYAPEETH
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2021

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part there of has not been submitted by me or any other person to any other University or Institute for a Degree or Diploma

Place: M.P.K.V., Rahuri
Date: / /2021

(L. U. Raut)

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CERTIFICATE

This is to certify that the thesis entitled **"SEASONAL INCIDENCE AND MANAGEMENT OF PESTS INFESTING JAMUN (*Syzygium cuminii* L.)"** submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra) in partial fulfilment of the requirement for the award of degree of **MASTER OF SCIENCE** in **AGRICULTURAL ENTOMOLOGY**, embodies the result of a piece of bonafide research work carried out by **RAUT LALIT UTTAM**, under my guidance and supervision and that no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been duly acknowledged.

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Place : M.P.K.V., Rahuri (P. N. Rasal)
Date : / / 2021 Associate Dean

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Place: MPKV, Rahuri

Date : / / 2021 (L. U. RAUT)

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LIST OF ABBREVIATIONS

@	:	At the rate
a.i.	:	Active ingredient
AZF	:	Arid zone fruit
Agric	:	Agriculture
Biopest	:	Biopesticides
^0C	:	Degree celcius
CD (P = 0.05)	:	Critical difference at 5
Cm	:	Centimeter
DAS	:	Days after spraying
Entomol	:	Entomology
N	:	North
Etc	:	et cetera (and the rest)
et al	:	et alia (and others)
G	:	Gram
Ha	:	Hectare
Hortic	:	Horticulture
Int	:	International
J	:	Journal
Kg	:	Kilogram
L	:	Litre
M	:	Meter
M^2	:	Meter square
Mg	:	Milligram
Ml	:	Milliliter
mngmt	:	Management
MW	:	Meteorological week
No.	:	Number
%	:	Per cent
q/ha	:	Quintal per hectare
R	:	Correlation coefficient
RBD	:	Randomized block design

ABSTRACT

SEASONAL INCIDENCE AND MANAGEMENT OF PESTS INFESTING JAMUN (*Syzygium cuminii* L.)

By

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Rahuri, Ahmednagar-413722

2021

Research Guide	**:**	**Dr. A. R. Walunj**
Discipline	**:**	**Agricultural Entomology**

The experiment on "Seasonal incidence and management of pests infesting jamun (*Syzygium cuminii* L.)" was carried out on jamun orchard located at Research farm of AICRP on Arid Zone Fruits, Department of Horticulture, M.P.K.V., Rahuri, during the months of February, 2019 to December, 2019.

The overall peak intensity of leaf eating caterpillar was noticed during the month of November and reached its peak to 28.71 per cent leaf damage in (47^{th} MW), chafer beetles were noticed to be reached its peak during (26^{th} MW) and causes maximum damage up to 19.18 per cent on the onset of monsoon and the infestation of leaf miner was noticed to attained its peak during the month of June and causes maximum damage up to 1.87 per cent/ shoot/ branch of tree. Whereas, the fruit borer was noticed to be reached its peak during (25^{th} MW) and causes maximum damage up to 67.70 per cent fruit damage.

Correlation studies shows that, there was highly positive significant correlation between leaf eating caterpillar and minimum temperature (r = 0.304), morning relative humidity (r = 0.707), evening relative humidity (r = 0.667) and rainfall (r = 0.667). Whereas, there was negatively significant correlation with maximum temperature (r = -0.404).

Chafer beetles indicated highly positive significant correlation with maximum and minimum temperature at (r = 0.447) and (r = 0.373) respectively. Whereas, there was negatively non-significant correlation with morning relative humidity (r = -0.209), evening relative humidity (r = -0.066) and rainfall (r = -0.066) and leaf miner had highly positive significant correlation with maximum and minimum temperature at (r = 0.585) and (r = 0.703) respectively. Whereas, there was negatively non-significant correlation with morning relative humidity (r = -

0.158), evening relative humidity (r = -0.124) and positively non-significant correlation with rainfall (r = 0.187).

Fruit borer had highly positive significant correlation with minimum temperature (r = 0.864) and evening relative humidity (r = 0.593) and there was highly positive non-significant correlation with morning relative humidity (r = 0.524) and rainfall (r = 0.344). Whereas, it was negatively non-significant correlated with maximum temperature (r = -0.138).

The results of present investigation on ecofriendly management of leaf feeders on jamun under field condition revealed that, the treatment with NSE 5% was found highly effective in managing the leaf feeders infestation, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ lit. water, followed by Neem oil @ 2 ml/ lit. water and Karanj oil @ 2 ml/lit. water, as next promising treatment.

For the management of fruit borer on jamun, the treatment with NSE 5% found most effective control, which recorded least (6.37 per cent) fruit borer damage, however it was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ lit. water, which recorded 8.32 per cent fruit borer damage, followed by Neem oil @ 2 ml/ lit. water which recorded 9.17 per cent fruit borer damage as against, 42.67 per cent fruit borer damage was recorded in untreated control.

As regards the yield of jamun, the treatment with NSE 5%, Azadiractin 10000 ppm @ 2 ml/ lit. water and Neem oil @ 2 ml/ lit. water registered the higher fruit yield i.e., 30.54, 28.45 and 27.25 kg/tree respectively. However, all the treatments were found significantly superior over control.

1. INTRODUCTION

Syzygium cuminii (Family: Myrtaceae) is also known as *Syzygium jamunum* and *Eugenia cumini*. Other common names are Jambul, Black Plum, Java Plum, Indian Blackberry, Jamun etc. The tree fruits once in a year and the berries are sweetish sour to taste. The ripe fruits are used for health drinks, making preserves, squashes, jellies and wine (Warrier *et al.* 1996). In association to its dietary use, all parts of the tree and importantly the seeds are used to treat a wide range of ailments, the most important being diabetes mellitus (Sagrawat *et al.* 2006). Different parts of the jamun were also reported for its antioxidant, anti-inflammatory, neuropsycho-pharmacological, anti-microbial, anti-bacterial, anti-HIV and anti-fungal, nitric oxide scavenging, free radical scavenging, anti-diarrheal, anti-fertility, gastro protective and anti-ulcerogenic and radio-protective activities.

Jamun possesses commercial importance as a minor fruit in tropical and subtropical conditions. It is a versatile fruit tree of best food and medicinal value. In India the maximum number of jamun trees are found scattered throughout the tropical and subtropical regions. It also occurs in the lower range of the Himalayas up to an elevation of 1,300 meters and in the Kumaon hills up to 1,600 meters. It is widely grown in the larger parts of India from the Indo-Gangetic plains in the north to Tamil Nadu in the South. It is found up to an altitude of 1800 m and its habitat starts from Myanmar and extended to Afghanistan. This plant is also found in other countries like Thailand, Philippines, Madagascar *etc*. (Singh *et al.* 2011).

India is the second largest producer of the fruits in the world. World production of jamun is estimated to 13.5 million tonnes, out of which 15.4% is contributed by India. In India Maharashtra is the largest jamun producer state followed by Uttar Pradesh, Tamil Nadu, Gujarat and Assam (Anon., 2014).

Jamun is an important under exploited indigenous fruit tree of India. It is a very common, large, evergreen tree of Indian subcontinent belongs to the Myrtaceae family. The tree is 8m to15m tall, with oblong opposite leaves that are smooth and glossy with a turpentine smell. The bark is scaly grey and the trunk is forks or multiple stem which has fragrant white flowers in branched clusters with hermaphrodite nature at stem tips and purplish-black oval edible berries with single seed.

There are several major and minor pests which infest leaves, flowers, fruits, seeds and barks but the perusal of literature reveals that there is no consolidated account available on the insects associated with jamun in India. The survey of insects associated with jamun in India was conducted and approximately 300 specimens belonging to five orders were collected, which comprises of 78 species mainly representing two orders i.e., Lepidoptera (34 species) and Hemiptera (26 species), (Kumar *et al.* 2010).

Among the pests, fruit borer and leaf feeders viz., leaf eating caterpillar, chafer beetles and leaf miner causes severe damage to tree in which the leaf eating caterpillar (*Carea subtillis*) infest the leaves and may defoliate the tree whereas, jamun fruit borer (*Meridarchis scyrodes* M.) has been reported one of the serious pest that damages the fruits of jamun upto high extent.

The fruit borer, *Meridarchis scyrodes* M. is a serious pest in southern states like Gujarat, Maharashtra, A.P., Karnataka, etc. of India. The pest causes up to 70% yield loss in ber under severe infestation. (Haldhar and Maheshwari, 2018).

Now a day's farmers are cultivating jamun as a commercial fruit crop and use several types of chemical pesticides for the control of the pests, which may result into several problems such as hazardous level of pesticide residue, adverse effect on the population of natural enemies, resurgence of the pest and pollution hazards in the environment etc. Therefore, in the view of the above, present investigation has undertaken to study a **"Seasonal incidence and management of pests infesting jamun (*Syzygium cuminii* L.)"** during season 2019 with the following objectives:

1) To study the seasonal incidence of major insect pests of jamun with biotic and abiotic parameter.
2) Eco-friendly management of leaf feeders and fruit borer of jamun.

2. REVIEW OF LITERATURE

During the present investigation, studies were carried out on seasonal incidence and eco-friendly management of leaf feeders and fruit borer of jamun. The literature pertaining to fruit borer and leaf feeders particularly in relation to these aspects have been reviewed and presented here under.

2.1 Review of Literature for Seasonal Incidence

Joshi *et al.* (1981) studied on jamun leaf miner during the period from June to August, 1979. Jamun trees *Syzygium jambolana* Lam. were severely damaged by jamun leaf miner, *Antispila anna* M. (Heliozidae: Lepidoptera) to the tune of 40.8%.

Bagmare (1995) reported that the jamun leaf miner *Acrocercops phaeospora* made blister like swellings on the dorsal surface of leaves. Adults of jamun leaf miner were very small in size and delicate with narrow long fringed wing.

Nandihalli *et al.* (1996) studied that the occurrence of fruit borer (*Meridarchis scyrodes* Meyrick) was positively correlated with the temperature and negatively correlated to relative humidity and wind speed.

Patil and Patil (1997) studied the biology of ber fruit borer *Meridarchis scyrodes* Merick (Carposinidae: Lepidoptera). It indicated that egg, larvae, pre-pupae and pupal periods averaged 5.30 ± 0.40, 16.30 ± 3.50, 1.20 ± 0.40 and 7.50 ± 0.80 days respectively. Fecundity ranged from 23 to 35 eggs. Larvae pupated in soil after male and female adults lasted for 2.65 ± 0.50 and 3.70 ± 0.27 days respectively. One generation was completed in about 30 days. Incidence of the pest started from second fortnight of November with a peak during second fortnight of December and then onward the incidence reduced and ceased totally by second fortnight of January.

Hosagoudar *et al.* (1999) studied on the incidence of ber fruit borer, *Meridarchis scyrodes* Meyrick. The incidence of fruit borer first noticed in the first fortnight of November, and reached peak during December.

Gopali *et al.* (2003) studied the population dynamics of ber fruit borer (*Meridarchis scyrodes* Meyrick) and found that, the activity of pest was observed from the first week of November (3.27%) reaching its peak (43.50%) during the fourth week of December and continued up to the second week of January (27.40%). The activity of pest gradually decreased towards the end of the season; that is the activity of fruit borer started from the first week of November and reaches its peak during fourth week of December and continued up to January. The population showed a negative correlation with the maximum (r = -0.75) and minimum (r = -0.83) temperatures, relative humidity (r = -0.34) and rainfall (r = -0.12) during 2002-03.

Sarwar (2006) observed that ber tree suffered severely from the attack of different insect pests (fruit flies, ber beetle, grey hairy caterpillar, leaf eating caterpillar, weevils and ber mite encompassing 9.66, 4.66, 2.66, 3.00 2.00 and 8.33 mean populations per tree respectively) on or after flowering to fruit maturity. Among insect species attacking *Zizyphus jujube*, caterpillars of the *Thiacidas postica, Euproctis fraterna* and *Porthmologa paraelina* and weevils *Amblyrrhinus poricollis* and *Myllocerus spp*. fed on leaves and inflorescence. Other pest species identified included ber beetle, *Adoretus pallens* and *A. nitidus* it fed on leaves cutting round holes in them.

Singh *et al.* (2009) reported that the jamun leaf miner (*Acrocercops syngramma* and *Acrocercops phaeospora*) causes damage during the reproductive phase, i.e., from April to September. The newly hatched caterpillar mines a narrow thread like silvery gallery on the leaf along the mid-rib upward.

Karuppainah *et al.* (2010) reported that the damage of ber leaf feeders viz., ber butterfly, leaf webber and grey weevil was more during June to September and stone weevil damage was noticed from October to February. In case of natural enemies, the fruit fly parasitoid *Fopius sp*. And other hymenopterans, braconids, icheunnimonid wasp; neuroptens, green lace wing and spiders also have been reported during this period. Besides to ber fruit fly, the stone weevil and ber butter fly seem to be serious pests of ber in this region.

Haldhar *et al.* (2016) reported that the incidence of fruit borer (*M. scyrodes*) was recorded on ber from October to February. The seasonal incidence of fruit borer, *M. scyrodes* attained its peak in the second fortnight of December (58.33%) in ber crop. The leaf feeder's *viz*., ber butterfly, leaf webber, mite, thrips and grey weevils were more active during June to September.

Haldhar *et al.* (2016) reported that chafer beetles devour ber leaves mainly during the night. They become active with the onset of the rainy season when new growth starts. They cause heavy damage to developing foliage of ber during June to August. Leaves become just like sieves and in severe cases, the whole tree is rendered leafless. They also damaged the nursery, where adults defoliate the leaves and grubs griddle the main roots causing seedlings to die. Eggs are laid in the soil during the early part of the rainy season (May to August in north India). Larvae hatch out in one week and feed on roots and vegetation. Adults emerge with the onset of rains. There is only one generation per year.

Papade (2016) studied on pests of ber and found that the overall peak intensity of leaf eating caterpillar and leaf webber was noticed during 29-30 meteorological week and 33-34 meteorological weeks respectively. Whereas the overall per cent infestation caused due to fruit borer was noticed from 51 to 3-4 meteorological weeks. For management of fruit borer two sprays of Spinosad 2.5 EC,

Fipronil 5 EC @ 1 ml/l and Neem oil + Pongomia oil @ 2ml/l at 50% flowering and fruiting stage can be considered better for control of the pests.

Kanhar *et al.* (2017) conducted experiment on mango leaf miner, *Acrocercops syngramma* (M.) infestation and its parasitoids. The leaf miner remained active during the emergence of new flushes in plants from August to October, with four population peaks. However, two parasitoids, *Chrysocharis nephereus* (W.) and *Sympiesis hyblaeae* (S.) were recorded in leaf miner larvae. The correlation results of temperature and relative humidity with leaf miner populations on different mango varieties showed non-significant and negative.

Singh and Gupta (2017) studied on the effect of weather i.e. temperature on fruit borer, *Helicoverpa armigera* (Hub.) activity. The correlation of *H. armigera* with maximum temperature was strongly positive (r= 0.5082 and 0.5393) and similarly with minimum temperature (r = 0.5880 and 0.6866).

Kumar *et al.* (2018) studied on the impact of weather parameters on population dynamics of soil borne insect pests infesting oats and revealed that white grub larvae and adult showed highly significant positive correlation with temperature (r =0.89, 0.93), (r =0.86, 0.91) and sunshine (r =0.65, 0.64).

Mahapatra *et al.* (2018) studied on the *Helicoverpa armigera* and *Spodoptera litura*. Both *H. armigera* and *S. litura* was negatively correlated to mean maximum temperature (-0.13 and -0.10), mean minimum temperature (- 0.47 and -0.43), evening RH (-0.52 and -0.49) and rainfall (-0.36 and -0.32) while a positive correlation was witnessed so far morning R.H (0.31 and 0.28).

Saran *et al.* (2018) studied on the incidence of (*Leucinodes orbonalis* Guenee) in relation to weather factors in brinjal. Among the weather parameters maximum temperature and morning relative humidity showed positive correlation but minimum temperature, evening relative humidity and rainfall showed negative correlation on the incidence of both shoot and fruit infestation by the pest.

Thorat (2018) studied on pests of ber and concluded from correlation studies that there was positive correlation between leaf eating caterpillar incidence and evening humidity (r = 0.72), while leaf webber incidence also had positive correlation with evening humidity (r = 0.74). Leaf webber incidence was found negatively correlated with maximum temperature (r = -0.74) and negatively correlated with minimum temperature (r = -0.71). It was noticed that there was negative correlation between morning humidity and stone weevil incidence (r = -0.73).

Bajad *et al.* (2019) studied the incidence and diversity of scarabs noticed from second week of June to third week of October. Peak activity of scarabs was noticed in 30th meteorological week (21st–27th July) scarab beetles population exhibited non-significant, negative correlation with

maximum temperature, evaporation, bright sunshine hours and significant, positive with minimum temperature, relative humidity and rainfall.

2.2 Review of Literature for Management of Pests

Yelshetty *et al.* (1996) studied on ber fruit borer and revealed that the plant treated with NSKE 5% maintain their efficacy against fruit borer by recording 15.91 percent fruit damage. However, 48.50 percent of fruit damage was noticed where the plants were not treated with insecticides.

Patil and Patil (1997) studied on insecticide bioefficacy and identification of critical stages for insecticide application against ber fruit borer *Meridarchis scyrodes* Meyrick (Carposinidae: Lepidoptera). Application of two spray at marble stage and one spray at maturation stage of the ber fruit recorded minimum infestation and was more economical than other critical stage combinations.

Hosagoudar *et al.* (1999) studied on ber fruit borer and observed that Monocrotophos 0.036% was effective in controlling ber fruit borer whereas Nimbicidin 0.03% and NSKE 5% were found inferior to all insecticidal treatments.

Kumar and Singh (2002) reported that many biopesticides have been developed from trees including neem (*Azadirachta indica*), Karanj (*Pongamia pinnata* or *P. glabra*), Mahua (*M. indica* or *M. longifolia*) and Chinaberry (*Melia azedarach*). Among these, methanolic seed extract, acetone leaf extract, aqueous seed extract, chloroform seed extract and petroleum ether seed extract of karanj were evaluated and found to act as oviposition deterrants, antifeedents and larvicides against a wide range of insect pests.

Rajaram and Siddeswaran (2006) studied the effect of chemicals and plant products against the fruit borer and fruit fly complex on ber and found that the azadiractin 1% and *Ocimum sanctum* extract 1% are also effective only up to 10 days after spray.

Rijal *et al.* (2008) evaluated the efficacy *Metarhizium anisopliae* and *Beauveria bassiana* and compared with four commercial biopesticides against Chickpea pod borer (*Helicoverpa armigera* Hubner). The number of *H. armigera* larvae observed in plots treated with *M. anisopliae* and *B. bassiana* were significantly lesser than the control plots during vegetative, flowering and pod setting stage of chickpea. Similarly, the chickpea yield was significantly higher in the plots treated with *M. anisopliae* and *B. bassiana* than control, however lesser than *NPV* and *Bt.* treated plots.

Rahman *et al.* (2009) studied on the efficacy of some botanicals against brinjal shoot and fruit borer and found that Neem oil at 4% concentration showed lowest larval survivability (26.67%). Considering the efficacy of all concentrations the order of toxicity was neem oil> karanj oil> mahogoni oil. The effectiveness of the botanicals viz., neem oil (4%), karanj oil (4%), mahogoni oil (4%), neem cake (250 kg/ha), neem oil + neem cake (4% + 250 kg/ha) were evaluated

by application at 15 days interval against BSFB in the field. The highest percentage of reduction (70.44% infested shoots/plant) of BSFB was found in neem oil + neem cake.

Shobharani and Nandihalli (2010) studied on shoot borer, *Leucinodes orbonalis*. and revealed that Nimbecidine @ 5 ml/l and NSKE @ 5 percent were significantly superior in reducing the shoot infestation after each spray followed by spraying of pongamia oil @ 2 per cent and single application of neem cake @ 240 kg/ha. The significantly higher tuber yields were recorded in Nimbecidine @ 5 ml/l (35.82 q/ha) and NSKE@ 5 per cent (33.38 q/ha) with higher B: C ratios of 6.78 and 4.48, respectively which were followed by pongamia oil @ 2 per cent (30.91 q/ha) and neem cake applied once 240 kg/ha (28.07 q/ha).

Swaminathan *et al.* (2010) reported the antifeedant activity of *Azadirachta indica* (L.) were evaluated against the adult *H. vigintioctopunctata* under laboratory conditions. Among the botanicals evaluated *P. glabra* oil showed the maximum anti-feedant activity. No feeding was observed up to 48 hours after treatment. Mortality was noticed 72 hours after treatment and cent per cent mortality was recorded 7 days after treatment at all the concentrations. Neem oil showed 60 per cent mortality at 5 per cent concentration. The leaf extract and seed kernel extract of *A. indica* had less anti-feedant activity as compared to the oil formulations of *A. indica* and *M. latifolia* (based on the per cent leaf area consumed). A decrease in feeding was evidenced after treatment with *M. verrucaria*, *M. verrucaria* and *M. anisopliae.*

Borkar and Sarode (2012) studied on the bollworm complex and their natural enemies on non *Bt* cotton. The minimum egg and larval population of *Helicoverpa armigera* was reported in the application of NSE 5% and Azadirachtin 1500 ppm followed by spinosad 45 and *HaNPV* 250 LE/ ha. However, the application of NSE 5% and Azadirachtin 1500 ppm followed by spinosad 45 SC was better in reducing larval population of *Earias vitella*. The sole treatments of botanicals and the applications of botanicals followed by *HaNPV* 250 LE/ ha have been observed to be safer to adults of coccinellids beetles, *Chrysoperla zastrowi sillemi* eggs and larvae as well as spiders.

Ahirwar *et al.* (2013) studied on the six microbial treatments against foliage feeders of soybean crop. Among various treatments, *B. thuringiensis* var. *kurstaki* was found to be most effective as it recorded the lowest larval population (3.63 larvae / mrl) followed by *B. bassiana* (3.93 larvae/ mrl), *M. anisopliae* (4.53 larvae/ mrl), Spinosad 45 SC (4.66 larvae/ mrl), Dipel (5.80 larvae/ mrl). All the treatments exhibited significantly higher yield as compared to control.

Nizamani *et al.* (2014) studied on the integrative pest management (IPM) approaches for jujube beetle (*Adoretus pallens* Har) and found significant reduction in the infestation of *A. pallens* was obtained with Neem Seed Extract (NSE) followed by NSE + Dhatura and Neem Leave Extract (NLE) + Dhatura indicates their higher efficacy.

Phukon *et al.* (2014) showed that neem oil was nearly as effective as cypermethrin in reducing fruit damaged by *Helicoverpa armigera* leading to increased yield. The entomopathogenic fungi- *Beauveria bassiana* and *Metarhizium anisopliae* could be effectively used as pest management option in production of organic tomato to reduce the pest population below economic threshold level and increased yield.

Rahman *et al.* (2014) studied on botanicals against *H. armigera.* The lowest fruit infestation, both by number and weight, was observed in neem seed kernel extract (27.15%, 22.29%) treated plot which was statistically similar to tobacco leaf extract (27.71%, 23.31%) treated plot and cypermethrin (28.87%, 25.44%) treated fruits. Percent infestation reduction over control was the highest in neem seed kernel extract (30.08%) followed by tobacco leaf extract (28.68%). The highest yield (18.14 t/ha) were also obtained from neem seed kernel extract treated fruits.

Razak *et al.* (2014) studied the efficacy of certain neem products *viz*., neem oil, neem seed kernel extract, neem cake extract, neem leaf extract and one commercial product *Vijaya neem* against third instar larvae of tobacco caterpillar *Spodoptera litura*. Among the neem products tested, NSKE 5% showed the highest larval mortality of 40%.

Chandrayudu *et al.* (2015) evaluated the efficacy of botanical and microbial insecticides against tobacco caterpillar, *Spodoptera litura* infesting groundnut. Among the treatments tested NPV (*S. litura***)** @ 250 LE ha-1 and *Bacillus thuringiensis* (*Bt*) sprays were significantly effective. This was followed by *Nomuraea rileyi* 1.5x1013 spores mL-1 and NSKE @ 5.0 per cent compared to other treatments neem oil @ 2.0 mlL-1 and *Beauveria bassiana* 1.5x1013 spores mL-1 respectively.

Faqiri and Kumar (2016) studied on the management of tomato fruit borer (*Helicoverpa armigera* H.) by chemical insecticides and neem products. The lowest infestation of fruit borer was recorded in treatments Profenophos 50% EC (4.350), Spinosad 45% SC (5.370), Deltamethrin 2.8% EC (5.90), NSKE (5.90), Chlorantraniliprole 18.5% SC (6.550), Neem oil (6.650). However, all these treatments were superior over control. The maximum yield was reported Neem oil (15 q/ha), followed by NSKE (13.00 q/ha), Deltamethrin 2.8% EC (14.00 q/ha), Profenophos 50% EC (16.00 q/ha), Chlorantraniliprole 18.5% SC (12.00 q/ha), Spinosad 45% SC (13.00 q/ha).

Nizamani *et al.* (2016) studied on the ber Hairy caterpillar, *Euproctis fraterna* Moore (Lepidoptera, Lymantriidae) and revealed that the light trap catches plus application of Neem seed extract (NSE) and lorsban significantly reduced the pest population. It is concluded that installation of light trap, application of Neem seed extract and Lorsban efficiently managed the population of hairy caterpillar in jujube orchards.

Singh *et al.* (2016) reported that the NSKE 5 % found most effective against Brinjal shoot and fruit borer followed by *Bacillus thuringensis, Verticellium lecanii* and *Beauveria bassiana*. The highest cost: benefit ratio was obtained from NSKE 5 percent (1:24.40) followed by Indoxacarb 14.5 SC (1:24.13) and Emamectin benzoate 5 SG (1:24.03) which were also economical than other treatments.

Bhagat *et al.* (2017) studied on the different botanicals and bio-pesticides that were tested against the natural incidence of the *Helicoverpa armigera* on marigold and observed that the larval incidence at 1, 3, 5, 7 and 10 days after both spraying was lowest in plots sprayed with *HaNPV*. However, the next best treatments in the order of effectiveness for the control of *Helicoverpa armigera* were NSKE 5%, *Bacillus thuringiensis* @ 2.5 gm / litre, Neem oil @ 4ml / litre, *Beauveria bassiana* @ 4ml / litre and Karanj oil @ 5%.

Kumar *et al.* (2017) studied on the maize cob borer *Helicoverpa armigera* and revealed that, the minimum cob borer larvae was recorded in plots sprayed with Indoxacarb (0.23) which was at par with NSKE 5% @ 25 l/ha, (0.27), followed by Neem oil 2% @ 10 l/ha, (0.33), Karanj oil 2% @ 10 l/ha, (0.37), Karanj seed powder @ 25kg/ha, (0.33) and Chilli-Garlic solution @ 9 kg/ha (0.33) treated plots. The maximum grain yield was recorded in plots treated with Indoxacarb 14.5 SC (30.05 q ha-1) followed by Neem oil 2 % (26.03 q/ha), Karanj oil (25.50 q/ha), NSKE (24.83 q/ha), Karanj seed powder (23.58 q/ha) and chilli-garlic solution (21.91 q/ha), respectively.

Srinivasulu *et al.* (2017) an experiment was conducted to identify the right time of spray of botanicals and chemical insecticides for the control of ber fruit borer, *Meridarchis scyrodes* M. Spray time significantly influenced the per cent mortality of pest. First spray with 5% neem seed kernel extract (NKSE), second spray with 0.07% acephate and third spray with 5% NSKE given on 15th September, 30th September and 15th October. Among the three sprays, first spray with 5% NSKE on 15th September recorded the lowest per cent borer damage (28.12). The highest fruit yield (73.85 kg/plant) and benefit cost ratio (1.72) were also recorded with first spray on 15th September.

Zhong *et al.* (2017) studied on the effects of azadirachtin on the development and mortality of *T. rufivena* (Lepidoptera) pest of areca palm. All larval instars were susceptible to azadirachtin, but the stomach and contact toxicities diminished as the larvae matured. Azadirachtin also prolonged larval development and duration of the pupal stage. The percentage of adult emergence decreased, and longevity of the emerged adults was shortened. Also, egg production and viability from females treated as larvae with azadirachtin were significantly affected.

Berani *et al.* (2018) studied the efficacy of botanicals against lepidopteran insect pest infesting black gram. Among the different botanicals, Azadirachtin 0.15 EC 0.0006 percent, Neem Seed Kernel Extract (NSKE) 5 percent, neem oil 0.3 percent and neem leaf extract (NLE) 10 percent

were found highly effective in managing *Spilosoma obliqua* Walker and *Maruca testulalis* (Geyer) in black gram. A treatment of Azadirachtin 0.15 EC 0.0006 percent, NSKE 5% neem oil 0.3 percent and neem leaf extract 10 percent registered the higher grain yield of black gram.

Bochare *et al.* (2018) studied on defoliator of soybean and revealed that *Beauveria bassiana* and *Nomuraea rileyi* each @ 7.5 g / l and neem seed extract 5 % were most effective in reducing the population of green semilooper and tobacco leaf eating caterpillar as well as registered highest yield of soybean. The neem seed extract 5 % was economically most effective treatment against soybean defoliators followed by *N. rileyi* @ 7.5 g/l.

Dhepe *et al.* (2018) studied on different microbial treatments against the foliage feeder of soybean crop (*Spodoptera litura*). Among these treatment *Beauveria bassiana* 5 g/l recorded 63.62 per cent larval reduction and it was found to be the most effective treatment.

Soni *et al.* (2018) studied on the tobacco caterpillar, *S. litura* is the most damaging insect pest of soybean. In the evaluation of plant products against *S. litura* NSKE @ 5% was found second most effective botanicals after recommended insecticide on soybean after both the sprays 1st as well as 2nd with benefit cost ratio of 1.14.

3. MATERIAL AND METHODS

Jamun (*Syzigium cuminii* L.) crop suffers heavily due to infestation of various pests. Keeping this in view, the economic importance of fruit borer (*Meridarchis scyrodes*), and Leaf feeders viz., Leaf eating caterpillar (*Carea subtilis*), Chafer beetles (*Adoretus spp*.) and Leaf miner (*Acrocercops spp.*) on jamun, studies were undertaken to identify seasonal incidence of fruit borer and leaf feeders on jamun and eco-friendly management of pests using biopesticides and botanicals.

The field experiment was carried out at jamun orchard located at Research farm of AICRP on Arid Zone Fruits, Department of Horticulture, M.P.K.V., Rahuri during the period of February, 2019 to December, 2019. The details of material used and methods adopted during the course of investigations are described as below in detail;

3.1 Seasonal Incidence of Leaf Feeders and Fruit Borer on Jamun

3.1.1 Selection of Jamun Orchard

The studies on seasonal incidence of jamun pests were carried out on fifteen-year-old orchard of jamun at AICRP on Arid Zone Fruits MPKV, Rahuri. All the experimental trees in the orchard were kept free from application of insecticides. All other agronomical practices were followed as per the recommendation made by MPKV, Rahuri. Ten trees were randomly selected from the orchard of variety Kokan Bahadoli and the monitoring of pests incidence was carried out during the period of February 2019 to December 2019. Observations were recorded at weekly interval from the 5^{th} to 52^{nd} MW.

3.1.2 Details of Experiment

a.	Location	:	AICRP, AZF(Horticulture), MPKV, Rahuri
b.	Crop	:	Jamun
c.	Variety	:	Kokan Bahadoli
d.	Spacing	:	6 m × 6 m
e.	Design	:	Randomized Block Design
f.	No. of treatments	:	Seven (07)
g.	Number of replication	:	Three (3)
h.	Plot size	:	1024 sq. m
i.	Age of orchard	:	15 years
j.	No. and date of spraying	:	Three, 19/03/2019, 03/04/2019 and 18/04/2019
k.	Year	:	2019

3.1.3 Method of Recording Observation of Pests

Seasonal incidence of pests infesting jamun *viz*., leaf feeders and fruit borer

3.1.3.1 Fruit Borer (*Meridarchis scyrodes* Meyrick)

The observations on incidence of fruit borer were recorded by randomly selecting four branches of same length (1.5 ft. each) on the tree from top, middle and bottom at weekly interval from fruit setting to harvest (14 MW to 28 MW of 2019). The per cent fruit damage was worked out by counting infested fruits as well as healthy fruits and then cumulative per cent fruit damage after harvesting was worked out.

3.1.3.2 Leaf Eating Caterpillar (*Carea subtilis*)

The observations on leaf eating caterpillar were assessed by counting damaged leaves by caterpillar at weekly interval from 5th meteorological week (February 2019) to 52nd meteorological week (December 2019).

The total number of damaged and healthy leaves of randomly selected leaves from four branches of same length (1.5 ft. each) on each tree was observed. The per cent leaf damage was calculated as follows.

$$\text{Per cent damage} = \frac{\text{Number of damaged leaves}}{\text{Total number of observed leaves}} \times 100$$

3.1.3.3 Chafer Beetles (*Adoretus spp*.)

The observation on chafer beetles were assessed by counting the infested leaves by chafer beetles at weekly interval from 5th meteorological week (February 2019) to 52nd meteorological week (December 2019).

The total number of damaged and healthy leaves of randomly selected leaves from four branches of same length (1.5 ft. each) on each tree was observed. The per cent leaf damage was calculated as follows.

$$\text{Per cent damage} = \frac{\text{Number of damaged leaves}}{\text{Total number of observed leaves}} \times 100$$

3.1.3.4 Leaf Miner (*Acrocercops spp.*)

The observations on leaf miner were recorded by counting the infested leaves by leaf miner at weekly interval from 5th meteorological week (February 2019) to 52nd meteorological week (December 2019).

The total number of damaged and healthy leaves of randomly selected leaves from four branches of same length (1.5 ft. each) on each tree was observed. The per cent leaf damage was calculated as follows.

$$\text{Per cent damage} = \frac{\text{Number of damaged leaves}}{\text{Total number of observed leaves}} \times 100$$

3.1.4 Data on Meteorological Parameters

To study the influence of abiotic factors (meteorological parameters) on seasonal incidence of pests, the meteorological data on maximum temperature (T max.), minimum temperature (T min.), relative humidity during morning (RH I) and evening (RH II) hours, rainfall (mm) and wind velocity were obtained from the Agricultural Meteorological Observatory, Water management project MPKV, Rahuri, for the period of February 2019 to December 2019.

3.2 Data on Eco-Friendly Management of Pests Infesting Jamun

Eco-friendly management of pests infesting jamun was studied by conducting separate field trial. The details of biopesticides and botanicals used for experiment with their common name, formulation and source are given below in Table-1.

For management experiment single jamun tree was considered as a treatment plot for evaluation of each spray treatment. Each treatment was replicated thrice in randomized block design.

3.2.1 Details of Evaluated Treatments

The particulars of treatments are stated in Table 1. Plan of layout for trial on jamun orchard based on indicated Sr. No. of treatments is depicted in Fig.1.

3.2.2 Preparation of Spray Fluid

For each treatment 15 L spray fluid were prepared by taking into account spray fluid rate 500 L ha^{-1}.

3.2.3 Application of and Botanicals and Biopesticides

Power sprayer was used to carry out spraying operation. Each selected plant was thoroughly sprayed at each spray.

Each treatment consisting of three sprays applied at an interval of about 15 days. First spray of biopesticides was taken at the flowering stage.

3.2.4 Care in Treatment

Care was taken to cover all target trees thoroughly while spraying. Spraying were carried out in the morning hours and care was taken to wash the spray pump with clean water to avoid contamination of one treatment product with other.

Table 1. Particulars of biopesticides and botanicals used during experiment

Sr. no.	Botanical / Biopesticide	Available Conc.	Trade name	Source
1.	*Metarhizium anisopliae*	1.15%	Phule Metarrhyzium	Biopesticide laboratory M.P.K.V., Rahuri.
2.	*Beauveria bassiana*	1.15%	Phule Beauveria	Biopesticide laboratory M.P.K.V., Rahuri.
3.	Neem oil			Vijaya Agro Industries, Sangamner. Ahmednagar (M. S.)
4.	Karanj oil			Vijaya Agro Industries, Sangamner. Ahmednagar (M. S.)
5.	Azadiractin	10000 ppm	Nimbika plus	R. B. Herbal Agro Satana, Nashik
6.	Neem seed extract	5%		Giridhar Agro Pvt. Ltd., Nashik (M.S.)-
7.	Untreated control	-	-	-

Table 2. Treatment details for field trial on jamun

Treatment No.	Treatment	Dose per Litre of water
T1	*Metarhizium anisopliae*	6.0 g/lit.
T2	*Beauveria bassiana*	6.0 g/lit.
T3	Neem oil	2.0 ml/lit.
T4	Karanj oil	2.0 ml/lit.
T5	Azadiractin 10000 ppm	2.0 ml/lit.
T6	NSE 5%.	50 gm/lit.
T7	Untreated control	-

3.2.5 Method of Recording Observation

Observation recorded pertaining to the efficacy of botanical and biopesticide treatments against fruit borer and leaf feeders were as follows.

Observation of management experiment was taken from three days after last spraying.

3.2.5.1 Fruit Borer (*Meridarchis scyrodes* M.)

The observations of fruit borer were recorded from randomly selected four branches of same length (1.5 ft. each) on the tree from top, middle and bottom at the time of harvesting. The per cent fruit damage was worked out by counting infested fruits as well as healthy fruits and then cumulative per cent fruit damage after harvesting was worked out.

3.2.5.2 Leaf Feeders *viz*., Leaf eating caterpillar and chafer beetles

The observation of leaf feeders was assessed by counting the total number of damaged and healthy leaves of randomly selected leaves from four branches of same length (1.5 ft. each) each tree were observed. The per cent leaf damage was calculated as follows.

$$\text{Per cent damage} = \frac{\text{Number of damaged leaves}}{\text{Total number of observed leaves}} \times 100$$

3.2.6 Recording of the Yield

As regards the yield of marketable fruits from each treatment plots, the fruits were harvested separately and weighed on electronic top balance and recorded in kg in three replications. The jamun fruit yield obtained from the individual tree of each treatment at each harvest was recorded in kg per tree and expressed in quintal per plant.

3.2.7 Statistical Analysis

The data on percent infestation of pests were converted into arcsine transformed values and then subjected to statistical analysis to find out the significant difference for interpreting the results. The data were transformed in kg/plant and subjected to statistical analysis to work out SE and CD. The significance of the treatment was assessed at 5 per cent level (Fisher and Yates, 1963).

4. RESULTS AND DISCUSSION

The studies on seasonal incidence and management of leaf feeder's *viz*., leaf eating caterpillar, chaffer beetles, leaf miner and fruit borer were carried out and results are presented in this chapter.

4.1 Seasonal Incidence of Leaf Feeder's *Viz*., Leaf Eating Caterpillar, Chafer Beetles, Leaf Miner and Fruit Borer

4.1.1 Leaf Eating Caterpillar (*Carea subtilis*)

It is revealed from the data presented in the Table 3 that, the degree of damage due to leaf eating caterpillar which was in the range of 5.50 to 28.71 per cent during the period of experimentation. Whereas, the incidence of leaf eating caterpillar damage was noticed from the last week of January (5th MW) and survived up to the last week of December (52nd MW). The incidence gradually increased up to the third week of November and reached its peak i.e., 28.71 per cent leaf damage / shoot / branch in 47th MW and the least incidence was recorded in the month of February i.e., 4.57 per cent in 9th MW. At the time of peak level infestation of leaf eating caterpillar, the maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall were 28.71^{0}C, 31.1^{0}C, 18.40 per cent, 76.14 per cent and 2.00 mm respectively.

Keeping in the view to above results during investigation, it was noticed that the literature on the seasonal incidence of leaf eating caterpillar on jamun was found negligible. However, as regards the foliage feeder, it was found serious pest causing the damage in the range of 5.50 to 28.71 per cent during the period of experimentation.

4.1.2 Chafer Beetles (*Adoretus spp.*)

It is revealed from the data presented in the Table 3 that, the degree of damage due to chafer beetles which were in the range of 7.25 to 19.18 per cent during the period of experimentation. Whereas, the incidence of chafer beetle damage was recorded from the last week of January (5th MW) and survived up to the 49th MW. The incidence gradually increased up to the fourth week of June and reached its peak i.e., 19.18 per cent leaf damage /shoot / branch in 26th MW. The least incidence was recorded in the month of December i.e., 0.70 per cent in 49th MW. At the time of peak level infestation of chafer beetles, the maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall were 37.20^{0}C, 24.90^{0}C, 58.71 per cent, 35.14 per cent and 0.40 mm respectively.

Keeping in the view to above results during investigation, Haldhar *et al.* (2016) reported that, the chafer beetles become active with the onset of the rainy season when new growth starts. They cause heavy damage to developing foliage of ber during the month of June to August, which was found confirmative with the present result of investigation.

4.1.3 Leaf Miner (*Acrocercops spp.*)

It is revealed from the data presented in the Table 3 that, the degree of damage due to leaf miner which was in the range of 0.12 to 1.87 per cent during the period of experimentation. However, the incidence of leaf miner damage was recorded from the last week of January (5th MW) to the second week of October (41st MW). The incidence gradually increased up to the third week of June and reached its peak i.e., 1.87 per cent in 25th MW and the least incidence was recorded in the month of February i.e., 0.12 per cent in 5th MW. At the time of peak level infestation of leaf miner, the maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall were 39.20^{0}C, 26.10^{0}C, 51.43 per cent, 30.29 per cent and 7.00 mm respectively.

Keeping in the view to above results during investigation, Singh *et al.* (2009) reported that, the jamun leaf miner (*Acrocercops syngramma* and *Acrocercops phaeospora*) causes heavy damage during the reproductive phase i.e., from April to September which was found confirmative with the present result of investigation.

4.1.4 Fruit Borer (*Meridarchis scyrodes* M.)

It is revealed from the data presented in the Table 3 that, the degree of damage due to fruit borer which was in the range of 2.85 to 67.70 per cent during the period of experimentation. However, the incidence of fruit borer damage was recorded from the first week of April (14th MW) to the second week of July (28th MW). The incidence gradually increased up to the third week of June and reached its peak i.e., 67.70 per cent fruit damage in 25th MW and the least incidence was recorded in the month of April i.e., 2.85 per cent in 14th MW. At the time of peak level infestation of fruit borer, the maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall were 39.20^{0}C, 26.10^{0}C, 51.43 per cent, 30.29 per cent and 7.00 mm respectively.

Keeping in the view to above results during investigation, it was noticed that the literature on the seasonal incidence of fruit borer on jamun was found negligible. However, the incidence of pest was found serious causing damage in the range of 2.85 to 67.70 per cent during the period of experimention, which was found confirmative with the results reported by Hosagoudar *et al.* (1999), Gopali *et al.* (2003) and Papade (2016) in ber.

4.1.5 Correlation Coefficient (r)

The correlation coefficient (r) between pests of jamun *viz*., leaf eating caterpillar, chafer beetle, leaf miner and fruit borer with abiotic factors *viz*., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall are given in Table 4.

It was evident from the data presented in the Table 4 that, the leaf eating caterpillar had highly positive significant correlation with minimum temperature (r = 0.304), morning relative humidity (r = 0.707), evening relative humidity (r = 0.667) and rainfall (r = 0.667). Whereas, there was negatively significant correlation with maximum temperature (r = -0.404).

It was evident from the data presented in Table 4 that, the chafer beetles had highly positive significant correlation with maximum (r = 0.447) and minimum temperature (r = 0.373). Whereas, there was negatively non-significant correlation with morning relative humidity (r = -0.209), evening relative humidity (r = -0.066) and rainfall (r = -0.066).

It was evident from the data presented in Table 4 that, the leaf miner had highly positive significant correlation with maximum (r = 0.585) and minimum temperature (r = 0.703). Whereas, there was negatively non-significant correlation with morning relative humidity (r = -0.158), evening relative humidity (r = -0.124) and positively non-significant correlation with rainfall (r = 0.187).

It was evident from the data presented in Table 4 that, the fruit borer had highly positive significant correlation with minimum temperature (r = 0.864) and evening relative humidity (r = 0.593) and there was highly positive non-significant correlation between morning relative humidity (r = 0.524), and rainfall (r = 0.344). Whereas, it was negatively non-significant correlated with maximum temperature (r = -0.138).

Keeping in the view to above results during investigation, Thorat (2018) reported that there was positive correlation between leaf eating caterpillar incidence and evening humidity, Bajad *et al.* (2019) reported that there was positive correlation between scarab beetles and minimum temperature, Kumar *et al.* (2018) reported that white grub adult showed highly significant positive correlation with temperature (r =0.89, 0.93), (r =0.86, 0.91), Kanhar *et al.* (2017) reported that there was negative non-significant correlation between mango leaf miner, *Acrocercops syngramma* (M.) and relative humidity.

Gopali *et al.* (2003) reported the negative correlation between ber fruit borer and the maximum (r = -0.75) and minimum (r = -0.83) temperatures, relative humidity (r = -0.34) and rainfall (r = -0.12), Nandihalli *et al.* (1996) reported that, the fruit borer (*Meridarchis scyrodes* Meyrick) was positively correlated with the temperature and negatively correlated to relative humidity, which was found more or less similar with the present results of investigation.

Table 3. Seasonal incidence of leaf feeders viz., leaf eating caterpillar, chafer beetles, leaf miner and fruit borer

M.W. No.	Mean percent infestation				Weather Factors				
	Leaf eating caterpillar	Chafer beetles	Leaf miner	Fruit borer	Temperature (^{0}C)		Relative humidity		Rainfall (mm)
					Max.	Min.	RH –I (%)	RH-II (%)	
5.	5.5	7.25	0.12	0	29.4	11.3	58	31	0
6.	5.8	7.9	0.25	0	27.2	10.3	60	42	0
7.	5.1	7.55	0.3	0	27.7	10.4	53.43	29.43	0
8.	6.7	8.35	0.65	0	27.6	9.1	54	29.29	0
9.	4.57	8.28	0.82	0	31.8	14.1	55.14	27.71	0
10.	5.8	9.4	0.9	0	34.7	15.4	49.86	24.43	0
11.	5.77	9.88	0.7	0	31.9	13	47.29	19.71	0
12.	6.75	10.27	0.72	0	33.3	14.1	45.14	19.86	0
13.	8.97	10.48	0.65	0	35.5	16	51.43	16.14	0
14.	8.75	10.37	0.82	2.85	36.4	16.1	46.14.	14.71	0
15.	9.87	11.43	0.85	4.12	39.3	18.8	39.57	13.14	0
16.	8.8	11.4	1.12	7.05	39.7	20	38	14	0
17.	10.7	11.85	1.25	13.82	40.4	21.2	35.28	13.43	0
18.	10.92	12.46	1.25	20.24	37.1	19.2	45	18.57	4.4
19.	10.1	12.05	1.3	28.36	41.3	24	30.57	11.71	0
20.	11.77	13.88	1.32	36.21	39.1	20.7	37.29	15.86	0
21.	11.35	14.04	1.4	43.6	39.3	21.7	44.29	17.57	0
22.	11.52	14.76	1.42	52.92	40	21.8	34.57	14	0
23.	11.1	15.55	1.58	60.5	41.3	25.5	38.29	16.29	0
24.	12.7	17.85	1.62	62.3	41.2	23.5	39.14	19	0
25.	12.8	18.4	1.87	67.7	39.2	26.1	51.43	30.29	7
26.	12.37	19.18	1.85	65.00	37.2	24.9	58.71	35.14	0.4
27.	13.2	19.1	1.82	63.42	36.1	24.3	69.86	40	182
28.	13.5	18.75	1.7	61.00	31.4	23.8	80.71	60.29	51.4

Table cont……..

M.W. No.	Mean per cent infestation				Weather Factors				
	Leaf eating caterpillar	Chaffer beetles	Leaf miner	Fruit borer	Temperature (^{0}C)		Relative humidity		Rainfall (mm)
					Max.	Min.	RH –I (%)	RH-II (%)	
29.	12.6	18.3	1.6	0	30.6	23.5	79	63	3.8
30.	13.39	17.7	1.42	0	32	23.6	76	56.57	32
31.	13.77	17.38	1.32	0	33.8	23.2	71.43	51.29	18.4
32.	14.00	17.00	1.3	0	30.5	23.6	78.43	68.14	47.8
33.	14.77	16.6	1.2	0	27	22.9	87	77.43	0
34.	16.00	16.37	1.00	0	28	23.3	80.57	68.14	0
35.	16.77	15.94	1.00	0	31	22.5	75.14	59.57	0
36.	17.75	14.87	0.92	0	32.5	21.3	72.43	47.57	87.2
37.	19.57	14.78	0.87	0	32	23	75.14	55.71	3
38.	20.53	12.76	0.6	0	30	23.3	77.57	70.57	21.6
39.	23.6	11.3	0.5	0	28.8	22.5	78.57	68.43	84.2
40.	22.00	10.00	0.42	0	29.8	21.7	83.57	71	36.6
41.	23.46	8.23	0.35	0	30.2	21.9	83.43	66.86	7.8
42.	24.5	7.25	0	0	31.1	21.1	80.57	58.71	2.8
43.	25.53	7.2	0	0	31.7	21.1	77	50.29	52.4
44.	26.00	5.12	0	0	28.3	18.6	81.57	67.71	141.8
45.	26.5	3.00	0	0	25.7	20.8	87.14	79.57	4
46.	27.25	2.7	0	0	30.4	21	84	58.57	23.4
47.	28.71	1.5	0	0	31.1	18.4	76.14	46.14	2
48.	27.46	1.00	0	0	29.7	16.7	73	48	0
49.	25.6	0.7	0	0	30	15.2	74	45.29	0
50.	23.00	0	0	0	30.47	15.9	73.86	44.24	0
51.	20.18	0	0	0	28.77	16.4	71.14	46.86	0
52.	18.13	0	0	0	29.65	16.3	74.29	42	0

Table 4. Correlation of weather parameters with pest incidence on jamun

Variable	Meteorological parameters				
	Max. Temp. (^{0}c)	**Min. Temp. (^{0}c)**	**R.H-I (%)**	**R.H-II (%)**	**Rainfall (mm)**
Leaf eating caterpillar	-0.404*	0.304*	0.707*	0.667*	0.667*
Chafer beetles	0.447*	0.373*	-0.209	-0.066	-0.066
Leaf miner	0.585*	0.703*	-0.158	-0.124	0.187
Fruit borer	-0.138	0.864*	0.524	0.593*	0.344

Note- *Significant at 5% p = 0.2907

**Significant at 1% p = 0.376

4.2 Efficacy of Different Botanicals and Biopesticides Treatment against Pests Complex on Jamun

The field experiment was carried out at jamun orchard at research farm of arid zone fruits (AICRP), Department of Horticulture, M.P.K.V., Rahuri. The experiment on efficacy different botanical and biopesticides against pests infesting jamun laid out in Randomized Block Design (RBD) with 7 treatments replicated three times**.** The three trees were randomly selected and tagged for each treatment and observation were taken by counting healthy and damaged leaves / shoot/ branch for leaf feeders. Whereas, the observations of fruit borer were taken by counting healthy and damaged fruits at the time of harvesting.

The data on per cent infestation caused by leaf feeder's *viz*., leaf eating caterpillar, chafer beetles per shoot per branch of jamun tree was taken on first day of the application and post count at 3rd, 7th, and 14th days after first, second and third spray application and mean of three applications were worked out.

4.2.1 Efficacy of Different Botanicals and Biopesticides Treatment against Leaf Eating Caterpillar on Jamun at 1st Day before First Spray (Precount)

The data presented in Table 5, revealed that, the leaf eating caterpillar damage was ranged from 13.00 to 15.50 per cent per shoot per branch of tree showing statistically non-significant.

4.2.1.1 Efficacy of Different Botanicals and Biopesticides Treatment against Leaf Eating Caterpillar on Jamun after First Spray

The data presented in Table-5 revealed that, all the treatments were found effective over untreated control at 3rd, 7th, and 14th days after first application.

4.2.1.2 Efficacy of Different Botanicals and Biopesticides Treatment against Leaf Eating Caterpillar on Jamun at 3rd Day after First Spray

On 3rd day after first spraying, all the treatments were found effective as compared to untreated control.

Among all the treatments, the treatment of NSE 5% found most effective control against leaf eating caterpillar and recorded least damage i.e., 11.50 per cent leaf damage, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 11.86 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 12.26 per cent damage, followed by Karanj oil @ 2ml / l. of water and recorded 13.05 per cent damage. Whereas, the untreated control recorded the highest (17.25 per cent) leaf damage/ shoot/ branch and the rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water, which recorded 14.48 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water recorded 14.75 per cent leaf damage, which were found least effective in controlling pest.

4.2.1.3 Efficacy of Different Botanical and Biopesticides Treatment against Leaf Eating Caterpillar on Jamun at 7th Day after First Spray

On 7th day after first spraying, all the treatments were found effective as compared to untreated control and similar trend was noticed as on 3rd day after spraying.

Among all the treatments, the treatment of NSE 5% found most effective control against leaf eating caterpillar and recorded least damage i.e., 10.11 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 10.68 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 11.41 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 11.91 per cent damage. Whereas, the untreated control recorded the highest 17.92 per cent damage/ shoot/ branch and rest of the treatment i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water, which recorded 14.24 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water and recorded 14.27 per cent leaf damage, which were found least effective in controlling pest.

4.2.1.4 Efficacy of Different Botanicals and Biopesticides Treatment against Leaf Eating Caterpillar on Jamun at 14th Days after First Spray

On 14th day after first spraying, all the treatments were found effective as compared to untreated control and similar trend was noticed as on 3rd day after spraying.

Among all the treatments, the treatment of NSE 5% found most effective control against leaf eating caterpillar and recorded least damage i.e., 9.85 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 10.00 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 10.61 per cent damage, followed by Karanj oil @ 2ml/ l. of water recorded 11.32 per cent damage. Whereas, the untreated control recorded the highest 18.09 per cent damage/ shoot/ branch and rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l of water which recorded 13.84 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water recorded 13.95 per cent damage, which were found least effective in controlling pest.

4.2.2 Efficacy of Different Botanicals and Biopesticides Treatment against Leaf Eating Caterpillar on Jamun after Second Spray

The data presented in Table 6 revealed that, all the treatments were found effective over untreated control at 3rd, 7th, and 14th days after second application.

4.2.2.1 Efficacy of Different Botanicals and Biopesticides Treatment against Leaf Eating Caterpillar on Jamun at 3rd Day after Second Spray

On 3rd day after second spraying, all the treatments were found effective as compared to untreated control.

Among all the treatments, the treatment of NSE 5% found most effective control against leaf eating caterpillar and recorded least damage i.e., 8.12 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 8.96 per cent damage followed by Neem oil @ 2 ml/ l. of water and recorded 9.55 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 9.73 per cent damage. Whereas, the untreated control recorded the highest 16.28 per cent leaf damage/ shoot/ branch and rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 11.66 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water recorded 12.16 per cent damage, which were found least effective in controlling pest.

4.2.2.2 Efficacy of Different Botanicals and Biopesticides Treatment against Leaf Eating Caterpillar on Jamun 7th Day after Second Spray

On 7th day after second spraying, all the treatments were found effective as compared to untreated control and similar trend was noticed as on 3rd days after spraying.

Among all the treatments, the treatment of NSE 5% found most effective control against leaf eating caterpillar and recorded least damage of 7.50 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 8.45 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 8.78 per cent damage, followed by Karanj

Table-5 Efficacy of different botanicals and biopesticides treatment against leaf eating caterpillar on jamun after first spray

Tr. No.	Treatments	Dose ml/l	% Leaf damage/ shoot/ branch				
			Precount	3 DAS	7 DAS	14 DAS	Mean
T_1	*Metarhizium anisopliae*	6.0 g/l	15.03 (22.80)	14.75 (22.58)	14.27 (22.18)	13.95 (21.92)	14.32 (22.23)
T_2	*Beauveria bassiana*	6.0 g/l	15.34 (23.04)	14.48 (22.37)	14.24 (22.15)	13.84 (21.83)	14.19 (22.12)
T_3	Neem oil	2.0 ml/l	13.00 (21.11)	12.26 (20.48)	11.41 (19.73)	10.61 (19.00)	11.43 (19.74)
T_4	Karanj oil	2.0 ml/l	14.25 (22.15)	13.05 (21.16)	11.91 (20.17)	11.32 (19.65)	12.09 (20.33)
T_5	Azadiractin (10000 ppm)	2.0 ml/l	13.37 (21.43)	11.86 (20.14)	10.68 (19.06)	10.00 (18.42)	10.85 (19.21)
T_6	NSE 5%	50 gm/l	13.33 (21.41)	11.50 (19.82)	10.11 (18.53)	9.85 (18.28)	10.49 (18.88)
T_7	Untreated control		15.50 (23.16)	17.25 (24.53)	17.92 (25.04)	18.09 (25.17)	17.75 (24.91)
	S.E.		0.66	0.47	0.56	0.53	0.52
	CD@5%		NS	1.45	1.74	1.65	1.61

Note – 1) DAS = Days after spray

2) Figures in the parenthesis are arcsine transformed values.

oil @ 2ml/ l. of water and recorded 9.08 per cent leaf damage, Whereas, the untreated control recorded the highest 16.10 per cent leaf damage/ shoot/ branch and rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 11.24 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water recorded 11.38 per cent leaf damage, which were found least effective in controlling pest.

4.2.2.3 Efficacy of Different Botanicals and Biopesticides Treatment against Leaf Eating Caterpillar on 14th Day after Second Spray

On 14th day after second spraying, all the treatments were found effective as compared to untreated control and similar trend was noticed as on 3rd days after spraying.

Among all the treatments, the treatment of NSE 5% found most effective control against leaf eating caterpillar and recorded least leaf damage of 6.25 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 7.53 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 8.10 per cent damage, followed by Karanj oil @ 2ml/ l. of water recorded 8.46 per cent damage. Whereas, the untreated control recorded the highest 15.60 per cent leaf damage/ shoot/ branch and rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 10.60 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water recorded 10.81 per cent leaf damage, which were found least effective in controlling pest.

4.2.3 Efficacy of Different Botanicals and Biopesticides Treatment against Leaf Eating Caterpillar on Jamun after Third Spray

The data presented in Table 7 revealed that, all the treatments were found effective over untreated control at 3rd, 7th, and 14th days after third application.

4.2.3.1 Efficacy of Different Botanicals and Biopesticides Treatment against Leaf Eating Caterpillar on Jamun at 3rd Day after Third Spray

On 3rd day after third spraying, all the treatments were found effective as compared to untreated control.

Among all the treatments, the treatment of NSE 5% found most effective control against leaf eating caterpillar and recorded least leaf damage of 4.36 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 4.65 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 5.40 per cent damage, followed by Karanj oil @ 2 ml/l. of water and recorded 5.77 per cent damage. Whereas, the untreated control recorded the highest 15.20 per cent leaf damage/ shoot/ branch and rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 8.64 per cent damage and *Metarhizium*

Table 6. Efficacy of different botanicals and biopesticides treatment against leaf eating caterpillar on jamun after second spray

Tr. N0.	Treatments	Dose ml/l	Per cent Leaf damage/ shoot/ branch			
			3 DAS	7 DAS	14 DAS	Mean
T_1	*Metarhizium anisopliae*	6.0 g/l	12.16 (20.40)	11.38 (19.70)	10.81 (19.14)	11.45 (19.75)
T_2	*Beauveria bassiana*	6.0 g/l	11.66 (19.95)	11.24 (19.58)	10.60 (18.99)	11.17 (19.51)
T_3	Neem oil	2.0 ml/l	9.55 (17.98)	8.78 (17.22)	8.10 (16.53)	8.81 (17.24)
T_4	Karanj oil	2.0 ml/l	9.73 (18.16)	9.08 (17.52)	8.46 (16.91)	9.09 (17.53)
T_5	Azadiractin (10000 ppm)	2.0 ml/l	8.96 (17.41)	8.45 (16.88)	7.53 (15.82)	8.31 (16.70)
T_6	NSE 5%	50 gm/l	8.12 (16.54)	7.50 (15.87)	6.25 (14.45)	7.29 (15.62)
T_7	Untreated control	-	16.28 (23.79)	16.10 (23.65)	15.60 (23.26)	15.99 (23.57)
	S.E.		0.56	0.59	0.81	0.65
	CD @ 5%		1.72	1.82	2.51	2.02

Note – 1) DAS = Days after spray

2) Figures in the parenthesis are arcsine transformed values.

anisopliae 1.15%WP @ 6 g/l. of water recorded 9.14 per cent leaf damage, which were found least effective in controlling pest.

4.2.3.2 Efficacy of Different Botanicals and Biopesticides Treatment against Leaf Eating Caterpillar on Jamun at 7th Day after Third Spray

On 7th day after third spraying, all the treatments were found effective as compared to untreated control and similar trend was noticed as on 3rd day after spraying.

Among all the treatments, the treatment of NSE 5% found most effective control against leaf eating caterpillar and recorded least leaf damage of 3.67 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 4.35 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 5.19 per cent damage, followed by Karanj oil @ 2ml/ l.of water and recorded 5.45 per cent damage, Whereas, the untreated control recorded the highest 14.78 per cent leaf damage/ shoot/ branch and rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 7.83 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water recorded 8.33 per cent damage, which were found least effective in controlling pest.

4.2.3.3 Efficacy of Different Botanicals and Biopesticides Treatment against Leaf Eating Caterpillar on Jamun 14th Day after Third Spray

On 14th day after third spraying, all the treatments were found effective as compared to untreated control and similar trend was noticed as on 3rd days after spraying.

Among all the treatments, the treatment of NSE 5% found most effective control against leaf eating caterpillar and recorded least leaf damage of 3.39 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 3.72 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 3.93 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 4.16 per cent damage. Whereas, the untreated control recorded the highest 14.66 per cent leaf damage/ shoot/ branch and rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 7.45 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water and recorded 8.25 per cent damage, which were found least effective in controlling pest.

4.2.4 Cumulative Efficacy of Different Botanicals and Biopesticides Treatment against Leaf Eating Caterpillar on Jamun after Three Sprayings

The mean data of three applications on per cent infestation of leaf damage caused by leaf eating caterpillar are presented in Table 8 reveals that, all the botanical and biopesticide treatments were significantly superior over untreated control in recording lowest per cent infestation of leaf damage caused by leaf eating caterpillar.

Table 7. Efficacy of different botanicals and biopesticides treatment against leaf eating caterpillar on jamun after third spray

Tr. N0.	Treatments	Dose ml/l	Per cent Leaf damage/ shoot/ branch			
			3 DAS	7 DAS	14 DAS	Mean
T_1	*Metarhizium anisopliae*	6.0 g/l	9.14 (17.59)	8.33 (16.78)	8.25 (16.68)	8.57 (17.01)
T_2	*Beauveria bassiana*	6.0 g/l	8.64 (17.08)	7.83 (16.16)	7.45 (15.81)	7.97 (16.35)
T_3	Neem oil	2.0 ml/l	5.40 (13.39)	5.19 (12.97)	3.93 (11.41)	4.84 (12.59)
T_4	Karanj oil	2.0 ml/l	5.77 (13.83)	5.45 (13.34)	4.16 (11.69)	5.13 (12.95)
T_5	Azadiractin (10000 ppm)	2.0 ml/l	4.65 (12.44)	4.35 (11.96)	3.72 (11.12)	4.24 (11.84)
T_6	NSE 5%	50 gm/l	4.36 (11.96)	3.67 (10.91)	3.39 (10.57)	3.81 (11.15)
T_7	Untreated control	-	15.20 (22.94)	14.78 (22.60)	14.66 (22.50)	14.88 (22.68)
	S.E.		0.78	1.18	0.63	0.86
	CD @ 5%		2.39	3.64	1.94	2.66

Note – 1) DAS = Days after spray

2) Figures in the parenthesis are arcsine transformed values.

On 3rd day after three sprayings, all the treatments were found effective as compared to untreated control. Among all the treatments, the treatment of NSE 5% found most effective control against leaf eating caterpillar and recorded least leaf damage of 7.99 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 8.49 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 9.07 per cent damage, followed by Karanj oil @ 2ml/ l. of water recorded 9.52 per cent damage as against, the untreated control recorded the highest 16.24 per cent damage/ shoot/ branch and rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 11.59 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water and recorded 12.02 per cent leaf damage, which were found least effective in controlling pest.

A similar trend was noticed on 7th day after three sprayings and all the treatments were found effective as compared to untreated control.

The treatment of NSE 5% found most effective control against leaf eating caterpillar and recorded least leaf damage of 7.09 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 7.83 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 8.46 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 8.81 per cent damage as against, 16.27 per cent leaf damage/ shoot/ branch recorded in untreated control and rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 11.10 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water and recorded 11.33 per cent leaf damage, which were found least effective in controlling pest.

A similar trend was noticed on 14th days after three sprayings and all the treatments were found effective as compared to untreated control.

The treatment of NSE 5% found most effective control against leaf eating caterpillar and recorded leaf least damage of 6.50 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 7.08 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 7.55 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 7.98 per cent damage as against, 16.12 per cent leaf damage/ shoot/ branch recorded in untreated control and rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 10.63 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water and recorded 11.00 per cent leaf damage, which were found least effective in controlling pest.

Keeping in the view to above results during investigation, the literatures on this issue was found negligible. However, the present result of investigation found confirmative on other crops, Razak *et al.* (2014) reported that, the NSKE 5% showed the highest larval mortality of 40% against third instar larva of tobacco caterpillar *Spodoptera litura*, Bochare *et al.* (2018) reported that, the

Table 8. Cumulative efficacy of different botanicals and biopesticides treatment against leaf eating caterpillar on jamun after three sprayings

Tr. No.	Treatments	Dose ml/l	Per cent Leaf damage/ shoot/ branch				
			Precount	3 DAS	7 DAS	14 DAS	Mean
T_1	*Metarhizium anisopliae*	6.0 g/l	15.03 (22.80)	12.02 (20.19)	11.33 (19.55)	11.00 (19.25)	11.45 (19.66)
T_2	*Beauveria bassiana*	6.0 g/l	15.34 (23.04)	11.59 (19.80)	11.10 (19.30)	10.63 (18.88)	11.11 (19.32)
T_3	Neem oil	2.0 ml/l	13.00 (21.11)	9.07 (17.29)	8.46 (16.64)	7.55 (15.64)	8.36 (16.52)
T_4	Karanj oil	2.0 ml/l	14.25 (22.15)	9.52 (17.72)	8.81 (17.01)	7.98 (16.08)	8.77 (16.94)
T_5	Azadiractin (10000 ppm)	2.0 ml/l	13.37 (21.43)	8.49 (16.66)	7.83 (15.970	7.08 (15.12)	7.80 (15.92)
T_6	NSE 5%	50 gm/l	13.33 (21.41)	7.99 (16.11)	7.09 (15.10)	6.50 (14.43)	7.19 (15.21)
T_7	Untreated control		15.50 (23.16)	16.24 (23.75)	16.27 (23.76)	16.12 (23.64)	16.21 (23.72)
	S.E.		0.66	0.60	0.78	0.66	0.68
	CD@5%		NS	1.85	2.40	2.03	2.09

Note – 1) DAS = Days after spray

2) Figures in the parenthesis are arcsine transformed values.

Neem seed extract 5 % were found most effective in reducing the population of green semilooper and tobacco leaf eating caterpillar, Berani *et al.* (2018) reported that, the Azadirachtin 0.15 EC 0.0006 per cent, Neem Seed Kernel Extract (NSKE) 5 per cent, neem oil 0.3 per cent were found highly effective in managing *Spilosoma obliqua* Walker and *Maruca testulalis* (Geyer) in black gram. However, the biopesticides were not found confirmative with the findings of Ahirwar *et al.* (2013) reported the efficacy of microbial treatments *viz*., *B. bassiana* (3.93 larvae/ mrl) and *M. anisopliae* (4.53 larvae/ mrl) against foliage feeders of soybean crop.

4.3. Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun

4.3.1 Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun at 1 Day before First Spray (Precount)

The data presented in Table 9 revealed that, the infestation of chafer beetles was ranged from 15.16 to 17.45 per cent/ shoot/ branch of tree showing statistically non-significant.

4.3.1.1 Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun after First Spray

The data presented in Table 9 revealed that, all the treatments were found significantly superior over untreated control at 3rd, 7th, and 14th days after first application.

4.3.1.2 Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun at 3rd Day after First Spray

All the treatments were found effective as compared to untreated control on 3rd day after first spraying.

Among all the treatments, the treatment of NSE 5% found most effective control against chafer beetles and recorded least leaf damage of 12.89 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 13.69 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 14.00 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 14.35 per cent damage as against, 18.05 per cent leaf damage/ shoot/ branch recorded in untreated control. However, the treatment of *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 15.65 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water and recorded 16.21 per cent leaf damage, which were found least effective in controlling pest.

4.3.1.3 Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun at 7th Day after First Spray

All the treatments were found effective as compared to untreated control on 7th day after first spraying.

Among all the treatments, the treatment of NSE 5% found most effective control against chafer beetles and recorded least leaf damage of 12.59 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 13.09 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 13.23 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 13.60 per cent damage as against 18.92 per cent leaf damage/ shoot/ branch recorded in untreated control. However, the treatment of *Beauveria bassiana* 1.15% WP @ 6 g/lit. water which recorded 15.15 per cent damage and *Metarhizium anisopliae* 1.15% WP @ 6 g/l. of water and recorded 15.51 per cent leaf damage, which were found least effective in controlling pest.

4.3.1.4 Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun 14th Day after First Spray

All the treatments were found effective as compared to untreated control on 14th day after first spraying,

Among all the treatments, the treatment of NSE 5% found most effective control against chafer beetles and recorded least leaf damage of 11.28 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 12.75 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 12.80 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 13.00 per cent damage as against, 19.23 per cent leaf damage/ shoot/ branch recorded in untreated control. However, the treatment of *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 15.00 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water and recorded 15.22 per cent leaf damage, which were found least effective in controlling pest.

4.3.2 Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun after Second Spray

The data presented in Table 10 revealed that, all the treatments were found significantly superior over untreated control at 3rd, 7th, and 14th day after second application.

4.3.2.1 Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun at 3rd Day after Second Spray

All the treatments were found effective as compared to untreated control on 3rd day after second spraying.

Among all the treatments, the treatment of NSE 5% found most effective control against chafer beetles and recorded least leaf damage of 11.13 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 11.41 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 12.00 per cent damage, followed by Karanj

Table 9. Efficacy of different botanicals and biopesticides treatment against chafer beetles on jamun after first spray

Tr. No.	Treatments	Dose ml/l	Per cent Leaf damage/ shoot/ branch				
			Precount	3 DAS	7 DAS	14 DAS	Mean
T_1	*Metarhizium anisopliae*	6.0 g/l	16.83 (24.18)	16.21 (23.74)	15.51 (23.18)	15.22 (22.94)	15.65 (23.28)
T_2	*Beauveria bassiana*	6.0 g/l	16.11 (23.64)	15.65 (23.30)	15.15 (22.88)	15.00 (22.74)	15.27 (22.97)
T_3	Neem oil	2.0 ml/l	15.62 (23.26)	14.00 (21.94)	13.23 (21.30)	12.80 (20.92)	13.34 (21.39)
T_4	Karanj oil	2.0 ml/l	16.10 (23.63)	14.35 (22.26)	13.60 (21.61)	13.00 (21.10)	13.65 (21.66)
T_5	Azadiractin (10000 ppm)	2.0 ml/l	15.16 (22.89)	13.69 (21.71)	13.09 (21.20)	12.75 (20.88)	13.18 (21.26)
T_6	NSE 5%	50 gm/l	15.50 (23.15)	12.89 (21.04)	12.59 (20.76)	11.28 (19.61)	12.25 (20.47)
T_7	Untreated control		17.45 (24.66)	18.05 (25.14)	18.92 (25.77)	19.23 (26.00)	18.73 (25.64)
	S.E.		1.02	0.45	0.70	0.88	0.68
	CD@5%		NS	1.39	2.16	2.71	2.09

Note – 1) DAS = Days after spray

2) Figures in the parenthesis are arcsine transformed values.

oil @ 2ml/ l. of water and recorded 12.20 per cent damage as against 18.60 per cent leaf damage/ shoot/ branch recorded in untreated control. However, rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/lit. water which recorded 14.49 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water recorded 14.60 per cent damage, which were found least effective in controlling pest.

4.3.2.2 Efficacy of Different Botanicals and Biopesticides Treatment gainst Chafer Beetles on Jamun at 7th Day after Second Spray

All the treatments were found effective as compared to untreated control on 7th day after second spraying.

Among all the treatments, the treatment of NSE 5% found most effective control against chafer beetles and recorded least leaf damage of 9.79 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 10.64 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 11.29 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 11.86 per cent damage as against 18.92 per cent damage/ shoot/ branch recorded in untreated control. However, rest of the treatment i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 13.62 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/lit. water recorded13.77 per cent damage, which were found least effective in controlling pest.

4.3.2.3 Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun at 14th Day after Second Spray

All the treatments were found effective as compared to untreated control on 14th day after second spraying.

Among all the treatments, the treatment of NSE 5% found most effective control against chafer beetles and recorded least leaf damage of 9.28 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 10.14 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 10.91 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 11.44 per cent damage as against 18.30 per cent leaf damage/ shoot/ branch recorded in untreated control. However, rest of the treatment i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 13.25 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water and recorded 13.46 per cent leaf damage, which were found least effective in controlling pest.

Table 10. Efficacy of different botanicals and biopesticides treatment against chafer beetles on jamun after second spray

Tr. N0.	Treatments	Dose ml/l	Per cent Leaf damage/ shoot/ branch			
			3 DAS	7 DAS	14 DAS	Mean
T_1	*Metarhizium anisopliae*	6.0 g/l	14.60 (22.41)	13.77 (21.74)	13.46 (21.48)	13.94 (21.88)
T_2	*Beauveria bassiana*	6.0 g/l	14.49 (22.35)	13.62 (21.65)	13.25 (21.30)	13.79 (21.77)
T_3	Neem oil	2.0 ml/l	12.00 (20.24)	11.29 (19.58)	10.91 (19.27)	11.40 (19.70)
T_4	Karanj oil	2.0 ml/l	12.20 (20.43)	11.86 (20.09)	11.44 (19.72)	11.83 (20.08)
T_5	Azadiractin (10000 ppm)	2.0 ml/l	11.41 (19.72)	10.64 (19.01)	10.14 (18.48)	10.73 (19.07)
T_6	NSE 5%	50 gm/l	11.13 (19.45)	9.79 (18.14)	9.28 (17.66)	10.07 (18.42)
T_7	Untreated control	-	18.60 (25.53)	18.42 (25.40)	18.30 (25.29)	18.44 (25.41)
	S.E.		0.92	1.05	1.20	1.06
	CD @ 5%		2.85	3.23	3.70	3.26

Note – 1) DAS = Days after spray

2) Figures in the parenthesis are arcsine transformed values.

4.3.3 Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun after Third Spray

The data presented in Table 11 revealed that, all the treatments were found significantly superior over untreated control at 3rd, 7th, and 14th day after third application.

4.3.3.1 Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun at 3rd Day after Third Spray

All the treatments were found effective as compared to untreated control on 3rd day after third spraying.

Among all the treatments, the treatment of NSE 5% found most effective control against chafer beetles and recorded least leaf damage of 7.75 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 9.27 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 9.76 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 10.00 per cent damage as against, 17.80 per cent leaf damage/ shoot/ branch reported in untreated control. However, rest of the treatment i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 11.82 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water and recorded 12.07 per cent leaf damage, which were found least effective in controlling pest.

4.3.3.2 Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun at 7th Day after Third Spray

All the treatments were found effective as compared to untreated control on 7th day after third spraying.

Among all the treatments, the treatment of NSE 5% found most effective control against chafer beetles and recorded least leaf damage of 6.69 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 8.78 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 8.86 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 9.19 per cent damage as against 17.26 per cent damage/ shoot/ branch reported in untreated control. However, rest of the treatment i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 10.42 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water and recorded 11.54 per cent leaf damage, which were found least effective in controlling pest.

4.3.3.3 Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun at 14th Day after Third Spray

All the treatments were found effective as compared to untreated control on 3rd day after third spraying.

Table 11. Efficacy of different botanicals and biopesticides treatment against chafer beetles on jamun after third spray

Tr. N0.	Treatments	Dose ml/l	Per cent Leaf damage/ shoot/ branch			
			3 DAS	7 DAS	14 DAS	Mean
T_1	*Metarhizium anisopliae*	6.0 g/l	12.07 (20.28)	11.54 (19.81)	11.05 (19.39)	11.55 (19.83)
T_2	*Beauveria bassiana*	6.0 g/l	11.82 (20.07)	10.42 (18.77)	10.24 (18.61)	10.83 (19.15)
T_3	Neem oil	2.0 ml/l	9.76 (18.14)	8.86 (17.25)	8.66 (17.04)	9.09 (17.48)
T_4	Karanj oil	2.0 ml/l	10.00 (18.34)	9.19 (17.58)	9.74 (18.13)	9.64 (18.02)
T_5	Azadiractin (10000 ppm)	2.0 ml/l	9.27 (17.66)	8.78 (17.16)	8.33 (16.69)	8.79 (17.17)
T_6	NSE 5%	50 gm/l	7.75 (16.09)	6.69 (14.96)	6.29 (14.41)	6.91 (15.15)
T_7	Untreated control	-	17.80 (24.94)	17.26 (24.52)	16.70 (24.12)	17.25 (24.53)
	S.E.		1.17	1.12	1.08	1.12
	CD @ 5%		3.61	3.46	3.32	3.47

Note – 1) DAS = Days after spray

2) Figures in the parenthesis are arcsine transformed values.

Among all the treatments, the treatment of NSE 5% found most effective control against chafer beetles and recorded least leaf damage of 6.29 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 8.33 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 8.66 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 9.74 per cent damage as against, 16.70 per cent damage/ shoot/ branch recorded in untreated control. However, rest of the treatment i.e., *Beauveria bassiana* 1.15%WP @ 6 g/lit. water which recorded 10.24 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water and recorded 11.05 per cent leaf damage, which were found least effective in controlling pest.

4.3.4. Cumulative Efficacy of Different Botanicals and Biopesticides Treatment against Chafer Beetles on Jamun after Three Sprayings

The mean data of three applications on per cent infestation of leaf damage caused by chafer beetles are presented in Table 12 reveals that, all the botanical and biopesticide treatments were found significantly superior over untreated control in recording lowest per cent infestation of leaf damage caused by chafer beetles.

On 3rd day after three sprayings, all the treatments were found effective as compared to untreated control. Among the all treatments, the treatment of NSE 5% found most effective control against chafer beetles and recorded least leaf damage of 10.59 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 11.46 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 11.92 per cent damage, followed by Karanj oil @ 2ml/ l. of water and recorded 12.18 per cent damage as against, 18.15 per cent leaf damage/ shoot/ branch recorded in untreated control. However, rest of the treatment i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 13.99 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water and recorded 14.29 per cent leaf damage, which were found least effective in controlling pest.

On 7th day after three sprayings, all the treatments were found effective as compared to untreated control.

Among all the treatments, the treatment of NSE 5% found most effective against chafer beetles and recorded least leaf damage of 9.69 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 10.84 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 11.13 per cent damage, followed by Karanj oil @ 2ml / l. of water and recorded 11.73 per cent damage as against, 18.20 per cent leaf damage/ shoot/ branch recorded in untreated control. However, rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 13.06 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6

Table 12. Cumulative efficacy of different botanicals and biopesticides treatment against chafer beetles on jamun after three sprayings

Tr. No.	Treatments	Dose ml/l	Per cent Leaf damage/ shoot/ branch				
			Precount	3 DAS	7 DAS	14 DAS	Mean
T_1	*Metarhizium anisopliae*	6.0 g/l	16.83 (24.18)	14.29 (22.14)	13.61 (21.58)	13.24 (21.27)	13.71 (21.66)
T_2	*Beauveria bassiana*	6.0 g/l	16.11 (23.64)	13.99 (21.91)	13.06 (21.10)	12.83 (20.88)	13.29 (21.30)
T_3	Neem oil	2.0 ml/l	15.62 (23.26)	11.92 (20.11)	11.13 (19.38)	10.79 (19.08)	11.28 (19.52)
T_4	Karanj oil	2.0 ml/l	16.10 (23.63)	12.18 (20.34)	11.73 (19.95)	11.21 (19.47)	11.71 (19.92)
T_5	Azadiractin (10000 ppm)	2.0 ml/l	15.16 (22.89)	11.46 (19.69)	10.84 (19.12)	10.41 (18.68)	10.90 (19.17)
T_6	NSE 5%	50 gm/l	15.50 (23.15)	10.59 (18.86)	9.69 (17.95)	8.95 (17.23)	9.74 (18.01)
T_7	Untreated control		17.45 (24.66)	18.15 (25.20)	18.20 (25.23)	18.08 (25.14)	18.14 (25.19)
	S.E.		1.02	0.85	0.96	1.05	0.95
	CD@5%		NS	2.62	2.95	3.24	2.94

Note – 1) DAS = Days after spray

2) Figures in the parenthesis are arcsine transformed values.

g/l. of water and recorded 13.61 per cent leaf damage, which were found least effective in controlling pest.

On 14th day after three sprayings, all the treatments were found effective as compared to untreated control.

Among all the treatments, the treatment of NSE 5% found most effective control against chafer beetles and recorded least leaf damage of 8.95 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 10.41 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 10.79 per cent damage, followed by Karanj oil @ 2ml/l of water and recorded 11.21 per cent damage as against, 18.08 per cent leaf damage/ shoot/ branch recorded in untreated control. However, rest of the treatment i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water which recorded 12.83 per cent damage and *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water and recorded 13.24 per cent leaf damage, which were found least effective in controlling pest.

Keeping in the view to above results during investigation, the literature on this issue was found negligible. However, the present result of investigation found confirmative with the result of Nizamani *et al.* (2014) reported that, the significant reduction in the infestation of jujube beetle (*A. pallens*) was obtained with Neem Seed Extract (NSE).

4.4 Effect of Different Botanicals and Biopesticides Treatment against Fruit Borer on Jamun

It is revealed from the data presented Table 13 that, all the botanical and biopesticide treatments were found effective in minimizing the damage of fruit borer over untreated control. All the treatments showed fruit damage in the range of 6.37 to 17.48 per cent as against 42.67 per cent in untreated control.

Among all the treatments, the treatment of NSE 5% found most effective control against fruit borer and recorded least fruit damage of 6.37 per cent, which was found at par with the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 8.32 per cent damage, followed by Neem oil @ 2 ml/ l. of water and recorded 9.17 per cent damage as against, 42.67 per cent damage of fruit borer recorded in untreated control. However, rest of the treatments i.e., *Beauveria bassiana* 1.15%WP @ 6 g/l. of water recorded 13.84 per cent damage, *Metarhizium anisopliae* 1.15%WP @ 6 g/l. of water recorded 15.90 per cent damage, and Karanj oil @ 2ml/ l. of water recorded 17.48 per cent damage, which were found least effective against fruit borer.

Keeping in the view to above results during investigation, the literature on fruit borer of jamun was found scanty. However, the result of present investigation found confirmative on other fruit crops. Yelshetty *et al.* (1996) reported that, the plant treated with NSKE 5% maintain their efficacy against fruit borer by recording 15.91% fruit damage in ber. However, 48.50% of fruit

damage was noticed where the plants were not treated with insecticides, Srinivasulu *et al.* (2017) reported that, the NSKE 5% recorded the lowest per cent borer damage (28.12) against ber fruit borer.

However, on other vegetable crops, Rahman *et al.* (2014) reported that, the per cent infestation reduction over control was highest in neem seed kernel extract (30.08%) against *H. armigera* in tomato, Singh *et al.* (2016) reported that the NSKE 5 % found most effective against brinjal shoot and fruit borer, Rahman *et al.* (2009) reported that, the Neem oil at 4% concentration showed lowest larval survivability (26.67%) against brinjal shoot and fruit borer, Phukon *et al.* (2014) reported that, the neem oil was nearly as effective as cypermethrin in reducing fruit damaged by *Helicoverpa armigera* leading to increased yield, Kumar *et al.* (2017) reported that, the minimum cob borer larvae was recorded in plots sprayed NSKE 5% @ 25 l/ha, (0.27), followed by Neem oil 2% @ 10 l/ha, (0.33) and Karanj oil 2% @ 10 l/ha, (0.37) in maize.

4.5 Effect of Different Botanicals and Biopesticides Treatment on Yield of Jamun

It was evident from the Table 14 that, the treatment of NSE 5% found effective in recording highest marketable yield of 30.54 kg/tree, followed by Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 28.45 kg/tree, followed by Neem oil @ 2 ml/ l. of water and recorded 27.25 kg/tree as against, 14.26 kg/tree fruit yield recorded in untreated control.

Keeping in the view to above results during investigation, the literature on jamun crop was found negligible. However, the present result of investigation found confirmative on other fruit crop, Srinivasulu *et al.* (2017) reported the highest fruit yield (73.85 kg/plant) were recorded with the treatment of NKSE 5% against fruit borer in ber, Rahman *et al.* (2014) reported the highest yield (18.14 t/ha) were obtained from neem seed kernel extract treated fruits against *H. armigera* in tomato, Shobharani and Nandihalli (2010) reported that, the significantly higher yield was recorded in Nimbecidine @ 5 ml/l (35.82 q/ha) and NSKE@ 5% (33.38 q/ha) followed by pongamia oil @ 2 per cent (30.91 q/ha) and neem cake @ 240 kg/ha in brinjal and Faqiri and Kumar (2016) reported that, the maximum yield was recorded with the treatment of Neem oil (15 q/ha), followed by NSKE (13.00 q/ha) against tomato fruit borer (*Helicoverpa armigera* (Hubner).

Table 13. Effect of different botanicals and biopesticides treatment against fruit borer on jamun

Tr. No.	Treatments	Dose ml/l	Per cent fruit damage			Average damage
			R-1	R-2	R-3	
T-1	*Metarhizium anisopliae*	6.0 g/l	15.51 (23.19)	18.43 (25.42)	13.76 (21.77)	15.90 (23.46)
T-2	*Beauveria bassiana*	6.0 g/l	15.94 (23.53)	12.32 (20.55)	13.25 (21.35)	13.84 (21.81)
T-3	Neem oil	2.0 ml/l	9.57 (18.02)	10.39 (18.80)	7.56 (15.96)	9.17 (17.59)
T-4	Karanj oil	2.0 ml/l	17.70 (24.88)	19.90 (26.49)	14.85 (22.67)	17.48 (24.68)
T-5	Azadiractin (10000 ppm)	2.0 ml/l	7.64 (16.05)	10.56 (18.96)	6.75 (15.06)	8.32 (16.69)
T-6	NSE 5%	50 gm/l	6.62 (14.91)	9.25 (17.71)	3.24 (10.37)	6.37 (14.33)
T-7	Untreated control	-	42.86 (40.90)	37.39 (37.70)	47.75 (43.71)	42.67 (40.77)
	S.E.					1.30
	CD @ 5%					3.99

Note - Figures in the parenthesis are arcsine transformed values.

Table 14. Effect of different botanicals and biopesticides treatment on yield of jamun

Tr. No.	Treatments	Dose ml/l	Yield (kg /tree)			Average Yield (kg/ tree)
			R-I	R-II	R-III	
1.	*Metarhizium anisopliae*	6.0 g/l	20.56	16.46	29.20	22.07
2.	*Beauveria bassiana*	6.0 g/l	29.25	17.50	24.10	23.62
3.	Neem oil	2.0 ml/l	28.25	24.50	29.00	27.25
4.	Karanj oil	2.0 ml/l	20.22	24.75	18.95	21.31
5.	Azadiractin (10000 ppm)	2.0 ml/l	26.36	30.25	28075	28.45
6.	NSE 5%	50 gm/l	27.75	31.38	32.50	30.54
7.	Untreated control	-	18.15	9.77	14.86	14.26
	S.E.					1.65
	CD @ 5%					5.07

5. SUMMARY AND CONCLUSION

The present investigation entitled **"Seasonal incidence and management of pests infesting jamun (*Syzygium cuminii* L.)''** was conducted during February 2019 to December 2019 at Research farm of Arid Zone Fruits (AICRP), Department of Horticulture, M.P.K.V., Rahuri (Maharashtra) and results obtained are summarized below:

5.1 Summary

5.1.1 Seasonal Incidence of Leaf Eating Caterpillar (*Carea subtilis*)

The incidence of leaf eating caterpillar damage was noticed from the last week of January (5th MW) and survived up to the last week of December (52nd MW). The maximum damage of this pest was noticed during the month of October and November (43-49 MW). The least incidence was recorded in the month of February i.e., 4.57 % in 9th MW. The incidence gradually increased up to the third week of November and reached its peak i.e., 28.71% leaf damage/ shoot/ branch.

5.1.2 Seasonal Incidence of Chafer Beetles (*Adoretus spp.*)

The incidence of chafer beetle damage was recorded from last week of January (5th MW) and survived up to (49th MW). The maximum damage of this pest was noticed during the month of June to August (23-35 MW). The least incidence was recorded in the month of December i.e., 0.70% in (49th MW). The incidence gradually increased up to the fourth week of June and reached its peak i.e., 19.18 per cent leaf damage/shoot/ branch.

5.1.3 Seasonal Incidence of Leaf miner (*Acrocercops spp.*)

The incidence of leaf miner damage was recorded from last week of January (5th MW) and survived up to (41st MW). The maximum damage of this pest was noticed during the month of June to August (23-33 MW). The least incidence was recorded in the month of February i.e., 0.12% in (5th MW). The incidence gradually increased up to the third week of June and reached its peak i.e., 1.87 per cent leaf damage/ shoot/ branch.

5.1.4 Seasonal Incidence of Fruit borer (*Meridarchis scyrodes* Meyrick)

The incidence of fruit borer damage was recorded from the first week of April (14th MW) and survived up to the second week of July (28th MW). The maximum damage of this pest was noticed during the month of June and July (23-28 MW). The least incidence was recorded in the month of April i.e., 2.85% in (14th MW). The incidence gradually increased up to the third week of June and reached its peak i.e., 67.70% fruit damage.

5.2.1 Correlation between Leaf eating caterpillar (*Carea subtilis*) and Weather Parameters

Correlation between leaf eating caterpillar and weather parameters indicated that, there was highly positive significant correlation with minimum temperature, morning relative humidity,

evening relative humidity and rainfall. Whereas, there was negatively significant correlation with maximum temperature.

5.2.2 Correlation between Chafer Beetles (*Adoretus spp.*) and Weather Parameters

Correlation between chafer beetle and weather parameters indicated that, there was highly positive significant correlation with maximum and minimum temperature. Whereas, there was negatively non-significant correlation with morning relative humidity, evening relative humidity and rainfall.

5.2.3 Correlation between Leaf Miner (*Acrocercops spp.*) and Weather Parameters

Correlation between leaf miner and weather parameters indicated that, there was highly positive significant correlation with maximum and minimum temperature. Whereas, there was negatively non-significant correlation with morning relative humidity, evening relative humidity and positively non-significant correlation with rainfall.

5.2.4 Correlation between Fruit Borer (*Meridarchis scyrodes* Meyrick) and Weather Parameters

Correlation between Fruit borer and weather parameters indicated that, there was highly positive significant correlation with minimum temperature and evening relative humidity and there was highly positive non-significant correlation with morning relative humidity, and rainfall. Whereas, it was found negatively non-significant correlated with maximum temperature.

5.3.1 Bio-efficacy of Botanical and Biopesticide Treatments against Leaf Eating Caterpillar (*Carea subtilis*)

The field experiment on management of pest on jamun revealed that, among the all treatments, the significantly less infestation of leaf eating caterpillar was recorded from the treatment of NSE 5% @ 50g/ l. of water, which was found at par with Azadiractin 10000 ppm @ 2 ml/ l. of water, followed by Neem oil @ 2 ml/ l. of water, followed by Karanj oil @ 2ml/ l. of water. The bioagents treatment of *Beauveria bassiana* 1.15%WP @ 6 g/l. of water and *Metarhizium anisopliae* 1.15%WP @ 6 g/lit. water were found least effective for the control of leaf eating caterpillar.

5.3.2 Bio-efficacy of Botanical and Biopesticide Treatments against Chafer Beetles (*Adoretus spp.*)

Among the treatments, the significantly less infestation of chafer beetles was recorded from the treatment of NSE 5% @ 50g / l. of water, which was found at par with Azadiractin 10000 ppm @ 2 ml/ l. of water, followed by Neem oil @ 2 ml/ l. of water, followed by Karanj oil @ 2ml/ l. of water. The treatment of *Beauveria bassiana* 1.15%WP @ 6 g/l. of water and *Metarhizium anisopliae* 1.15%WP @ 6 g/lit. water were found least effective.

5.3.3 Bio-efficacy of Botanical and Biopesticide Treatments against Fruit Borer (*Meridarchis scyrodes* Meyrick)

Results from the experiment revealed that, all the treatments were found effective in reducing the infestation of fruit borer over absolute control. Among the treatments, the significantly less infestation of fruit borer was recorded from the treatment of NSE 5% @ 50g/ l. of water, which was found at par with Azadiractin 10000 ppm @ 2 ml/ l. of water, followed by Neem oil @ 2 ml/ l. of water. The treatment of biopesticides, *Beauveria bassiana* 1.15%WP @ 6 g/l. of water, *Metarhizium anisopliae* 1.15%WP @ 6 g/lit. water and Karanj oil @ 2ml / l. of water were found least effective in the control of fruit borer on jamun.

5.3.4 Influence of Botanical and Biopesticide Treatments on Yield of Jamun

Results from the experiment revealed that, all the treatments were found effective in achieving higher yield over absolute control. Among the treatments, the higher fruit yield of 30.54 kg/tree was obtained by the treatment of NSE 5%. Whereas, the treatment of Azadiractin 10000 ppm @ 2 ml/ l. of water which recorded 28.45 kg/tree, followed by Neem oil @ 2 ml/ l. of water which recorded 27.25 kg/tree as against, 14.26 kg/tree fruit yield was recorded in untreated control.

5.4 Conclusion

Following conclusions were drawn and made from the present investigation.

- The seasonal incidence of leaf eating caterpillar infestation was noticed from the 5th MW to the 52nd MW in the range of 5.50 to 28.71% leaf damage/ shoot/ branch and it reach its peak i.e., 28.71% leaf damage/ shoot/ branch in 47th MW.
- Chafer beetles infestation was noticed from the 5th MW to the 49th MW in the range of 7.25 to 19.18% leaf damage/ shoot/ branch and it reach its peak i.e., 19.18% leaf damage/ shoot/ branch in 26th MW.
- Leaf miner infestation was noticed from the 5th MW to the 41st MW in the range of 0.12 to 1.87 % leaf damage/ shoot/ branch and it reach its peak i.e., 1.87% in 25th MW.
- Fruit borer infestation was noticed from 14th MW to the 28th MW in the range of 2.85 to 67.70% fruit damage and it reach its peak i.e., 67.70% fruit damage in 25th MW.
- The correlation analysis between leaf eating caterpillar and weather parameters indicated that, there was highly positive significant correlation with minimum temperature, morning relative humidity, evening relative humidity and rainfall. Whereas, there was negatively significant correlation with maximum temperature.
- The correlation analysis between chafer beetles and weather parameters indicated that, there was highly positive significant correlation with maximum and minimum temperature.

Whereas, there was negatively non-significant correlation with morning relative humidity, evening relative humidity and rainfall.

- The correlation analysis between leaf miner and weather parameters indicated that, there was highly positive significant correlation with maximum and minimum temperature. Whereas, there was negatively non-significant correlation with morning relative humidity, evening relative humidity and positively non-significant correlation with rainfall.
- The correlation analysis between fruit borer and weather parameters indicated that, there was highly positive significant correlation with minimum temperature and evening relative humidity and there was positively non-significant correlation with morning relative humidity and rainfall. Whereas, it was found negatively non-significant correlated with maximum temperature.
- For effective management of leaf feeders *viz*., leaf eating caterpillar, chafer beetles and fruit borer, among the all treatments, the treatment of NSE 5% found the most effective treatment over control, followed by Azadiractin 10000 ppm @ 2 ml/ l. of water and Neem oil @ 2 ml/ l. of water as next promising treatment.
- The highest fruit yield of 30.54 kg/tree was recorded from the treatment of NSE 5%, followed by Azadiractin 10000 ppm @ 2 ml/ l. of water and recorded 28.45 kg /tree, followed by Neem oil @ 2 ml/ l. of water and recorded 27.25 kg/tree.

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7. VITAE

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MASTER OF SCIENCE

IN

AGRICULTURAL ENTOMOLOGY

2021

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