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Eco-Friendly Management of Flea Beetle (*Phyllotreta spp.*) on Som Plant *(Machilus bombycina* King) by Traditionally Used Plant Extracts

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Abstract: Muga silk worm (*Antheraea assama* West wood) rearing is done on som plant *(Machilus bombycina* King). Larval growth and silk production depends on nutritional value of som plant leaves. Large number of insect pests infests som plant and so rearing becomes difficult. Flea beetle (*Phyllotreta spp.*) (Coleoptera: Chrysomellidae) is a harmful pest pest and cause damage to som plant leaves. The study was carried out to find out the incidence pattern of flea beetle (*Phyllotreta spp.*) infesting som plant (*Machilus bombycina* King) and bio-efficacy evaluation of plant products for its safe management. For the experiments five plant extracts and one botanical pesticide were evaluated and their effectiveness was compared with standard check, Profenophos along with one untreated control. The floral parts of polygonum (*Polygonum hydropiper*), pongamia (*Pongamia pinnata*) leaves, garlic bulb (*Allium sativum*), spilanthes (*Spilanthes paniculata*) floral parts were extracted in methanol. Water was used for extraction of tobacco (*Nicotiana tabacum)* leaves. Harmful activity of flea beetles was recorded throughout the year on som plant leaves. The highest population (8.92/twig) was found on the last week of May (21^{st} standard meteorological week). Significant positive correlation was seen between flea beetle population and temperature. Flea beetle had non-significant negative correlation with relative humidity. Profenophos 50 EC @ 0.05% was found most effective pesticide against flea beetle which provided about 70 per cent suppression. However, plant based pesticide and extract, Azadirachtin and *Polygonum*provided moderate to higher flea beetle suppression. They recorded more than 50 per cent flea beetle control on som plant. Bio-pesticides including plant extracts are safe to our environment. It has no harmful effect on muga silk worm rearing. So it can be used for management of flea beetle on som plant.

Keywords: Abiotic Factors, Bio-Pesticides, Muga Rearing, Plant Extracts, Silk Industry

1. Introduction

Som plant *(Machilus bombycina* King) is popularly cultivated in terai region of North-East India as medium sized tree. Farmers cultivate this tree for rearing of muga silk worm (*Antherae aassama* West wood) and its timber. Muga silk worm, *A. assama,* is polyvoltine in nature. They pass five to six generations per year year. Climatic factors and seasons affect its commercial production. Larval growth and silk productivity are affected by the nutritional value of som plant leaves. Farmers earn extra income from timber of som plant. It is cultivated mainly at Bhrambhaputra river valley of Assam state, India and many areas of north-east India. Terai region is situated at the northern part of West Bengal, India. These areas have more or less similar type of agro-climatic condition with lower Assam and these parts comprising Coochbehar, Jalpaiguri and Alipurduar district of West Bengal state, India have possibility of its cultivation in a commercial scale [11].

Som plant is infested by a large number of insect-pests. Due to infestation of the insect and mite pests it becomes difficult for its successful rearing [25]. Different species of flea beetle (*Phyllotreta spp.*) **(**Coleoptera: Chrysomellidae) is very harmful infesting som plant leaves and badly affects food quality for which muga cultivation is affected. Moreover, the larvae of silk worm do not prefer infested and damaged leaves of som plant. Flea beetle has wide host range because it is polyphagus insect pest. In Coochbehar district of

West Bengal, India flea beetle is a major insect pest of brinjal/eggplant and causes significant damage during summer season [5]. A number of round holes are found on the leaves due to direct feeding on leaves by the adult beetles. Photosynthetic areas of leaves are reduced due to severe infestation and damage by feeding of the beetles. A large number of pests such as stem borer, leaf miner, gall insect, hairy caterpillar, flea beetle, aphid and termite attack som plants from nursery to mature plants [2, 24, 25]. Zhang *et al.* [32] reported that peak infestation of flea beetle (*Phyllotreta spp.)* was found during early April to late May and in middle of September in China. From terai region of West Bengal, India, Biswas *et al.* [3] reported that the flea beetle population is positively correlated with average temperature, average relative humidity, sunshine hour and total rainfall. Flea beetle was active throughout the year in terai region including Coochbehar, West Bengal and higher population was found during 10^{th} standard meteorological week to 20^{th} standard meteorological week with a peak population level (1.11/plant) on 23^{rd} standard meteorological week [29]. The population had a positive but non-significant correlation with temperature (maximum, minimum, and average). Ghosh *et al.* [13] studied in Coochbehar, terai region, West Bengal in eggplant field and reported that highest population of flea beetle was observed (7.16/plant) on 20^{th} standard meteorological week and population had a significant positive correlation with average temperature and non-significant negative correlation with weekly total rainfall and average relative humidity.

Osteen C D & Szmedra P I. [19] reported that pest developed resistance against pesticides because of use of higher level of synthetic pesticides by the farmers. Use of synthetic insecticides on host plant of silk worm rearing is too much harmful. Singh R N & Saratchandra B [26] and Mandol *et al.* [16] reported that neem, *Pongamia*, chrysanthemum, adathoda, turmeric, *Ocimum*, garlic, tobacco, custard apple, zinger etc. were most common pesticidal plants used for controlling different types of pests in all types of sericulture. Plant based pesticides acts as feeding deterrents, repellents, insect growth regulators (IGR), confusants etc [23]. Vijayalakshmi *et al.* [31] reported that neem based bio-pesticides act in various ways on insect pest viz. insect repellent, antifeedant, growth regulator, chemosterilant and toxicant. Azadirachtin (neem based product) is considered an excellent plant based bio-pesticides for its lower toxicity to animals, biodegradability, environmental safety, and safer for non-target organisms [15, 21]. In Coochbehar district, West Bengal, India *Polygonum* is a well known weed popularly known as "biskanthali" [22]. Ghosh *et al.* [10] studied the effect of plant extracts in methanol on aphid in ladys'finger field and reported that *Polygonum* plant flower extracts recorded 59.77% aphid control. In Coochbehar, West Bengal, India, Ghosh S K & Senapati S K. [12] studied the effect of neem based bio-pesticides on flea beetle in eggplant field and reported that neem provided moderate control of flea beetle (41.70%). Ujvary I. [30] reported that alkaloid nicotine is obtained from *Nicotiana tabacum, N. glutinosa and N. rustica* which are well-established plant based insecticides. Dhaliwal G S & Arora R. [4] reported that nicotine is highly toxic to *Bemisia tabaci* Genn. Ghosh S K. [6] reported that azadirachtin and *Polygonum* flower extracts recorded moderate to higher flea beetle suppression. Use of mixed formulation viz. synthetic and tobacco was found more economical than using synthetic pesticides alone [18]. The objective of these experiments is to formulate sustainable management of flea beetle on som plant and thus promoting better rearing of muga silk worm having higher and quality production in silk industry.

2. Materials and Methods

2.1. Location and Study Period

Two years (2018-19) studies were carried out in the farm and bio-pesticide laboratory of UBKV–Agriculture University at Pundibari, Coochbehar, West Bengal, India. The location of the University is in the sub-Himalayan region of north-east India. This terai zone is situated between $25^0 57'$ and 27^0 N latitude and $88^0 25'$ and $89^0 54'$ E longitude [27]. This area contains sandy loam soil having pH value 6.9 [28]. The climate of this zone is humid subtropical having a short winter spell during November to February [8].

2.2. Population Dynamics of Flea Beetle (Phyllotreta spp.) on Som Plant

Som plants were maintained under proper fertilizer doses and locally recommended cultural practices to study the population dynamics and infestation of flea beetle. Reading of climatic conditions in this locality during the study period were also taken to study the influence of climatic condition on the pest population. Som plants were grown by using standard package and practices. Plants had spacing of 3 m X 3 m in 5 m X 5 m sized plots having four plants with four replications. For this experiment no plant protection measures were taken. Four replications were taken for each treatment in a Randomized Block Design (RBD). The flea beetle populations per twig were recorded from top, middle and bottom from four randomly selected plants per replication at weekly (Standard Meteorological Week) interval throughout the year. The observations were recorded from January to end of December during the experimental period. Cumulative data recorded for this two years, 2018 and 2019 were presented graphically with important climatic parameters viz. temperature, relative humidity, total rainfall etc. Correlation co-efficient (r) was worked out between population dynamics of flea beetle and climatic parameters during the period. This helps to find out the influence of climatic parameters on the population incidence.

2.3. Bio-Efficacy Test of Plant Extracts Against Flea Beetle (Phyllotreta spp.)

2.3.1. Cultivation Practices

There is unique pest problem in terai region of West Bengal, India. Main objective of the experiment was to formulate a safe pest control strategy of som plant which should be environmentally sound, technically feasible and economically viable. Som plants were grown by using standard package and practices. Fertilizers were applied to the plants once per year (90 g Urea+140 g SSP+30 g MOP/ plant) having spacing as 3 m X 3 m in 5 m X 5 m sized plots with 4 plants and four replications each.

2.3.2. Treatment Details

Under this study seven pesticides were sprayed three times were done at 10 day intervals. Generally the plants remained vacant from rearing of muga silk worm during March-April and August-September. So these periods were suitable for application of pesticides against insect pests on som plant. Hence, during March-April spraying had been made.

Table 1. *Treatments details.*

Treatments	Dose ml or g /L of water and (%)
T_1=*Polygonumhydropiper*extract	50.00 ml/L (5%)
T_2=*Pongamiapinnata*extract	50.00 ml/L (5%)
T_3=Azadirachtin (NIMARIN 1500 ppm) phyto-insecticide	2.5 ml/L
T_4=Garlic (*Allium sativum*) extract	50.00 ml/L (5%)
T_5=Profenophos (carina50 EC) chemicalinsecticide	1 ml/ L (0.05%)
T_6=Tobacco (*Nicotianatabacum)* extract	50.00 ml/L (5%)
T_7=*Spilanthespaniculata*extract	50.00 ml/L (5%)
T_8=Untreated Control	---

Five botanical extracts (prepared by certain procedure), viz. floral parts of *Polygonum hydropiper,* leaves of *Pongamia pinnata,* garlic bulb (*Allium sativum*), tobacco (*Nicotiana tabacum)* leaf, and floral parts of *Spilanthes paniculata*, one botanical insecticide, azadirachtin (nimarin1500 ppm) were sprayed and compared with the chemical insecticide, profenophos (carina 50 EC).

2.3.3. Preparation of Extracts

For plant parts extraction methodology developed by Ghosh *et al.* [9] was followed. Methanol was used for extraction of plant parts viz. polygonum (*Polygonum hydropiper*) floral parts, pongamia (*Pongamia pinnata*) leaves, garlic (*Allium sativum*), spilanthes (*Spilanthes paniculata*) floral parts. Dried plant parts were made in powdered form. In a conical flask 250ml methanol were kept and then fifty g powder of plant parts was placed to the conical flask and dipped in the methanol. The conical flask was stirred occasionally and kept them to stand for 72 hours at room temperature. Then the extract was filtered through Whatman 42 filter paper was used for filtration of the extract. The residues of the plant material were washed twice with methanol. Water was used for extraction of tobacco (*Nicotiana tabacum)* leaves. Tobacco leaves were washed with water and then dried. The dried material was made in powdered form in a grinder. 100 g of the powdered material was placed to a pot and dipped in one litre water. The material was allowed to stand for 72 hours at room temperature with occasional stirring. Whatman 42 filter paper was used for filtration of tobacco extracts. Fifteen ml liquid soap was added in the product for easy spreading on the plant surface.

2.3.4. Data Recording for Bio-Efficacy Evaluation of Pesticides

During March-April three round sprays were done at 10 day intervals. Flea beetle population was counted 3, 6, and 9 days after each application of pesticides. The total flea beetle population / twig from top, middle and bottom leaves from four randomly selected plants per replication were recorded. Flea beetle pest population suppression (%) compared to population recorded on the untreated check treatment were calculated. Per cent reduction of flea beetle population over untreated check was calculated by following [1] formula:

$$\text{Pt} = \frac{Po - Pc}{100 - Pc} \times 100$$

Where, Pt = Corrected mortality, Po = Observed mortality and Pc = Control mortality.

$$\text{Per cent reduction over control} = \frac{\text{Per cent reduction in treatment} - \text{Per cent reduction in control} \times 100}{100 - \text{Per cent reduction in control}}$$

The treatments contained four replications in Randomized Block Design (RBD). Data were analyzed by using INDO-STAT- software for analysis of variance. Treatment means were separated by applying CD Test (critical difference) at 5% level of significance. Randomized block design (RBD) were followed.

3. Results

3.1. Population Dynamics of Flea Beetle (Phyllotreta spp.) Throughout the Year

Population of flea beetle was found throughout the year. In 2018, its incidence was recorded at the beginning of the year and higher level of population recorded during 18^{th} standard meteorological week to 28^{th} standard meteorological week that is during 1^{st} week of May to 2^{nd} week of July when average temperature, relative humidity and weekly average rainfall were 29.71°C-32.09°C, 75.64%-86.92% and 0.40mm-112.50mm respectively. Highest population (10.21/twig) was found on 22^{nd} standard meteorological week that is on 1^{st} week of June when average temperature, relative humidity and weekly average rainfall were 31.96°C, 77.21% and 11.30mm respectively. Lower population level was observed during 38^{th} standard meteorological week to 52^{nd} standard meteorological week that is during 4^{th} week of September to last week of December when average temperature, relative humidity and weekly average rainfall were 19.60°C-30.51°C, 76.42%-87.65% and 0.00mm-70.00mm respectively. In 2019, higher level of population found during 19^{th} standard meteorological week to 28^{th}

standard meteorological week that is during 2nd week of May to 2nd week of July when average temperature, relative humidity and weekly average rainfall were 26.78°C-29.85°C, 73.21%-92.50% and 37.50mm-291.40mm respectively. Highest population (8.87/twig) was recorded on 27th standard meteorological week that is on 1st week of July when average temperature, relative humidity and weekly average rainfall were 28.06°C, 88.21% and 98.10mm respectively. Lower population level was observed during 38th standard meteorological week to 52nd standard meteorological week that is during 4th week of September to last week of December when average temperature, relative humidity and weekly average rainfall were 16.49°C-29.13°C, 65.29%-92.85% and 0.00mm-344.70mm respectively.

The pooled data (2018 and 2019) on year round flea beetle pest incidence for the two years showed that the pest caused damage throughout the year (Figure 1). Lower level of incidence was recorded during 38th standard meteorological week to 52nd standard meteorological week that is during 4thweek of September to last week of December. Higher level of incidence was maintained during 20th standard meteorological week to 27th standard meteorological week that is during 3rd week of May to 1st week of July with the highest population (8.92/twig) was found on 21st standard meteorological week that is on the last week of May.

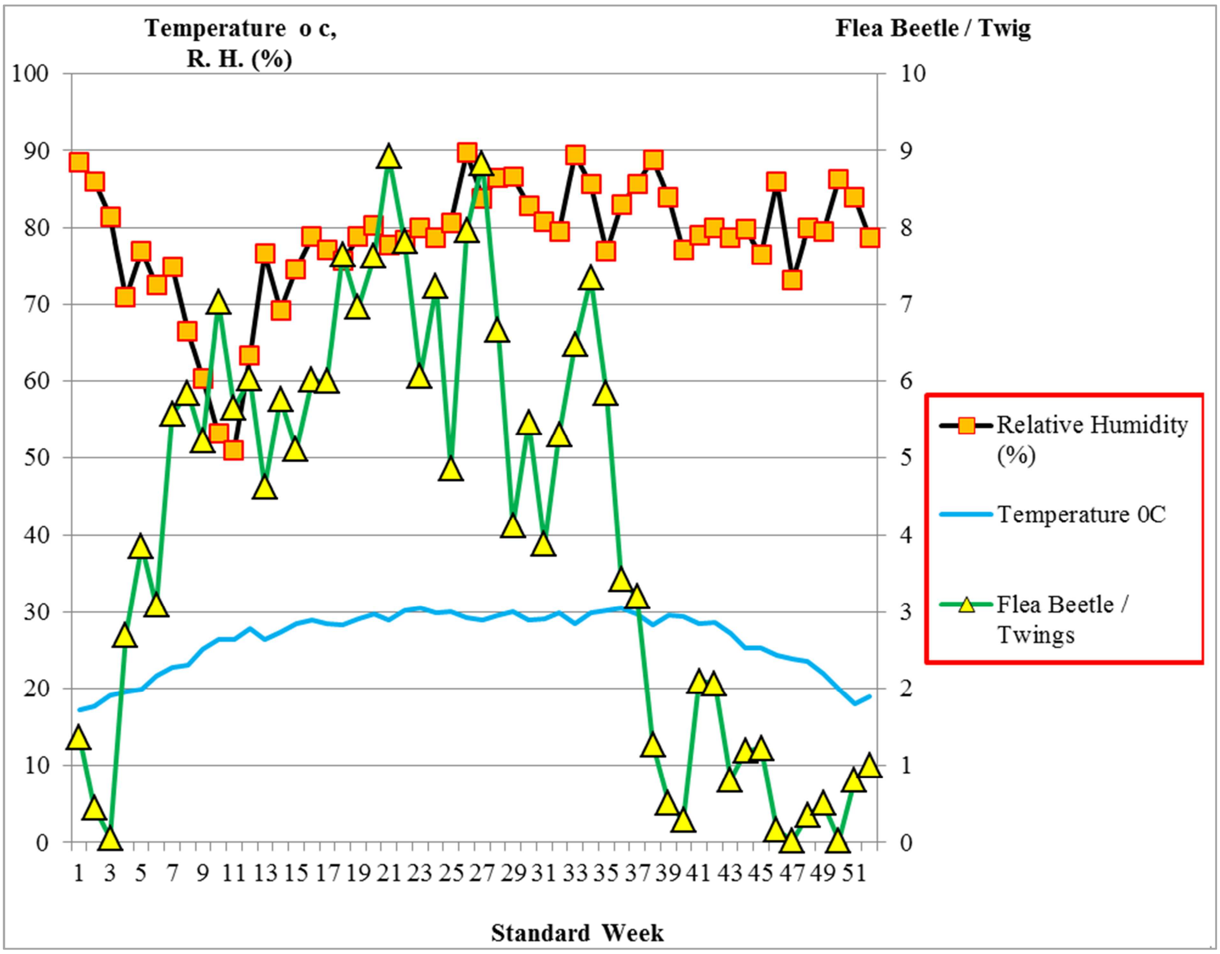

Figure 1. *Fluctuation of flea beetle (Phyllotreta spp.) population (average) as influenced by temperatureand relative humidity.*

Table 2. *Correlation co-efficient between flea beetle (Phyllotreta spp.) and abiotic factors.*

Environmental parameter		Correlation co-efficient (r)	Co-efficient of determination (R^2)	Regression equation
Temperature°C	Maximum	0.547**	0.299	Y= 0.519x - 12.05
	Minimum	0.558**	0.310	Y= 0.291x - 2.208
	Difference	-0.434**	0.188	Y= -0.383x + 7.706
	Average	0.572**	0.326	Y= 0.397x - 6.382
Relative Humidity (%)	Maximum	-0.197	0.038	Y= -0.077x + 10.55
	Minimum	-0.200	0.040	Y= - 0.053x + 8.014
	Average	-0.214	0.045	Y= -0.072x + 9.789

* Significant at 5% level of significance; ** Significant at 1% level of significance

Correlation studies (Table 2) between flea beetle population and environmental parameters were done.

Significant positive correlation had been seen between flea beetle population and temperature (maximum, minimum and average). Flea beetle had non-significant negative correlation with relative humidity (maximum, minimum and average).

3.2. Bio-Efficacy Evaluation of Botanical Extracts Against Flea Beetle (Phyllotreta spp.)

(Garlic (*Allium sativum* L.) Karanj (*Pongamia pinnata*)

Spilanthes paniculata Tobacco (*Nicotiana tabacum*)

Polygonum hydropiper

Figure 2. *Locally available plants having pesticide properties used as plant extracts.*

As rearing of muga silk worm was done on som plants so it was not possible to apply pesticides on som plant leaves throughout the year. March-April was selected for spraying as som plant remained vacant from silk worm rearing. The different bio-pesticide treatments and their persistence at different days after spraying varied significantly in their control of flea beetle populations (Table 3). In the present experiment, among the seven pesticides evaluated (Table 3) profenophos50 EC @ 0.05% (carina 50 EC) was found most effective and significantly different from all other treatments against flea beetle. This treatment provided 71.10% suppression of flea beetle, followed by azadirachtin providing 54.05% suppression. From over all experiment it was found that extracts of *Polygonum*, tobacco, *Spilanthes* and *Pongamia* plant gave moderate to higher control, recording about 50.33%, 47.89%, 36.14% and 31.94% flea beetle suppression respectively. Garlic extracts provided least suppression (28.07% suppression) against flea beetle.

Three days after spraying, profenophos 50 EC @ 0.05% (carina 50 EC) recorded highest control (80.83% suppression) of flea beetle, very closely followed by azadirachtin recording 56.02% suppression. Among the plant extracts, *Polygonum* and tobacco were found to be moderate to higher control of flea beetle providing 52.02% and 50.52% suppression respectively. These two treatments of bio-pesticides (plant extracts) were not significantly different from each other.

However, least effectiveness was found in garlic extract, recording only 30.34 % control of flea beetle. Six days after spraying, also profenophos 50 EC @ 0.05% (Carina 50 EC) was found to be superior insecticide (67.37% suppression) closely followed by botanical insecticide, azadirachtin (58.78% suppression). Among the botanical extracts, *Polygonum* and tobacco provided moderate to higher control offlea beetle providing 49.36% and 47.77% suppression respectively. These two treatments of bio-pesticides (plant extracts) were not significantly different from each other. However, least control was recorded from garlic extract, recording only 26.79% control of flea beetle. Nine days after spraying similar trend of control was found. Profenophos 50 EC @ 0.05% was found to be most effective (65.11% suppression) against flea beetle, followed by botanical extract *Polygonum* (49.60% suppression) and azadirachtin (47.36% suppression). Tobacco extracts, *Pongamia*and *Spilanthes* recorded moderate to higher control of flea beetle providing 45.38% and 33.85% and 32.86% suppression respectively. However, garlic extract provided least control, recording only 27.08 % control of flea beetle.

Table 3. *Overall efficacy of plant extracts against flea beetle (Phyllotreta spp.) on som plant (2018 and 2019- Grand Mean).*

Treatments	Doseml / Litre (%)	Over all efficacy (% reduction or increase)				
		Pre-spraying obs. flea beetle / twig	3 DAS	6 DAS	9 DAS	Mean
Polygonum (T1)	50.00 ml/L (5%)	6.49	52.01 (45.97)	49.37 (44.65)	49.60 (44.77)	50.33 (45.13)
Pongamia (T2)	50.00 ml/L (5%)	6.19	31.33 (34.01)	30.64 (33.54)	33.85 (35.51)	31.94 (34.35)
Azadirachtin (nimarin 1500 ppm) (T3)	2.5 ml/L	5.89	56.02 (48.48)	58.78 (50.07)	47.35 (43.46)	54.05 (47.34)
Garlic (T4)	50.00 ml/L (5%)	6.21	30.34 (33.29)	26.79 (30.89)	27.08 (31.22)	28.07 (31.80)
Profenophos (carina 50 EC) (T5)	1 ml/ L (0.05%)	5.97	80.83 (64.10)	67.36 (55.21)	65.12 (53.84)	71.10 (57.71)
Tobacco (T6)	50.00 ml/L (5%)	5.72	50.52 (45.30)	47.78 (43.71)	45.37 (42.25)	47.89 (43.75)
Spilanthes (T7)	50.00 ml/L (5%)	5.84	38.41 (38.25)	37.16 (37.54)	32.86 (34.92)	36.14 (36.90)
Untreated check (T8)	---	6.05	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)
S Em (±)	---	---	2.07	1.82	2.18	---
CD at 5%	---	NS	6.33	5.45	6.67	---

Figure in the parenthesis are angular transformed values, DAS = Days after spraying, NS = Not significant

4. Discussion

Population of flea beetle was found throughout the year. The pooled data on year round flea beetle pest population dynamics for the two years found that the pest caused damage throughout the year (Figure 1). So it is not easy to formulate the management of the pest. Subba *et al.* [29], from Coochbehar district, terai region of West Bengal, India reported that flea beetle was found active throughout the year with peak population (1.11/plant) on 23rd standard meteorological week which supported the present findings. Study of pest incidence throughout the year is helpful to formulate sustainable pest management schedule and Integrated Pest Management (IPM). Present findings of flea beetle fluctuation were supported by Ghosh *et al.* [13]. They reported from terai region of West Bengal that highest population of flea beetle on eggplant was recorded (7.16/plant) on 20th standard meteorological week and population had significant positive correlation with average temperature and non-significant negative correlation with average relative humidity and weekly total rainfall. This indicates that there is proportional relationship between activity of flea beetle and temperature and inversely proportional relationship with relative humidity. Thus the activity of flea beetle population increased with the rise of temperature and population decreased with the rise of relative humidity. Study of seasonal population fluctuation throughout the year is helpful to prepare suitable pest control measure. Pesticides should be sprayed at the time of higher level of pest incidence.

From the overall observations it was revealed that profenophos 50 EC @ 0.05% (Carina 50 EC) was recorded highest flea beetle control providing more than 70% suppression. However, plant extract viz azadirachtin and *Polygonum* provided moderate to higher flea beetle management, providing more than 50% suppression on som plant. In an experiment in the same zone i.e. in Coochbehar, Ghosh S K. [6] reported that azadirachtrn (neem based bio-pesticide) and extracts of *Polygonum* plant provided moderate to higher flea beetle management, providing more than 50% suppression of pest and produced higher yield of ladys'finger. Present findings were supported by this study. profenophos 50 EC being a highly toxic synthetic chemical insecticide there is every possibility to contaminate som plant leaf with the toxic chemicals, as som plant leaf is the major food component of muga silk worm. Highly toxic synthetic chemical pesticide like profenophos 50 EC may contaminate the som plant leaves which kill the larvae. So if the chemical pesticides are used for controlling pest of som plant may become harmful to the rearing of muga silk worm and hamper commercial production in the silk industry. Chemical pesticides also cause abnormalities like environmental pollution, health hazards, killing of beneficial insects etc. Microbial pesticides cause different diseases to muga silk worm and immediately kill it. Microbial pesticides should not be applied due to their harmful effect. Rahardjo *et al.* [20] reported that the spraying of plant based formulation having an insecticidal property was considered as one promising alternative in reducing the negative effects of chemical pesticides. They also reported that the respected treatments of Chinese mahogany leaf extract pyrethrum petal, chinaberry leaf and commercial botanical insecticide Neem plus also provided good control of pest. Extracts of *Polygonum* plant provided better aphids control, providing about 60% control [9] and they also reported that *Polygonum* plant extracts provided 59.77% control in ladyfinger. Mandol T& Ghosh S K. [17] reported that extract of *Polygonum, Spilenthes,* tobaccoand azadiractin provided moderate to higher mealy bug control on som plant. Ghosh *et al.* [14] reported that a rapid degradation of persistency found in imidacloprid and neem oil than other pesticides tested. So small amount of imidacloprid may be used mixing with plant based formulation for general use of the farmers for its higher efficacy and rapid degradation. Ghosh S K. [7] reported that mixed formulation of botanical pesticide, azadirachtin with botanical extract, *Spilenthes*provided70.66% suppression of mite pest. Bio-pesticides including plant extracts are safe to rearing of silk worm. It is also safe to health and environment and so can be incorporated in Integrated Pest Management Programme (IPM) programme. Bio-pesticides are suitable in organic cultivation for controlling flea beetle on som plant.

5. Conclusions

Flea beetle caused damage throughout the year. Higher level of incidence was observed during 3rd week of May to 1st week of July with the highest population (8.92/twig) was found on the last week of May. From correlation studies between flea beetle population and environmental parameters, significant positive correlation was found between flea beetle population and temperature (maximum, minimum and average). Flea beetle had non-significant negative correlation with relative humidity (maximum, minimum and average). Thus the activity of flea beetle population increased with the rise of temperature and population decreased with the rise of relative humidity. Study of seasonal population fluctuation throughout the year is helpful to prepare suitable pest control measure. Pesticides should be sprayed at the time of higher level of pest incidence. Profenophos 50 EC @ 0.05% (Carina 50 EC) was found most effective and significantly different from all other treatments against flea beetle. This treatment provided 71.10% suppression of flea beetle, followed by azadirachtin providing 54.05% suppression. From over all observation it was revealed that extracts of *Polygonum*, tobacco, *Spilanthes* and *Pongamia* plant gave moderate to higher control, recording about 50.33%, 47.89%, 36.14% and 31.94% flea beetle suppression respectively. Bio-pesticides including plant extracts are safe to rearing of silk worm. It is also safe to health and environment and so can be incorporated in Integrated Pest Management Programme (IPM) programme. Bio-pesticides are suitable in organic cultivation for controlling flea beetle on som plant. Use of chemical pesticides should be avoided as silk worm rearing in done on som plant.

Authors' Contribution

SKG conceived and designed the study. He executed the experimental work and analyzed the data. He also supervised the work and prepared the manuscript and communication.

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Conflicts of Interest

The author proclaims that he does not have a conflict of interest.

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