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Effect of Panchagavya on Major Insect Pests in the *Dalbergia oliveri* Gamble ex Prain Plantation

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Contents

List of Table

List of Figure

တမလန်းစိုက်ခင်းတွင် ကျရောက်သော အဓိကအင်းဆက်ဖျက်ပိုးများအပေါ် အော်ဂဲနစ်ပိုးသတ်ဆေး Panchagavya ၏ သက်ရောက်မှုကိုလေ့လာခြင်း

ခင်မာမြင့်၊ လက်ထောက်သုတေသနအရာရှိ
ဒီလေးဘာထွေး၊ သုတေသနအရာရှိ

စာတမ်းအကျဉ်း

တမလန်းစိုက်ခင်းတွင် ကျရောက်သော အင်းဆက်ဖျက်ပိုးများအပေါ် အော်ဂဲနစ်ပိုးသတ်ဆေး **Panchagavya** နှင့် တမာပိုးသတ်ဆေးတို့၏ သက်ရောက်မှုလေ့လာခြင်းကို စစ်ကိုင်းတိုင်းဒေသကြီး၊ ကသာမြို့နယ်၊ အောင်ပုံကြိုးပြင်တော တမလန်းစိုက်ကွက်တွင် ၂၀၁၈ ခုနှစ် မှ ၂၀၁၉ ခုနှစ် မိုးရာသီတွင် ဆောင်ရွက်ခဲ့ပါသည်။ စမ်းသပ်ခြင်းလုပ်ငန်းတွင် စိုက်ခင်း၌ အကွက်ကြီး(၃) ကွက်၊ တစ်ကွက်စီတွင် အကွက်ငယ် (၅) ကွက်ပါဝင်ပြီး အကွက်ငယ်တစ်ကွက်တွင် နမူနာအပင် (၁၅) ပင် ပါရှိသည်။ စမ်းသပ်ကွက်များကို (က) ၅% Panchagavya (ခ) ၇% Panchagavya (ဂ) ၁% Azadirachtin (ဃ) ၁% Azadirachtin +၅% Panchagavya (င) Control ဟူ၍ သတ်မှတ်ပါ သည်။ ဖျက်ပိုးတစ်မျိုးစီပေါ်တွင် Treatments များ၏ သက်ရောက်မှု ရလဒ်များကို ဆွေးနွေး တင်ပြထားပါသည်။ Treatment အားလုံးသည် *Bradina* sp. (Lepidoptera) ဖျက်ပိုးအပေါ်တွင် ထိရောက်မှုရှိသည်ကို တွေ့ရှိရသော်လည်း *Myllocerus discolor, M. viridanus and Polydrusus cervinus* နှင့် *Chrysomela auratus ဖျက်ပိုးတို့အပေါ်တွင်မူ* ၁% Azadirachtin သုံးစွဲခြင်းသည် ထိရောက်မှုမရှိခြင်းနှင့် စာရင်းစစ်တမ်းတွင် ၁% Azadirachtin နှင့် Control သည်လည်း ကွာခြားမှုမရှိသည်ကို တွေ့ရသည်။ သုတေသနရလဒ်အရ ၅% Panchagavya ၊ ၇% Panchagavya နှင့် ၁% Azadirachtin + ၅% Panchagavya treatment များ၏ ရလဒ်များမှာ Statistic အရ ထင်ရှားသည့် ကွဲလွဲချက်မရှိသည်ကို တွေ့ရှိရပါသည်။

Effect of Panchagavya on Major Insect Pests in the *Dalbergia oliveri* Gamble ex Prain Plantation

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Abstract

A survey was carried out to record the pests associated with *Dalbergia oliveri* Plantation at Aung Pone Nataga Protected Public Forest Katha Township at the north latitude 24°10' and east longitude 96°20', Sagaing Region starting from June, 2018 and 2019 only in monsoon seasons. A Randomized Complete Design was used three blocks with three replications. From each block, 5 sample plots each measuring 15 m x 15 m consisted of 15 sample trees were randomly selected. In this experiment; (i) 5% Panchagavya (ii) 7% Panchagavya (iii) 1% Azadirachtin (iv) 1% Azadirachtin +5% Panchagavya and (v) control were tested. All treatment significantly reduced the level of infestation compared to the check of control for *Bradina* sp, especially. The treatment of 1% Azadirachtin was not significantly difference with control on beetles of *Myllocerus discolor, M. viridanus, Polydrusus cervinus, and Chrysomela auratus* coleopteran pests. According to the result, among the treatment of 5% Panchagavya, 7% Panchagavya and 1% Azadirachtin +5% Panchagavya; their effect was no significant differences on the individual pest at α=0.05 %.

Keywords: *Dalbergia oliveri* Gamble ex Prain, Caterpillar *Bradina* sp., Adult stage of *Myllocerus discolor, M. viridanus, Polydrusus cervinus, Chrysomela auratus,* Panchagavya, Azadirachtin, Myanmar.

Effect of Panchagavya on Major Insect Pests in *Dalbergia oliveri* Gamble ex Prain Plantation

1. Introduction

Insect pests constitute an important single factor which plays a remarkable role in limiting the Forest productivity. Quite often, these pose serious problems and constraints in protecting our resources particularly nurseries and plantations (Sen-Sharma and Thakur, 1985). The natural resources of the *Dalbergia oliveri* trees have gradually been threatened by human interventions and quantitative impact of forests on the environment. Due to increasing population and socioeconomic pressure, nowadays plant conservation has consequently emerged as a crucial environmental issue and the problems have to solve as a first priority not only for the biodiversity conservation but also for sustainable utilization of natural resources and long term benefits. The plantations *D. oliveri* are being established to conserve the species composition. As the trees grow, the plantation will be faced with the infestation of various insect pests and thus the control measure will be needed to suppress the potential pests.

The use of chemical pesticide in modern agriculture and forest plantations resulted in the development of several problems such as pesticide resistance insects, resurgence of target and secondary pest outbreak, destruction of beneficial organisms like honey bees, pollinators, parasitoids and predators and pesticide residue in food, feed and fodder. Panchagavya is an organic preparation made from five different cow products viz., milk, curd, ghee, urine and dung, commonly applied to crop plants in organic forming and against insect pests (Vallimayil & Sekar, 2012 and Amalraj et al., 2013). Panchagavya contains growth regulatory substances such as IAA, GA, Cytokinin, essential plant nutrients, effective microorganisms like lactic acid bacterium, yeast and Actinomycetes. It also contains biofertilizers like Acetobactor, Azospirillum and Phosphobacterium and plant protection substances (Somasundram et al, 2004).The awareness about the health and environmental problems due to the continuous use of pesticides resulted in the development of integrated pest management (Thomas & Prabhu, 2001; Prabhu, 2004).

Nowadays liquid organic manures are becoming popular to combat the adverse effect of chemical fertilizers. And also they can supply essential nutrients to the crop plant and bio-control agents to prevent disease and pest infestation. Due to indiscriminate harvesting, cutting branches and lopped trees attract the infestation of insect pests which adversely affect the growth and productivity. There was limited information about the infestation of insect pests on *Dalbergia oliveri* trees not only in Myanmar but also in other countries. If there is a heavy infestation with insects, the growth of tree may be severely affected. Therefore, the present study was undertaken in the plantation of *D. oliveri* to find out the major insect pests and formulated control.

2. Objectives

- To observe the natural incidences of insect pests in *Dalbergia oliveri* plantation
- To investigate the effect of organic pesticide (Panchagavya) on major insect pest of *Dalbergia oliveri* Gamble ex Prain plantations

3. Literature Review

The species, *Dalbergia oliveri*, is related to the species, *Dalbergia sissoo* Roxb which was attacked by totally 17 insect pests; five species belongs to Coleoptera viz. *Apoderuss issu, Anomala dalbergiae, Anomala bengalensis, Myllocerus undecimpustulatus* and *Myllocerus discolour*, five species of Lepidoptera viz. *Agrotis ipsilon, Plecoptera reflexa, Ascotisinfix aria*, *Dichomeris eridantis* and *Leucoptera sphenograpta*, and seven Hemiptera species viz. *Lawana conspersa*, *Ceroplaste srusci*, *Leptocentrus taurus*, *Myzus persicae*, *Icerya seychellarum, Drosicha dalbergiae* and *Odontotermes obesus*. Among them, *Lawana conspersa* and *Iceryasey chellarum* were found first on D. sissoo (Arvind Kumar, 2017).

The Coleopteran weevils is one of the most economically important insect orders due to its feeding habits diversity and damage potential to number of forestry and agricultural crops (Stebbing E.P. 1977).Several weevils (Coeleoptera: Curculionidae) are visualized as pests of agricultural crop which damage fruits, seeds and leaves of crops and also grains. Among these beetles, the species of genus *Myllocerus* are economic importance pests (Marshall, 1916).*Myllocerus discolor* beetle feeds on *Acacia intsia, Dalbergia paniculata, Tectona grandis, Dalbergia sissoo, Mangifera indica* and *Zizyphus jujube* (Beeson, 1941).

Biology of Genus *Myllocerus* sp, **e**ach female may lay up to 360 eggs over 24 days directly on organic material at the soil surface. The first instar larvae emerge after 3-5 days. There are four larval instars which burrow into the soil and feed on plant roots for approximately one to two months. The larvae pupate in the soil for approximately one week. In the laboratory, the life cycle is completed in less than two months so there can be several generations each year if the climate is suitable. The weevils were abundant in monsoon season from July to October. *Myllocerus discolor* and *M. viridanus* was found throughout the year feeding (Khairmode and Sathe, 2014).

Leaf feeders of the orders Lepidoptera and Coleoptera are the common leaf feeding insects. The simplest is the wholesale consumption of leaf by groups such as caterpillars and beetles on almost all species of trees. Defoliation by caterpillars often results in widespread damage to forest plantations. Some caterpillars, such as leaf skeletonizer feed only on the green leaf tissue between the networks of veins which results in skeletonization of leaves. Some caterpillars tie the leaf together or roll the leaves and feed from within.

Effect of Panchagavya on pest and diseases which increases immunity power in plants thereby confers resistance against pest and diseases. It produce various beneficial metabolites such as organic acids, hydrogen peroxide and antibiotics, which are effective against various pathogenic microorganisms (Dhama et al., 2005; Kumar, 2005).

Properties of Panchagavya contains several nutrients i.e. macronutrients like nitrogen, phosphorus, potassium and micronutrients which are required for the growth and development of plants and also contains various amino acids, vitamins, growth regulators like Auxins, Gibberellins and also beneficial microorganisms like pseudomonas, azatobacter and phosphor bacteria etc. (Raghavendra et al., 2014).

Traditional methods of control include pesticides, many of which provide only limited management of this pest. Chemical control of the adults is difficult because of their ability to fly, hide, or feign death and drop to the ground. Chemical control of the eggs, larvae, and pupae is more difficult due to their location on or in the soil.

4. Materials and Methods

4.1. Study Area

A survey was carried out to record the pests associated with *Dalbergia oliveri* Plantation at Aung Pon Nataga Protected Public Forest, which was established in 2016 at Katha Township (North Latitude 24°10' and East Longitude 96°20'), Sagaing Region starting within the monsoon of 2018and 2019.

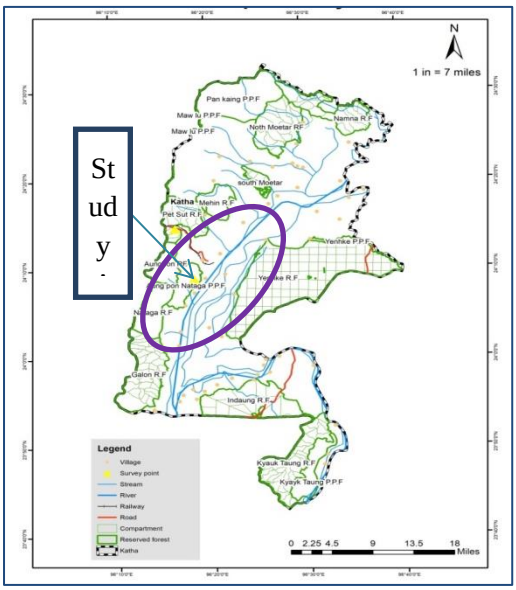

Figure.1. Map showing the study site

4.2. Research Design

A Randomized Complete Design was used with three blocks. In each block, 5 sample plots were randomly assigned with the measuring on a sample plot (15 m x 15 m) consisted of 15 sample trees. The different percentages of Panchagavya and Azadirachtin were used for the treatments to investigate their effect on the pests in *Dalbergia oliveri* plantation. The

treatment plots were remarked as Control (without any applications), 5% Panchagavya, 7% Panchagavya, 1% Azadirachtin, and 5% Panchagavya + 1%Azadirachtin.

4.3. Preparation Method for Panchagavya

We prepared the organic insecticide call Panchagavya in India as described by (Kane, 1941 and Kumar et al, 2015). It is made from five different cow products viz., milk, curd, ghee, urine and dung, commonly applied to crop plants in organic forming (Vallimayil and Sekar, 2012). In Panchagavya preparation; Fresh cow dung (0.5 kg), Cow's urine (1lit), Cow's milk (1lit), Cow's curd (1lit), and Cow's ghee (0.5 kg) involved.

These ingredients were taken in a 25.0 L clay pot, mixed well and allowed to stand in shade for 21 days with intermittent stirring. Treatments were conducted by the foliar application using a back pack sprayer. Experiments were carried out an interval of 15 days from July to August, 2019 by two times.

4.4. Data Analysis

The collected data of pests attacking was sorted by Microsoft office Excel 2010 and means multiple comparison of Dunnett's method was also used to examine the difference among treatments at the $P<0.05$ level. Mean values of pests attacking numbers was analyzed by using MS Excel 23, SPSS.

5. Results

5.1. Natural Incidence of Individual Pest

In this study, five species of defoliated insect pests; *Bradina* sp (Crambidae, Pyraustinae: Lepidoptera), 2 species of adult weevils; *Myllocerus discolar and M. viridanus* (Curculionidae: Coleoptera), *Polydrusus cervinus* (Entiminae: Curculionidae: Coleoptera), *Chrysomela auratus* (Eumolpinae: Chrysomelidae:Coleoptera) were recorded within the monsoon season in 2018and 2019.

When we surveyed in the first year monsoon season, six species were recorded; *Bradina* sp, *Myllocerus discolar* and *M.viridanus, Polydrusus cervinus, Chrysomela auratus* and shoot borer. Mean infestation level of Genus *Bradina* caterpillars and *Polydrusus cervinus* was about (30%), (20%), and shoot borer (2%) at experimental plants in June, 2018. The incidence was in progress to (45%) and (35%) in August, 2018. In addition another three species; *Myllocerus discolor, M. viridanus* and *Chrysomela auratus*; the level of mean infestation by pests was about (40), (35) and (39) percentage in August, 2018. The progress mean level of infestation about *Bradina* caterpillars (54%), *P. cervinus* (40%), *M. discolor* (42%), *M. viridanus* (45%), and *C. auratus* (40%) was observed in September, 2018.

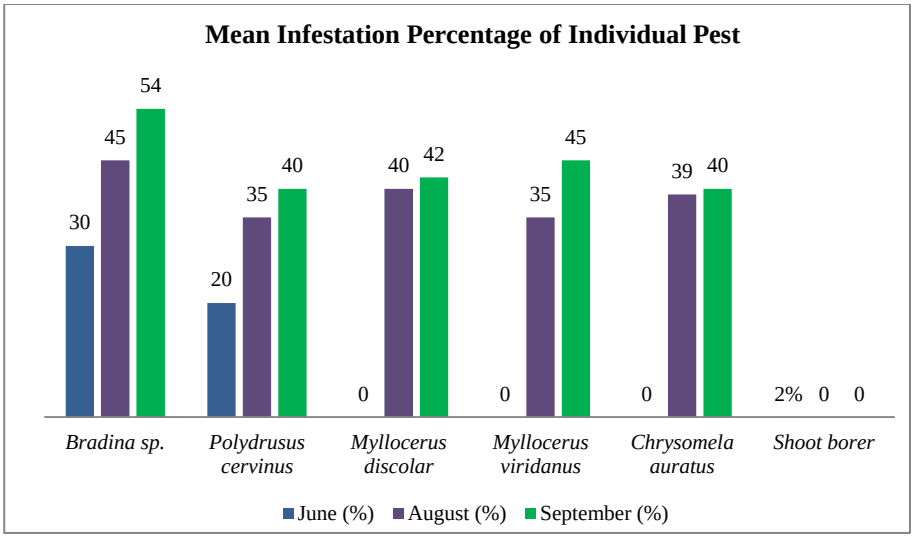

Figure 2 Natural incidence of individual pest in 2018

5.2. Damage Symptom of Pests

5.2.1. Damage symptom of *Bradina* sp.

Damage symptoms are drooping leaves rolled in the form of trumpets fastened by silken threads. The larva feeds on the green leaf tissue between the networks of veins, leaving the skeleton of veins intact.

5.2.2. Damage symptom of Weevils (*Myllocerus discolor, M. viridanus* and *Polydrusus cervinus*)

A small hole is seen in the leaflet and gradually the entire leaf is eaten leaving the midrib. Adult weevils of coleopteran feed on leaves, tender shoots, and nibbling the leaves from the margins and eating away small patches of leaf lamina (Butani, 1979). The adults prefer new plant growth.

5.2.3. Damage symptom of *Chrysomela auratus* (Chrysomelidae: Coleoptera)

When adult beetle feed on leaves, they feed inward from the leaf margins causing the typical leaf notching. There are some instances where the leaf material is almost completely defoliated.

5.3. Effect of Different Treatments on Recorded Pests

Before the treatment, data was collected in July, 2019. The infestation percentage of individual pest was presented in (Table1).

Table 1. **The effect of Panchagavya and Azadirachtin on the incidence of insect pests on *Dalbergia oliveri* Plantation between July and August, 2019**

Insect pest	Con	5%Panchagavya			7%Panchagavya			1%Azadirachtin			1%Aza+5%Pan		
	Infestation %	Before	After	Reduction %	Before	After	Reduction %	Before	After	Reduction %	Before	After	Reduction %
Bradina sp.	39	39	5	**87.18**	38	3	**92.10**	39	10	**74.35**	38	7	**81.57**
Myllocerus discolar	25	25	9	**64.00**	25	5	**80.00**	24	21	**12.50**	24	11	**54.16**
Myllocerus viridanus	25	25	9	**64.00**	25	5	**80.00**	28	25	**12.50**	24	10	**58.33**
Polydrusus cervinus	29	28	7	**75.00**	29	4	**86.20**	28	25	**10.71**	29	10	**65.51**
Chrysomela auratus	22	21	6	**71.42**	20	2	**90.00**	20	19	**5.00**	20	8	**60.00**

From our finding, it was evident that all the treatments in different formulation were proved to be effective in the reduction of insect pests except 1% Azadirachtin. Among the treatments, 7% panchagavya was the most effective, 5% Panchagavya was the second and the third was 1% Azadirachtin + 5% Panchagavya treatment. The treatment of 1% Azadirachtin was not effective on Coleopteran pests except the Lepidoptera caterpillar *Bradina* sp. (Table 1).

7%Panchagavya resulted in reduction was *Bradina* sp (92%), *Myllocerus discolar* and *M. viridanus* (80%), *Polydrusus cervinus* (86%) and *Chrysomela auratus*(90%) respectively (Table 1and Fig 1). Using the 5% Panchagavya; the results were found about 87, 64, 64, 75, and 71percentages concerned as *Bradina* sp., *Myllocerus discolor*, *M. varidanus*, *Polydrusus cervinus*, and *Chrysomela auratus*.Treatment of 1% Azadirachtin was not effective except the *Bradina* sp, the reduction percentage about 74, 13, 13, 11, 5and the treatment of 1% Azadirachtin+5% organic pesticide was recorded 82, 54, 58, 66, and 60 percentage (Table 1).

Table 2. Results of an ANOVA on reduction of *Bradina* sp.at the end of the experiments

Source	Sum of Squares	df	Mean Square	F	Sig.
Treatment	2244.133	4	561.033	14.532	.000
Replication	.178	2	.089	.002	.998
Monthly	4954.444	2	2477.222	64.166	.000
Error	1389.822	36	38.606		
Corrected Total	8588.578	44			
CV% = 24.4833					

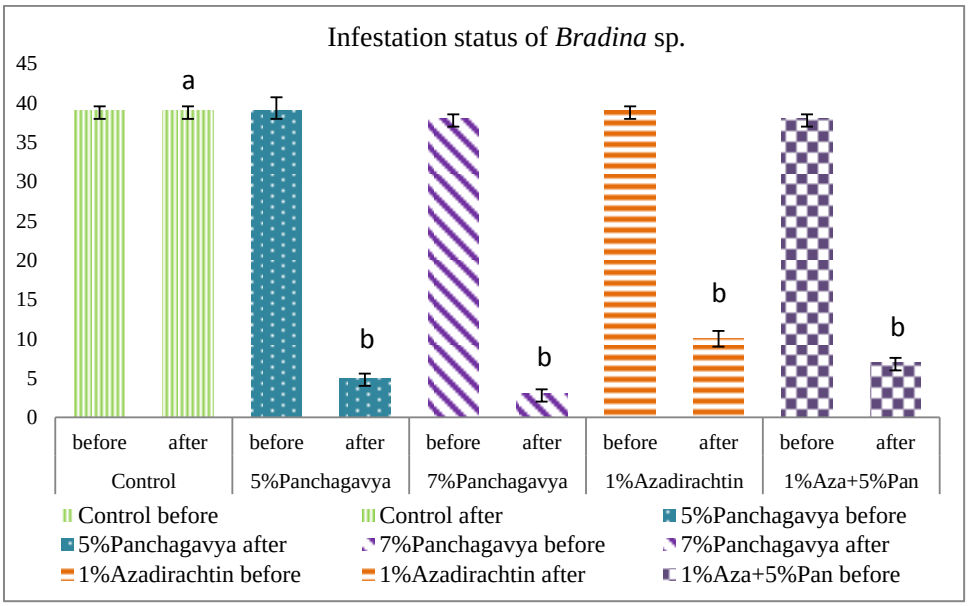

Figure 3.Infestation status of *Bradina* sp before and after treatments. Different letters indicate significant differences among the treatments by LSD, Dunnett's multiple range test at $p < 0.05$.Error bars represent standard deviations of mean values

All treatments were effective to reduce the infestation of *Bradina* sp which was significant with control at (α=0.05) level. However, there was no statically different among them (Fig 3).The 7 % Panchagavya resulted in reduction percentage was (92), 5% Panchagavya about (87), 1% Azadirachtin+ 5% Panchagavya about (82%), and 1% Azadirachtin about (74%) respectively.

Table 3. Results of an ANOVA on the reduction of *Myllocerus discolor* at the end of the experiments

Source	Sum of Squares	df	Mean Square	F	Sig.
Treatment	642.222	4	160.556	12.038	.000
Replication	5.911	2	2.956	.222	.802
Monthly	832.178	2	416.089	31.198	.000
Error	480.133	36	13.337		
Corrected Total	1960.444	44			
CV% = 19.10934					

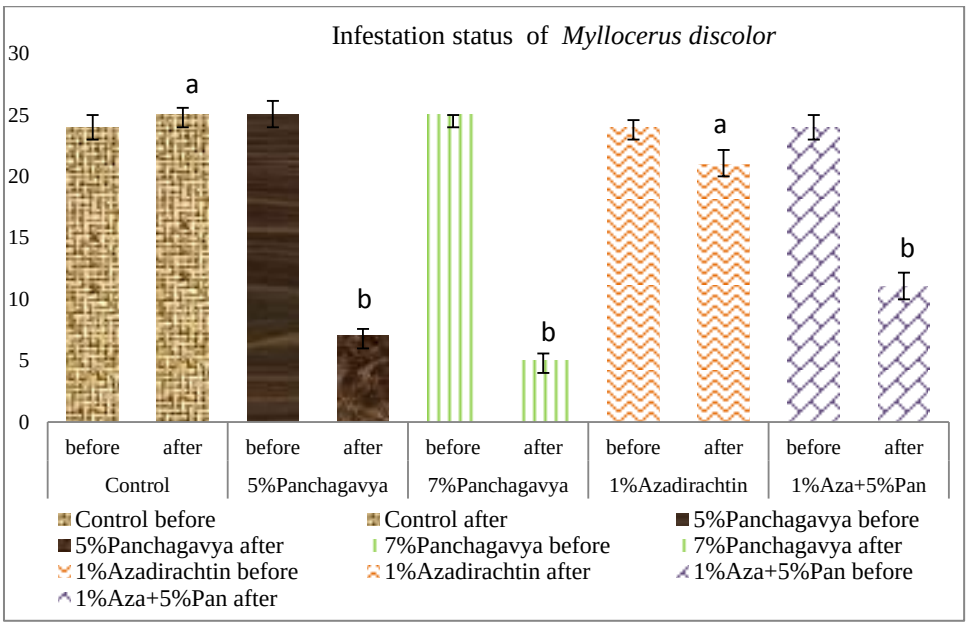

Figure 4.Infestation status of *Myllocerus discolor* before and after treatments. Different letters indicate significant differences among the treatments by LSD, Dunnett's multiple range test at $p < 0.05$.Error bars represent standard deviations of mean values

Table 4. Results of an ANOVA on reduction of *Myllocerus viridanus* at the end of the experiments

Source	Sum of Squares	df	Mean Square	F	Sig.
Treatment	695.244	4	173.811	13.578	.000

Replication	5.644	2	2.822	.220	.803
Monthly	886.178	2	443.089	34.613	.000
Error	460.844	36	12.801		
Corrected Total	2047.911	44			
CV% = 18.67816					

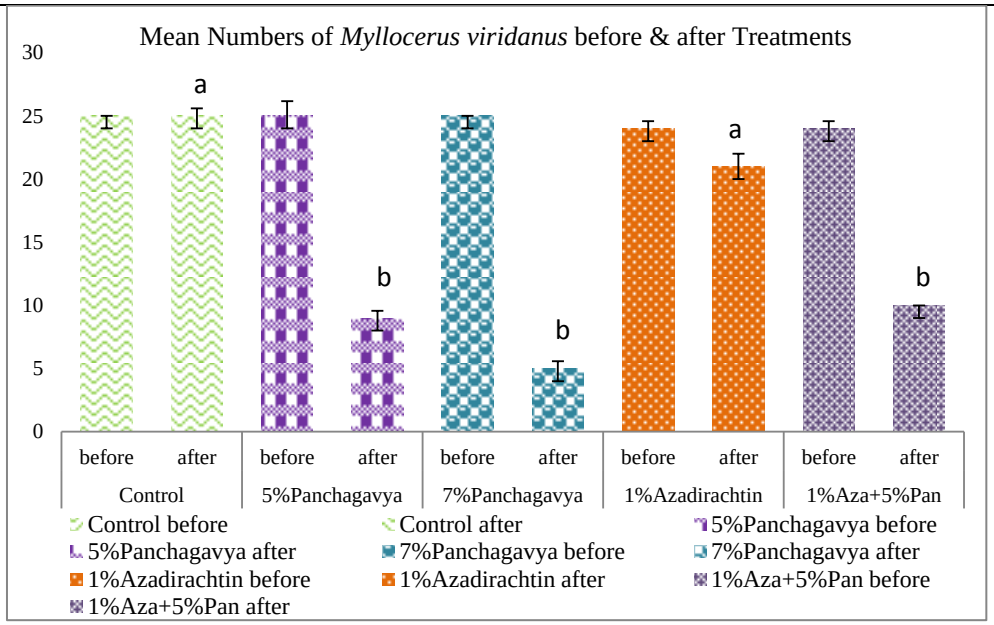

Figure 5. Infestation status of *Myllocerus viridanus* before and after Treatments. Different letters indicate significant differences among the treatments by LSD, Dunnett's multiple range test at $p < 0.05$.Error bars represent standard deviations of mean values

All treatments except the 1% Azadirachtin were effective for reduction of weevils *Myllocerus discolor* and *M. viridanus.* They were significantly different from control at (95%) confidence interval; however, they were no statically significantly different from one another. The treatment of 1% Azadirachtin was not significant control at $p< 0.05$ level (Fig 4&5).

Table 5. Results of an ANOVA on reduction of *Polydrusus cervinus* at the end of the experiments

Source	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Treatment	1188.311	4	297.078	12.485	.000
Replication	.133	2	.067	.003	.997
Monthly	1282.133	2	641.067	26.941	.000
Error	856.622	36	23.795		
Corrected Total	3327.200	44			
CV% = 22.72331					

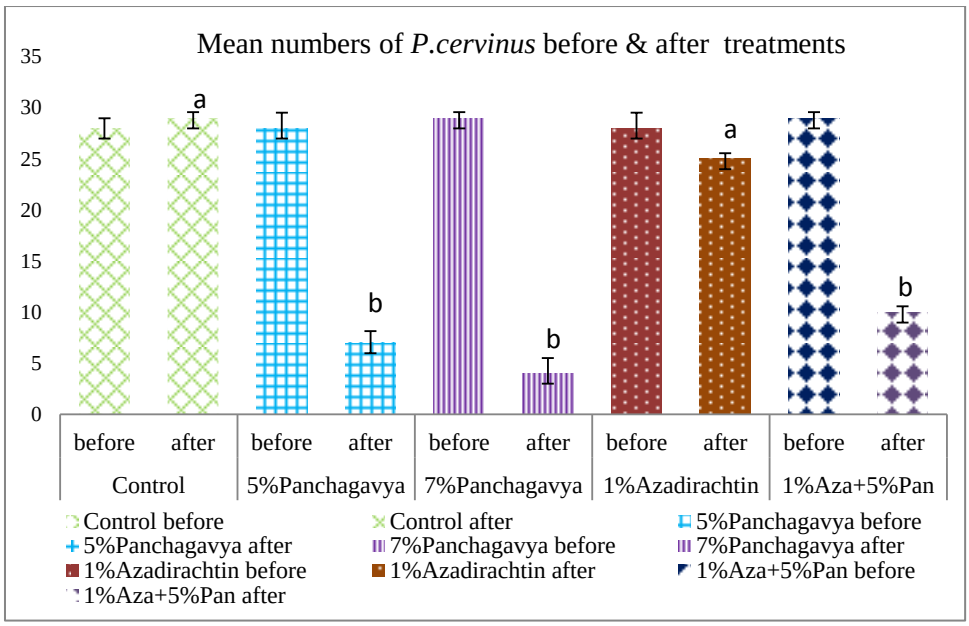

Figure 6. Infestation level of Polydrusus *cervinus* before and after treatments. Different letters indicate significant differences among the sites by Dunnett's multiple range test at α=0.05.Error bars represent standard deviations of mean values

All treatments were effective on *Polydrusus cervinus* except 1% Azadirachtin. Here, application of 7% Panchagavya was the highest, 5% Panchagavya and 1% Azadirachtin+5% Panchagavya followed in series. However, they were not statically significant from one another at (α=0.05). There was not statically significant between the treatments of 1% Azadirachtin and control (Fig 6).

Table 6. Results of an ANOVA on reduction of *Chrysomela auratus* at the end of the experiments

Source	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Treatment	720.978	4	180.244	12.554	.000
Replication	2.133	2	1.067	.074	.929
Monthly	581.200	2	290.600	20.240	.000
Error	516.889	36	14.358		
Corrected Total	1821.200	44			
CV% = 23.88098					

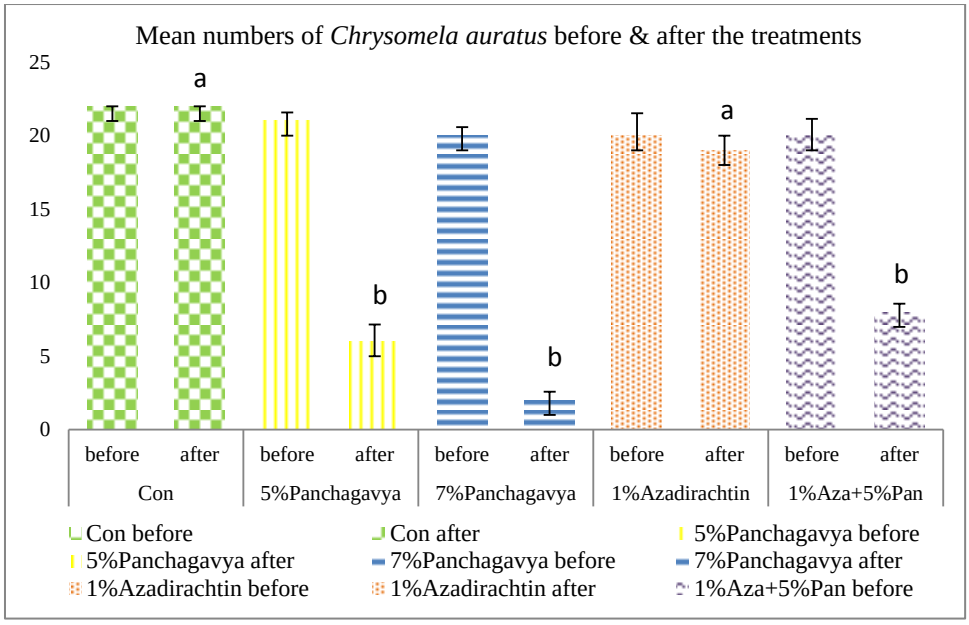

Figure 7. Infestation of *Chrysomela auratus* before and after treatments. Different letters indicate significant differences among the sites by Dunnett's multiple range test at α=0.05.Error bars represent standard deviations of mean values

The formulated treatments of 7% Panchagavya, 5% Panchagavya, and 1% Azadirachtin+5% Panchagavya was significantly different compared with 1% Azadirachtin and control. The treatment of 1% Azadirachtin was not significantly different from that of control. The most effective one was the 7% Panchagavya (90.0%) followed by treatments5% Panchagavya (71%) and 1% Azadirachtin+ 5% Panchagavya (60%). However, they were not significantly from one another (Table 1& Fig 7).

6. Discussion

In the first year monsoon season, the mean infestation level was about *Bradina* (30%), and *Polydrusus cervinus* (20%), and shoot borer (2%) at experimental plants in June, 2018. The incidence was in progress to (45%), (35%), and (2%) in August, 2018. Moreover, another species of leaf feeder *Myllocerus discolor*, *M. viridanus* and *Chrysomela auratus* were observed. The survey was continuously conducted in September, 2018. The progress mean level of attacking was observed. Among them attack of shoot borer was very low about 2% in experimental plots and only in symptom was found. We did not found attacking shoot borer in second year. Therefore, we could not identify mention the species of shoot borer.

According to the results, it is evident that all the treatments were proved to effective to reduce the infestation of *Bradina* sp (Table 1&Fig 3). However, the treatment of 1% Azadirachtion had no effect on the others pests coleopteran species. The treatments of 7% Panchagavya, 5% Panchagavya, and 1% Azadirachtin+5% Panchagavya had no statistically significant from each other at α=0.05 level.

The 5% and 7% Panchagavya formulations were claimed to be useful reduction the pest numbers (Sadar and Kulkarni et al, 2010). The Coleopteran weevils and *Chrysomela auratus* were found on *Dalbergia oliveri* plantation until in September, 2018. However, after conducting the treatments, their population was significantly reduced in August, 2019. *Myllocerus discolor* and *M. viridanus* were abundant from July to October (Khairmode and Sathe, 2014). Concerning with the other species of Lepidoptera pest *Bradina* sp., Coleopteran pests' *Polydrusus cervinus* and *Chrysomela auratus*, there was limited information. As several leaf beetles feed on trees, actions need to be taken before causing further damage to the plantation. Panchagavya is a proved organic source beneficial in suppressing the insect pest of teak and in addition, attracted and increased the natural enemies (Kumar et al., 2015).

The leaf feeder causes severe damage to both mature and immature leaves when their population becomes high in plants. The timing application of pesticide is essential before damage become serious in the plantation. The plants should be spray during the monsoon season when the pests would be found. Several reports indicate that Panchagavya contain pesticide and pest repellent activity (Natarajan 2002, Vivekanandan 1999, Belina et al 2005; Selvaraj 2004). The most of leaf feeders should be controlled by using Panchagavya under the conserving environmental condition. By using of Panchagavya, the use of chemical insecticides can be reduced. Consequently, environmental pollution and the harmful effect on the natural enemies can be reduced.

7. Conclusion

The objective of this research was to investigate the effect of Panchagavyaon major insect pest of *Dalbergia oliveri* plantations. The results show that 7% Panchagavya, 5% Panchagavya and1% Azadirachtin+ 5%Panchagavyareducedthe number of all pests. There were numerous instances citing the beneficial effect of Panchagavya and this was clearly brought out for insect pests. Moreover, the increasing concern for environmental safety has evoked keen interest in eco-friendly which are easily biodegradable and do not leave any harmful toxic residues besides conserving nature. It is recommended therefore that the Panchagavya can be used for spray after diluted properly. The present study will be helpful for designing control strategies of pests on *D. oliveri* plantations.

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