Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(5): 2720-2724
Received: 07-07-2018
Accepted: 09-08-2018

Shashidhar KR
Scientist (Sericulture), ICAR-Krishi Vigyan Kendra, Tamaka, Kolar, Karnataka, India

Thulasiram K
ICAR- Krishi Vigyan Kendra, Tamaka, Kolar, Karnataka, India

Noorulla Haveri
ICAR- Krishi Vigyan Kendra, Tamaka, Kolar, Karnataka, India

Correspondence
Shashidhar KR
Scientist (Sericulture), ICAR-Krishi Vigyan Kendra, Tamaka, Kolar, Karnataka, India

Effectiveness of bed disinfectants on silkworm diseases and cocoon yield under tropical conditions of Kolar district, Karnataka

Shashidhar KR, Thulasiram K and Noorulla Haveri

Abstract
The impact of bed disinfectants for successful cocoon harvest and crop stability was successfully demonstrated in the farmer's field during 2014-15. The study revealed that, application of Ankush vijetha green and slaked lime powder combination (T_3) bed disinfectant was recorded low incidence of silkworm diseases like grasserie (0.10 – 0.08 %), flacherie (0.25 – 0.15%) and muscardine (0.05 – 0.35%) and lower defective cocoon percentage *viz*., stained cocoons (0.10 – 0.10 %), flimsy cocoon (0.30 – 0.04%) and uzi pierced cocoon (0.80 - 0.30 %) during *post rainy* and *rabi* seasons respectively. Further, single cocoon weight (1.821 g), shell weight (0.340 g), pupal weight (1.456 g), shell percentage (18.75 %), filament length (851.13 mtrs) and cocoon yield (81.10 kg/100 dfls) were recorded high in T_3 compared to application of bundh powder (T_1).

Keywords: Silkworm disease, defective cocoon, bed disinfectant, silkworm

Introduction
The mulberry silkworm *Bombyx mori* L. is one of the productive insects exploited for silk of commerce. The management of silkworm diseases is a vital component of successful silkworm rearing for obtaining higher cocoon yield and quality. The silkworms are more sensitive to environmental, nutritional and microbial factors, resulting in various diseases leading to silkworm mortality and cocoon crop loss all through the year. The most prevalent and serious diseases in the silkworm are grasserie, flacherie, muscardine and pebrine caused by virus, bacteria, fungi and microsporidia, respectively (Jiang and Xia, 2014) [9]. The diseases prevail throughout the year, and in tropics they are significantly high (Srivastava and Kumar, 2009) [12]. In India, the cocoon crop loss due to diseases was reported as 15-20 % (Balavenkatasubbaiah *et al*., 2011; Selvakumar *et al*., 2002) [3, 11]. Viral diseases account for almost 70 % of the total loss due to diseases (Babu *et al*., 2009) [2].
One of the major constraints in silk cocoon production is the diseases in silkworm rearing. Once the pathogen invades the silkworm, it is difficult to curb the pathogen. Hence, prevention of any disease is rather essential than attempting to control or cure. To curb the diseases in silkworm rearing, different bed disinfectants are evolved *viz*., Vijetha, hydrated lime, Bundh powder, active lime, Captan, Dithane M-45, RKO, Ankush, Vijetha Supplement, Resham jyothi, Labex and formalin chaff. Among these most commonly used bed disinfectants by the farmers are slaked lime, bundh powder, Vijetha which are being used in large quantities without any justification. Hence, the present study was carried out to find the suitable bed disinfectant to reduce the silkworm disease effectively for quality cocoon production at farmers fields.

Materials and Methods
The present study was carried out to know the effectiveness of bed disinfectants against diseases of silkworm during *Post Rainy* and *Rabi* season in 2014-15 at fifteen sericulture farmers in Hoohalli Village of Kolar District by ICAR-Krishi Vigyan Kendra, Kolar, Karnataka, India. For silkworm rearing, V-1 mulberry variety grown in red soil with spacing of 90 x 90 cm of the 5-10 years old plantations was used for the study. Before the commencement of silkworm rearing, the rearing room and appliances were thoroughly cleaned and the floor was washed using 5 per cent bleaching powder solution. Then the whole rearing house was disinfected with four per cent formalin at the rate of 1.5ml/ m2. Popular multi x bivoltine cross breed $PMxCSR_2$ was used in all the experiments. Silkworm rearing was carried out in individual compartments assigned with following treatments

T_1 : Application of Bundh Powder (0.5 gm + 5 kg Lime Powder) after every moult @ 3g/sqft (Control).
T_2 : Application of Slaked lime powder at every moult and after moult @ 3-5 g/sqft
T_3 : Application of Ankush Vijetha Green after every moult @ 5g/sqft + Slaked lime powder at moult @ 5g/sqft
T_4 : Application of Rakshak bed disinfectant after every moult @ 5g/sqft + Slaked lime powder at moult @ 5g/sqft

Five hundred worms were maintained in each replication in individual treatment by adopting Complete Randomized Design. These bed disinfectants were applied soon after bed cleaning, half an hour before giving the first feed. The package of practices for mulberry production and silkworm rearing were followed as per the methods described by Dandin *et al.* (2003) [6]. Observations such as disease incidence (muscardine, flacherie and grasserie), defective cocoon percentage (stained, flimsy and uzi pierced), cocoon yield and cocoon parameters like single cocoon weight, single shell weight, single pupal weight, shell ratio and filament length were recorded. Data recorded on silkworm was analysed statistically for test of significance using Fisher's method of "Analysis of Variance" as outlined by Sundararaj *et al.* (1972) [13]. The level of significance of 'F-test' was tested at 5 per cent. The data was analyzed statistically by adopting two way factorial CRD as outlined by Cochran and Cox (2000) [5].

Results and discussion

The results on the effectiveness of bed disinfectants on silkworm diseases, defective cocoon percent and cocoon yield (Table 1-2) are discussed in the light of earlier works.

Table 1: Impact of bed disinfectants on silkworm diseases during *Post rainy* and *Rabi* seasons, 2014-15

Treatments	*Post Rainy* (%)				*Rabi* (%)				Mean of two seasons (%)
	Grasserie	Flacherie	Muscardine	Total disease incidence	Grasserie	Flacherie	Muscardine	Total disease incidence	
T1	1.25(6.42)*	2.20(8.53)	0.56(4.29)	4.01(11.55)	1.10(6.02)	1.70(7.49)	2.25(8.63)	5.05(12.99)	4.53(12.29)
T2	1.10(6.02)	2.17(8.47)	0.51(4.10)	3.78(11.21)	1.07(5.94)	1.65(7.38)	2.10(8.33)	4.82(12.68)	4.30(11.97)
T3	0.25(2.87)	0.05(1.28)	0.40(3.63)	0.08(1.62)	0.15(2.22)	0.35(3.39)	0.58(4.37)	0.49(4.01)	0.25(2.87)
T4	0.30(3.14)	0.06(1.40)	0.49(4.01)	0.10(1.81)	0.20(2.56)	0.40(3.63)	0.71(4.83)	0.60(4.44)	0.30(3.14)
S.Em.±	0.36	0.39	0.06	-	0.32	0.54	0.59	-	-
CD (0.01)	0.84	0.91	0.13	-	0.73	1.21	1.33	-	-
CV (%)	3.91	5.12	2.98	-	4.51	4.67	3.21	-	-

*Values in parentheses are arc sine transformed

Table 2: Impact of bed disinfectants on cocoon parameter (mean of *Post rainy* and *Rabi* seasons, 2014-15)

Treatments	Single cocoon wt (g)	Single shell wt (g)	Single pupal wt (g)	Shell percentage (%)	Filament length (mtrs)	Cocoon yield (Kg/100dfls)
T1	1.691	0.297	1.377	17.68	797.40	72.51
T2	1.694	0.299	1.381	17.77	800.46	72.54
T3	1.821	0.340	1.465	18.75	851.13	81.10
T4	1.798	0.337	1.448	18.72	826.93	80.30
S.Em.±	0.031	0.009	0.022	0.280	8.804	1.764
CD (0.01)	0.070	0.020	0.050	0.630	19.810	3.970
CV (%)	3.31	4.29	2.38	5.11	4.79	4.13

Disease incidence

Higher percentage of flacherie incidence was observed in application of Bundh Powder (0.5 gm + 5 kg Lime Powder) after every moult (T_1) control batches (2.20%) followed by application of lime powder as per recommendation (2.17%) and significantly lower disease incidence was recorded in application of ankush vijetha green bed disinfectant and slaked lime powder combination (0.25 %) followed by rakshak bed disinfectant and slaked lime powder combination (0.30 %) compare to incidence of grasserie and muscardine diseases during *post rainy* season. Similarly, higher percentage of muscardine disease incidence was observed in T_1 applied batches (2.25%) followed by application of lime powder (T_2) as per recommendation (2.10%) and significantly lower disease incidence was recorded in application of ankush vijetha green bed disinfectants and slaked lime powder combination (0.35 %) followed by rakshak bed disinfectant and slaked lime powder combination (0.40 %) compare to grasserie and Flacherie diseases incidence during *rabi* season. The average mean value of silkworm diseases was high in control (4.53 %) followed by T_2 (4.30 %). Further, lower disease incidence was recorded in T_3 (0.49 %) combination followed by T_4 (0.60 %).

The results indicated that unfavourable conditions make silkworm susceptible to infection, due to variations in environmental conditions specially, the temperature and water vapors in the atmosphere and also effectiveness of the bed disinfectant (Etebari *et al*., 2007) [8]. Further, Srivastava and Kumar (2009)[12] reported that incidences of bacterial flacherie and cytoplasmic polyhedrosis caused losses up to 48.9 and 35.4 per cent respectively to the commercial silkworm crop growers. These results are in agreement with results obtained by (Rasool *et al*., 2018) [10]. This can also be attributed to the facts that allelochemicals and other phenolic compounds could be detrimental to pathogens so that the silkworms can survive better.

Further, muscardine infection was reported higher during winter season, less during rainy season and it may be due to low temperature with high humidity in silkworm rearing environment which work as a pre-requisite for outbreak of the fungal disease and also efficacy of the bed disinfectants (Chandrasekharan 2009) [4]. Application of ankush vijetha green and slaked lime powder combination as per recommended schedule leads to low muscardine incidence during winter season.

Defective cocoon percentage

Lower percentage of stained cocoon was recorded in dusting of ankush vijetha green bed disinfectant as per recommendation (0.10 %) followed by T_4 (0.11 %). More number of uzi pierced cocoon was observed in control batch T_1 (4.25 %) followed by T2 (4.10 %) during *post rainy* season. Further, lower number of flimsy cocoon was recorded in dusting of ankush vijetha green bed disinfectant (0.04 %) followed by T_4 (0.05 %) and more number of uzi pierced cocoon was recorded in control batch T_1 (3.85 %) followed by T2 (3.68 %) during *Rabi* season. The average mean value of defective cocoon percent was recorded maximum in case of control batch T_1 (6.24 %) followed by T_2 (5.97 %) and it was less in case of T_3 (0.82 %) followed by T_4 (0.87 %).

The results indicated that Seasonal influences and the environmental conditions such as temperature and humidity lead to defective cocoon and also the effectiveness of the bed disinfectants. Due to heavy urination before the onset of spinning and due to oozing of silk and its driage during spinning, humidity will be more in the rearing house and also infestation of uzifly on silkworm.

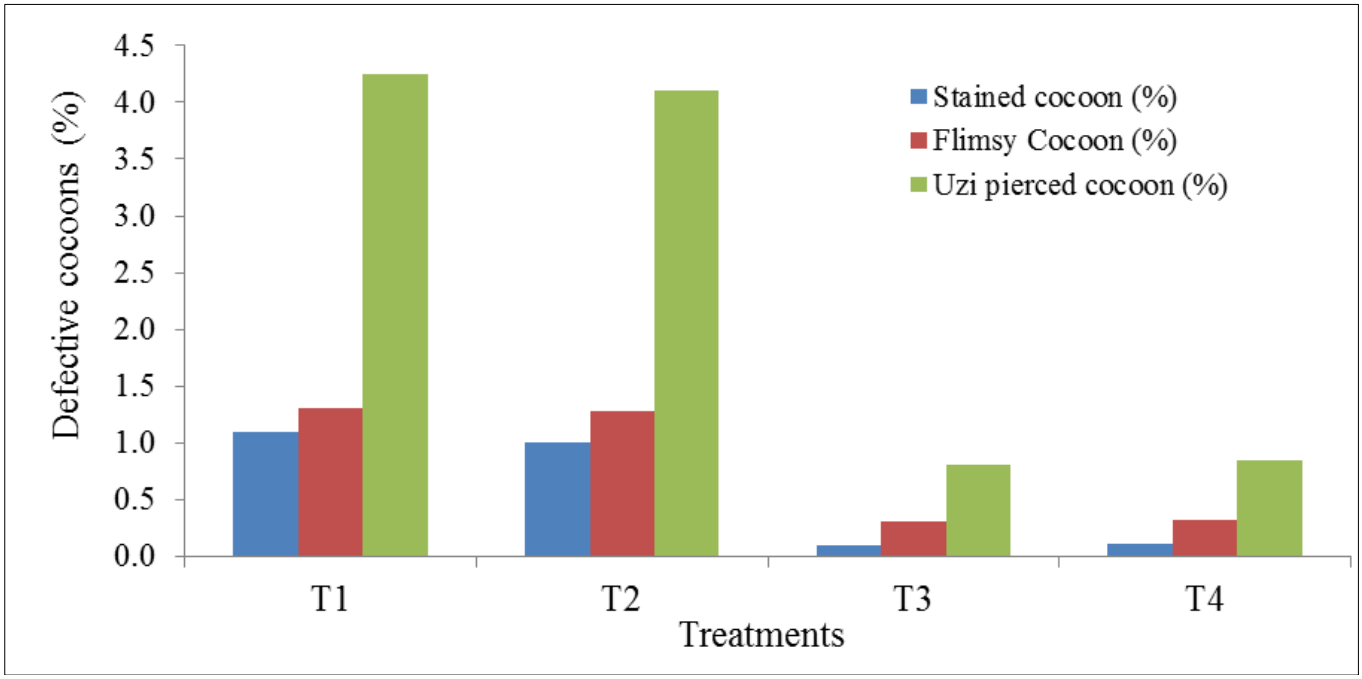

Fig 1: Impact of bed disinfectants on defective cocoon percentage during *Post rainy* season, 2014-15

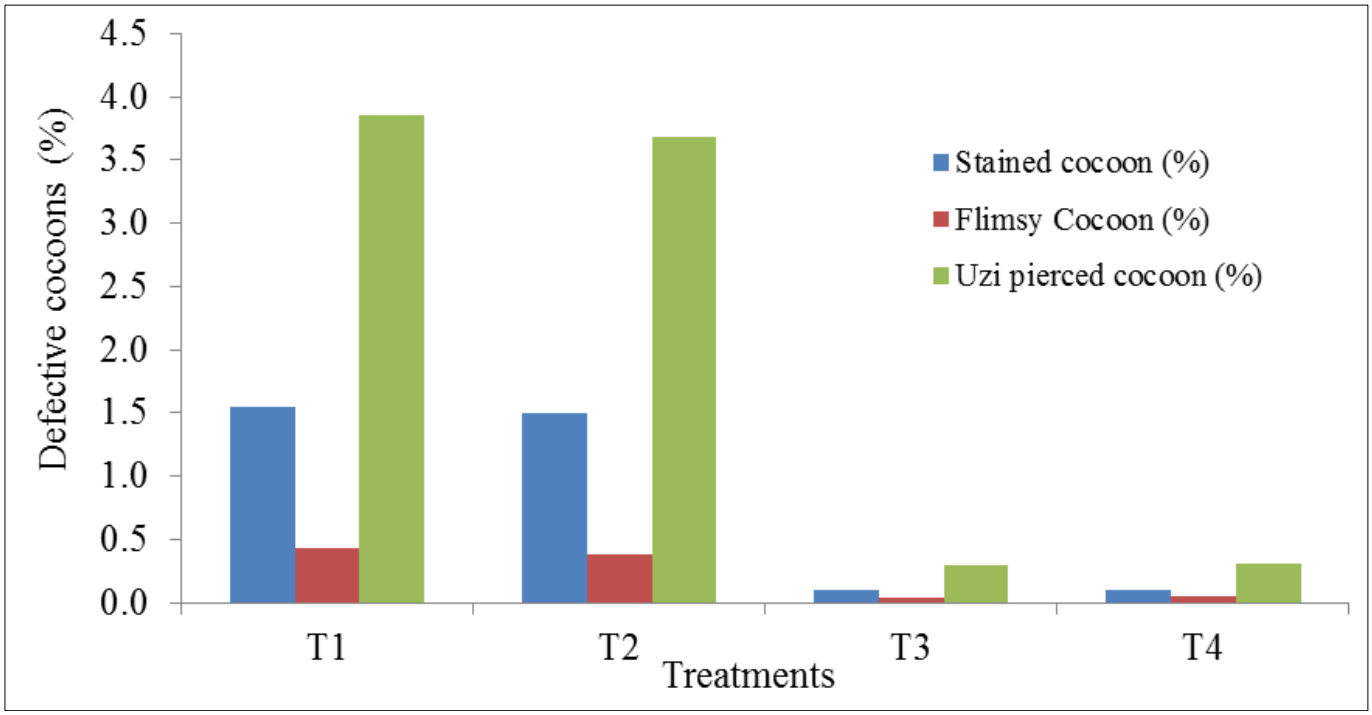

Fig 2: Impact of bed disinfectants on defective cocoon percentage during *Rabi* season, 2014-15

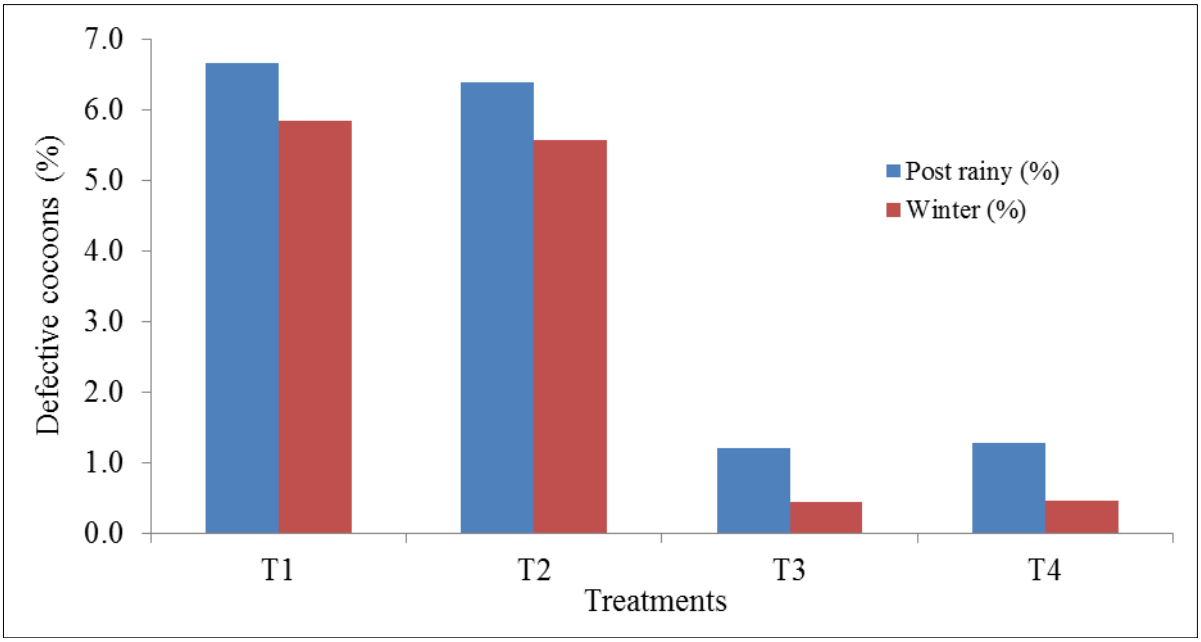

Fig 3: Effect of bed disinfectants on mean total defective cocoon percentage during *Post rainy* and *Rabi* seasons, 2014-15

Cocoon Parameter and Yield

The cocoon spun by the silkworm fed with V-1 mulberry and application of bed disinfectants after every moult differed significantly. The maximum cocoon weight (1.821 g), shell weight (0.340g), pupal weight (1.465 g), shell ratio (18.75 %), filament length (851.13 mtrs) and cocoon yield (81.10 kg/100 dfls) were significantly high in dusting of ankush vijetha green and slaked lime powder (T_3) and was followed by Rakshak bed disinfectant and slaked lime powder T_4 which recorded 1.798 g, 0.337 g, 1.448 g, 18.72 %, 826.93 mtrs and 80.30 kg/100 dfls, respectively. Similarly, the lowest cocoon weight (1.691 g), shell weight (0.297g), pupal weight (1.377 g), shell ratio (17.68 %), filament length (797.40 mtrs) and cocoon yield (72.51 kg/100 dfls) were recorded in control batch (T_1) followed by T_2 (1.694 g, 0.299 g, 1.381 g, 17.77 %, 800.46 mtrs and 72.54 kg/100 dfls, respectively). The results of the finding exhibited that dusting of ankush vijetha green bed disinfectant contains para formaldehyde and benzoic acid compounds which are known to contain anti-microbial properties reduced the diseases in silkworm which inturn increased the cocoon yield and cocoon paramaters and these results are inconformity with Datta *et al*., 1998 [7]. Similarly, Vijetha dusted batches found more effective in the parameters studied such as larval mortality, cocooning %, single cocoon weight etc., than the Resham keet oushadh dusted batches (Amardevsingh, 2012) [1]. The results clearly indicate that the farmers are achieving higher cocoon productivity mainly because of low incidence of diseases and the technology was effectively adopted (Balavenkatasubbaiah *et al*., 2015) [3].

Silkworm diseases are very difficult to manage due to a very short life cycle of silkworm. Prevention is better than cure is the correct approach that should be adopted in integrated silkworm disease management. The successful harvest of cocoons in silkworm rearing may be attributed to efficacy of the disease management technology. The practice of technology through selection of silkworm rearing house for effective disinfection, use of suitable disinfectant and use of bed disinfectant and hygiene maintenance helped in avoiding infection of silkworm and the spread of diseases.

Acknowledgement

Authors are sincerely thankful to ICAR - Agricultural Technology Application Research Institute (ATARI), Zone XI, India for having provided financial and technical support to conduct this study.

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