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Fluctuation of population of storage pest under different storage structure

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Abstract
Population fluctuation of *P. pulverea* and *E. amabilis* were recorded under storage structures. The mean monthly population (larvae + pupae) of *P. pulverea* and *E. amabilis* at its peak were (16.33) and (15.33) in month of December and November 2015, respectively. High populations of these pests were found in kuchcha storage structures. The adult of *P. pulverea* and *E. amabilis* emerged from the stored lac samples were recorded. The adult of *P. pulverea* are generally small to medium size, dull-blackish patterned moths while the adult of *E. amabilis* is generally white-pinkish in colour. The adult emergence (%) of *P. pulverea*was highest (81.99 %) from the October 2015 lac samples while in case of *E. amabilis*itwas highest (80.18 %) in the August 2015. There was no emergence of adult of these pests from the lac samples collected in the months of September 2015, January and February 2016. The mean population of *P. pulverea* was highest (16.33) in Kuchcha storage and lowest (6.00) in Pucca storage. The mean population of *P. pulverea* was highest (12.67) among Small traders and lowest (6.67) in Big traders. The mean population of *E. amabilis* was highest (15.33) in Kuchcha storage and lowest (6.67) in Pucca storage. The mean population of *E. amabilis* was highest (12.00) among Small traders and lowest (7.00) in big traders.

Keywords: *P. pulverea*, E. *amabilis,* Storage structure, Adult, Trader

1. Introduction
Lac is cultivated as a cash crop in different countries of south, southeast and east Asian countries including India, China (Ramani*et al.,* 2007) [20]. It is only the resinous compound of animal origin with great economic importance due to its safety for human use, renewable and ecosystem friendly source of different chemicals (Ranjan *et al*., 2011) [21]. It is secreted by phytophagous scale insect *Kerrialacca* Kerrbelonging to the family Tachardiidae (Kerriidae) andorder Hemiptera (Ahmad *et al*., 2012**)** [2]**.** Common lac host trees especially *Butea monosperma, Zizyphus mauritiana* and *Schleichera oleosa* are usually found on undulating landscape in rainfed area (Ogle *et al*., 2006) [14]. Lac insects are reported to have 400 host plant species in the world (Sharma *et al*., 1997) [24], while in India there are 113 species (Roonwal*et al.,* 1958) [22]. There are two strains of lac insect viz., *Rangeeni* and *Kusmi.* Each strain is specific to particular host trees, having different life cycle and produces different body extracts but morphologically is too similar to be separated into different species. *Rangeeni*strain is specific to *B. monosperma* and *Z. mauritania*, and the *Kusmi* strain is specific to *S.oleosa.* The lac produced by the *kusmi*strain is of higher quality (Dwivedi, 1993) [6].
India is the largest producer of Lac in the world, followed by Thailand, Indonesia, China, Vietnam and Burma (Ogle *et al.,* 2006) [14]. India has a share of 62 per cent of the world production of 44,000 m tons. India export lac and its products worth Rs 15,262 lakh (Ogle *et al*., 2006) [14]. Lac is produced mostly by tribal, in the states of Jharkhand, West Bengal, Chhattisgarh, Madhya Pradesh, Orissa, Maharashtra and part of Uttar Pradesh, Andhra Pradesh, Gujarat and NEH region (Pal *et al.,* 2010) [15]. On an average around 28 per cent of total agriculture income is contributed by lac cultivation (Jaiswal *et al.,* 2006) [11], and more than 80 per cent of lac produced in India is exported (Chamberlin, 1923; Prasad *et al.,* 2004; Pal *et al.,* 2010; Ramani*et al.,* 2010) [4, 17, 15, 19]. The annual lac production of the country varied from 18000 tons (Prasad *et al.,* 2004) [17], 23,229 tons (Pal *et al.,* 2007) [16] and 21,935 tons (Pal *et al.,* 2010) [15]. On the basis of survey in the markets of different lac producing districts and states, the estimated national production of lac during 2013-14 was approximately 21,008 tons (Yogi *et al*., 2014) [27].

Madhya Pradesh is traditionally a Lac production centre of the country since late 19th century and early 20th century (Ogle *et al.,* 2006) [14]. In MP, Jabalpur division is the major producer of lac. Balaghat and Seoni districts in Jabalpur division are the largest producer of lac in the state. Anuppur district is the largest producer and seller of brood lac in MP. In MP, (Jaiswal *et al.,* 2010) [10] observed that Seoni district contributed maximum in the lac production (41.6 %) followed by Balaghat (30.6 %), Hosangabad (8.4 %) and Mandla (7.0 %).

Biotic and abiotic stress is the two factors responsible for yield reduction of lac crop. Predators and parasitoids are the biotic stress factors, while weather factors create abiotic stress. *Eublemmaamabilis* Moore (Lepidoptera; Noctuidae), *Psuedohypatopapulverea* Meyr (Lepidoptera; Blastobesidae) and *Chrysopalacciperda*Kimmins and *Chrysopamadestes* Banks (Chrysopidae; Neuroptera) are the major predators (Sharma *et al.,* 2006) [24]. Predators cause around 35 to 40 per cent loss to lac production (Glover, 1937 [7]; Jaiswal*et al*., 2008 [9]) while 5 to 10 per cent damage by parasitoids (Varshney, 1976). The predator *Pseudohypatopapulverea*are destructive predator of lac insects and found in all lac growing areas of the country. It feeds on the live and dead lac insects and is found in large numbers in stored lac and so it is responsible for the qualitative and quantitative deterioration of stored lac. Larval stages feed on the lac larvae and spin a loose web. A single larval predator is capable of destroying 45-60 mature lac cells (Chattopadhyay, 2011) [5]. Therefore the present investigation was carried to see the population fluctuation of predators under different storage structure.

2. Materials and Methods

The present research was conductedin different categories of lac traders of Barghat block, Seoni district, M.P, from July 2015 to February 2016, as well as in the laboratory of Department of Entomology JNKVV, Jabalpur M.P. The study was planned under Split plot design, with 3 replications (lac samples/factor) and 3 main factor (Storage conditions) and 3 sub factors (lac traders). The details are the mentioned in (Table 1)

Table 1: Details of the Experiment

Commodity		**Stored Lac samples**
Design		**Split Plot Design**
Total no. of Lac traders		09
No. of main factors (storage conditions)		03
No. of sub factors (lac traders)/ main factors		03
No. of replication		03
Stored Lac samples/factor/replication		50 g
Total no. of samples		27 / Month (Seven months)
Duration of the study		August 2015 to February 2016
Treatment details		
S. No.	**Main factor (storage conditions)**	**Sub factor(Lac traders)**
1.	Pucca storage structures (S_1)	Big trader (T_1)
		Medium trader (T_2)
		Small trader (T_3)
2.	Semi-pucca storage structures (S_2)	Big trader
		Medium trader
		Small trader
3.	Kuchcha storage structures (S_3)	Big trader
		Medium trader
		Small trader

2.1 Description

- Pucca storage structures are made up of baked bricks and cement.
- Semi –pacca storage structures are made up of baked bricks and mud with G.I. sheet roof.
- Kuchcha storage structures are made up of bricks and mud without cement plaster and roof either baked tiles or G.I. sheet.

The observations were recorded weekly from stored lac in different storage structure maintained by different traders during Aug.2015-Feb.2016 for the study. The observations were recorded the following parameter as given below-

2.2 Insect emergence from stored lac in laboratory-

(a) Total initial counting of storage insect including larva and pupa / sample/replication.
(b) Total adult counting /sample/replication

2.3 Lac storage loss in laboratory-

(a) Lac weight at collection 50g/replication (initial weight)
(b) Lac weight in March (final weight)

2.4. Storage loss

$$\text{Storage loss (\%)} = \frac{\text{Initial weight of lac sample} - \text{final weight of lac sample}}{\text{Initial weight of lac sample}} \times 100$$

2.5. Statistical Analysis

The experiment was laid in a split plot design with different storage structures as the maintreatment and different categories of lac traders as the sub-treatments. Statistical analysis was performed to test the population fluctuation of storage pest of lac under different storage condition with different treatment and sub-treatments. Analysis of variance was performed to determine the different lac traders and their interactions. The data recorded on different observations were tabulated and analyzed statistically by using the techniques of analysis of variance (ANOVA) as suggested by Gomez and Gomez (1984) [8].

3. Results and Discussions

3.1. Population fluctuation of storage pests under different storage conditions of lac.

Population fluctuation of *P. pulverea* and *E. amabilis,* is directly related to the stage of the lac as well as storage structures. Fresh lac from lac growers have higher population from that bought during later season. No population being present during September 2015, January and February 2016 may be due to sale of all the lac from the storage due to market demand. Whenever there is a demand, fresh lac is sold first. This is because of two reasons fresh lac purchased from the lac growers is dumped on the older stock in the godown. Thus when the traders sell their lac, the workers in the godown fill the jute bags with lac on the top layer. This in a way takes away the pest along with the materials.

The mean monthly population (larvae + pupae) of *P. pulverea* and *E. amabilis*were at its peak (16.33) and (15.33) in month of December and November 2015, respectively. High population of these pests were found in kuchcha storage structures because the prevalence of moisture and darkness in kuchcha storage which is conducive for growth and development of the pests.

There is a scarcity of work done on lac storage, thus similar work on food grains are relied for discussion. Manandhar and Shrestha (2000) [12] reported that the Maize cobs stored in the local storage structures such as open storage, semi open storage or closed storage were found to be heavily infested by insect pests in the mid and high hills of Nepal. But in mid hills of Nepal, maize cobs are stored on Thankro/Suli, hanging on ropes, Kuniu and sundried mud structures (Dehari). An infestation level of up to 49 % by *Sitotroga cerealella* and weevils stored in Thangro/Suli for a period of 6 months in Nepal was reported by Shivakoti (1981) [25]. Storage in underground and mud structures is prone to insect pests infestation reported by Satimehin (2004) [23]. In the typical African traditional storage structures expose the grain to insect attack and favourable climatic conditions for their proliferation and those of micro-organisms and rodents reported by Adejumo and Raji (2007) [1].

3.2. Adult emergence of storage pests of lac from stored lac samples

The adult of *P. pulverea* and *E. amabilis* emerged from the stored lac samples were recorded. The adult of *P. pulverea* are generally small to medium size, dull-blackish patterned moths while the adult of *E. amabilis* is generally white-pinkish in colour. In present experiment, the adult emergence (%) of *P. pulverea and E. amabilis* depend upon the stage of the larvae and pupae, generation of the pests, nature of lac samples and storage conditions. The adult emergence (%) of *P. pulverea*was highest (81.99 %) from the October 2015 lac samples while in case of *E. amabilis* was highest (80.18 %) in the August 2015. There was no emergence of adult of these pests from the lac samples collected in the months of September 2015, January and February 2016 because the lac samples had no immature stage of them.

Mishra and Gupta (1934) [13] reported that the emergence of *P. pulverea* adult in large numbers in the month of March-April after eight weeks of storage was due to the fact that it laid eggs in the months of September, completing its life cycle in 198 days including winter hibernation of larvae. Rahman *et al.* (2009) [18] reported that in field condition third generation of *E. amabilis* laid egg in September-October which usually develop, some adult emerge in during November-December while the rest hibernate in Katki stored lac from November to March. Similarly, Bhattacharya and Yogi (2015) [3] reported that the adult emergence of *E. amabilis* during November-December while the rest hibernate and emerged during January to March.

3.3. Stored lac pests population in different storage structure and lac traders

a. *P. pulverea*

The mean population of *P. pulverea* was highest (16.33) in Kuchcha storage and lowest (6.00) in Pucca storage. The mean population of *P. pulverea* was highest (12.67) among Small traders and lowest (6.67) in big traders.

b. *E. amabilis*

The mean population of *E. amabilis* was highest (15.33) in Kuchcha storage and lowest (6.67) in Pucca storage. The mean population of *E. amabilis* was highest (12.00) among Small traders and lowest (7.00) in Big traders.

Light, dry and airy conditions in the Pucca lac storage structures may be hostile to the survival of the pests. Kuchcha storage structures of lac are usually dark inside and mostly moiusture condition remain which is conducive for growth and development of the pests. This may be reasons for more pest in Kuchcha storage.

Similarly, the more pests among Small traders and least in big traders can be best understood in term of the purchase, storage and sale cycle of the lac by the different types of traders. Small traders are very active and procure lac from the lac growers at their door steps. Lac growers scrape and sale to small lac traders therefore contains more moisture and pests. Lac procured are stored for a short period before it is sold either to medium or big traders, thus storage period is very short at small traders level. The lac procured and sold reaches to the big traders either directly or through medium traders. In both case, the lac passes through a long process of transport, thus by the time lac reaches big traders, the pests die or a few of them reaches to big traders.

3.4. Stored lac pests population in different storage structures and lac traders

3.4.1. Stored lac pests population in August 2015

a. Storage structures

i. *P. pulverea*

The mean monthly (larvae + pupae) population of *P. pulverea* per 50 g of stored lac samples significantly differed among all the three storage structures. It was highest (11.00) in Kuchcha storage structures (S_3) followed by that (7.67) in Semi-pucca (S_2) and (6.00) in Pucca storage structures (S_1).

ii. *E. amabilis*

Similarly the mean monthly (larvae + pupae) population of *E. amabilis* per 50 g of stored lac samples significantly differed among all the three storage structures. It was highest (11.33) in Kuchcha storage structures (S_3) followed by that (9.33) in Semi-pucca (S_2) and (7.00) in Pucca storage structures (S_1).

b. Lac traders

i. *P. pulverea*

Among the lac traders mean monthly population (larvae + pupae) of *P. pulverea* per 50 g of stored lac samples significantly differed among all the three lac traders. It was highest (10.00) in Small lac traders (T_3) followed by that (8.00) in Medium traders (T_2) and (6.67) in Big traders (T_1).

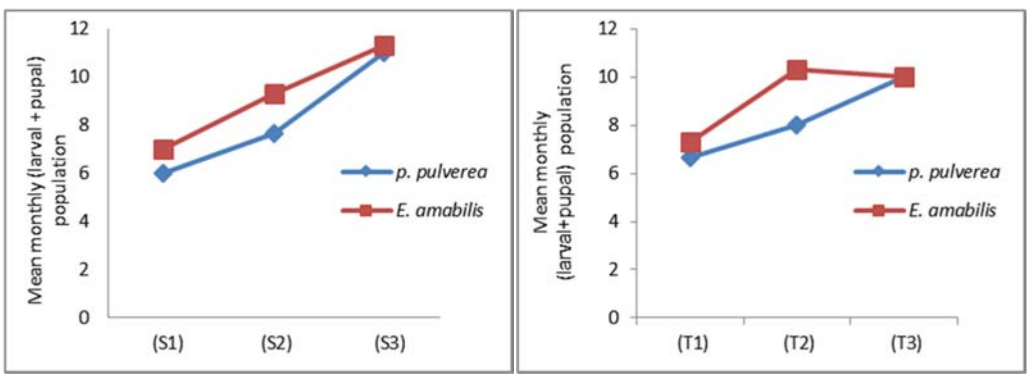
ii. *E. amabilis*

Among the lac traders mean monthly population (larvae + pupae) of *E. amabilis* per 50 g of stored lac samples was highest (10.33) in Medium traders (T_2) and was lowest (7.33) in big traders (T_1). The mean monthly population of *E. amabilis* recorded among big traders were significantly less than that (10.33 and 10.00) found in Medium traders (S_2) and Small traders (S_3) respectively. However the mean monthly population of *E. amabilis* among Medium and Small traders was at par. (Table 2).

Table 2: Mean monthly population of storage pests of lac (Larvae + Pupae) in different storage structures and lac traders in August 2015

Mean population (larvae + pupa) of storage pests of lac in August 2015		
Main plot (Storage structures)	***P. pulverea***	***E. amabilis***
Pucca (S_1)	6.00 (4.69)	7.00 (4.98)
Semi pucca (S_2)	7.67 (5.16)	9.33(5.67)
Kuchcha (S_3)	11.00 (6.02)	11.33(6.19)
SEm±	0.06	0.02
CD 5%	0.22	0.07
Sub plot (Lac traders)		
Big trader (T_1)	6.67 (4.83)	7.33(5.06)
Medium trader (T_2)	8.00 (5.20)	10.33(5.95)
Small trader (T_3)	10.00 (5.83)	10.00(5.83)
SEm±	0.08	0.07
CD 5%	0.24	0.21
Interaction (SxT)		
S_1T_1	1.67(1.46)	1.33(1.34)
S_1T_2	1.67(1.46)	3.33(1.95)
S_1T_3	2.67(1.76)	2.33(1.68)
S_2T_1	2.00(1.56)	2.33(1.68)
S_2T_2	2.33(1.64)	3.33(1.95)
S_2T_3	3.33(1.95)	3.67(2.04)
S_3T_1	3.00(1.81)	3.67(2.04)
S_3T_2	4.00(2.10)	3.67(2.04)
S_3T_3	4.01(2.11)	4.00(2.11)
SEm±	0.14	0.12
CD 5%	0.42	0.36

Figures in parenthesis () are √x square root transformation



(Storage structures) **(Lac traders)**

Fig 1: Stored lac pests population (Larvae + Pupae) influenced by storage structures and lac traders in August 2015

c. Interaction of Storage structures x Lac traders (SxT)

i. *P. pulverea*

In the interaction of storage structures x lac traders (SxT), mean monthly population (larvae + pupae) of *P. pulverea* per 50 g stored lac samples was recorded highest (4.01) in Kuchcha storage structures x Small lac traders S_3T_3 followed by (4.00) in S_3T_2 and (3.33) in S_2T_3. It was least (1.67) in S_1T_1 and S_1T_2. The mean monthly population of *P. pulverea* was significantly highest (4.01) in S_3T_3 over all other interactions, but it was at par with S_3T_2 (4.00) and S_2T_3 (3.33).

ii. *E. amabilis*

In case of *E. amabilis* the mean monthly (larvae + pupae) population of *E. amabilis* per 50 g stored lac samples was recorded highest (4.00) in S_3T_3 Kuchcha storage structures x Small lac traders followed by (3.67) in S_3T_2, S_3T_1, S_2T_3 and (3.33) in S_2T_2, S_1T_2. It was least (1.33) in S_1T_1. The mean monthly (larvae + pupae) population of *E. amabilis* was significantly highest (4.00) in S_3T_3 over all other interactions, but it was at par with S_3T_2, S_3T_1, S_2T_3 (3.67) and S_2T_2, S_1T_2 (3.33). (Table 4.4)

3.4.2. Stored lac pests population in October 2015

a. Storage structures

i. *P. pulverea*

The mean monthly population (larvae + pupae) of *P. pulverea* per 50 g of stored lac samples significantly differed among all the three storage structures (Table 3). It was highest (12.00) in Kuchcha storage structures (S_3) followed by that (8.67) in Semi-pucca (S_2) and (7.33) in Pucca storage structures (S_1).

ii. *E. amabilis*

The mean monthly population (larvae + pupae) of *E. amabilis* per 50 g of stored lac samples significantly differed among all the three storage structures. It was highest (10.33) in Kuchcha storage structures (S_3) followed by that (9.00) in Semi-pucca (S_2) and (6.67) in Pucca storage structures (S_1).

b. Lac traders

i. *P. pulverea*

Among the lac traders the mean monthly population (larvae + pupae) of *P. pulverea* per 50 g of stored lac samples significantly differed among all the three lac traders. It was highest (11.33) in Small lac traders (T_3) followed by that (9.67) in Medium traders (T_2) and (7.00) in Big traders (T_1).

ii. *E. amabilis*

Among the lac traders mean monthly population (larvae + pupae) of *E. amabilis* per 50 g of stored lac samples significantly differed among all the three lac traders. It was highest (10.00) in Small lac traders (T_3) followed by that (9.00) in Medium traders (T_2) and (7.00) in Big traders (T_1).

c. Interaction of Storage structures x Lac traders (SxT)

i. *P. pulverea*

In the interaction of storage structures x lac traders (SxT), mean monthly population (larvae + pupae) of *P. pulverea* per 50 g stored lac samples was recorded highest (4.67) in S_3T_3 Kuchcha storage structures x Small lac traders followed by (4.00) in S_3T_2, (3.67) in S_2T_3 and (3.33) in S_3T_1. It was least (1.67) in S_1T_1.The mean monthly (larvae + pupae) population of *P. pulverea* was significantly highest (4.67) in S_3T_3 over all other interactions, but it was at par with S_3T_2 (4.00), S_2T_3 (3.33) and S_3T_1.(Table 4.5)

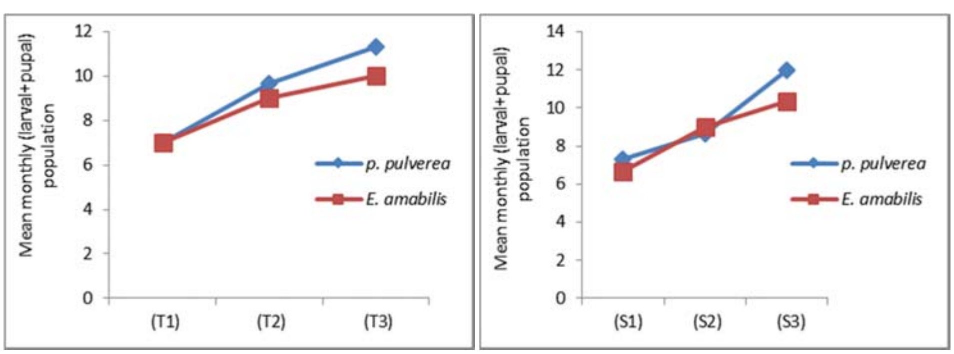
ii. *E. amabilis*

In the interaction of storage structures x lac traders (SxT), mean monthly population (larvae + pupae) of *E. amabilis* per 50 g stored lac samples was recorded highest (3.67) in S_3T_2 and S_2T_3 followed by (3.33) in S_3T_3, S_3T_1, S_2T_2 and (3.00) in S_1T_3. It was least (1.67) in S_1T_1. The mean monthly population (larvae + pupae) of *E. amabilis* was significantly highest (3.67) in S_3T_2 and S_2T_3 over all other interactions, but it was at par with S_3T_3, S_3T_1, S_2T_2 (3.33) and S_1T_3 (3.00).

Table 3: Mean monthly population of storage pests of lac (Larvae + Pupae) in different storage structures and lac traders in October 2015

Mean population (larvae + pupa) of storage pests of lac in October 2015		
Main plot (Storage structures)	***P. pulverea***	***E. amabilis***
Pucca (S_1)	7.33(5.08)	6.67(4.82)
Semi pucca (S_2)	8.67(5.45)	9.00(5.55)
Kuchcha (S_3)	12.00(6.39)	10.33(5.95)
SEm±	0.04	0.04
CD 5%	0.17	0.16
Sub plot (Lac traders)		
Big trader (T_1)	7.00(5.04)	7.00(4.98)
Medium trader (T_2)	9.67(5.73)	9.00(5.57)
Small trader (T_3)	11.33(6.16)	10.00(5.77)
SEm±	0.07	0.06
CD 5%	0.23	0.19
Interaction (SxT)		
S_1T_1	1.67(1.46)	1.67(1.46)
S_1T_2	2.67(1.76)	2.00(1.58)
S_1T_3	3.00(1.86)	3.00(1.77)
S_2T_1	2.00(1.56)	2.00(1.56)
S_2T_2	3.00(1.86)	3.33(1.95)
S_2T_3	3.67(2.04)	3.67(2.04)
S_3T_1	3.33(2.02)	3.33(1.95)
S_3T_2	4.00(2.11)	3.67(2.04)
S_3T_3	4.67(2.26)	3.33(1.95)
SEm±	0.13	0.11
CD 5%	0.40	0.33

Figures in parenthesis () are √x square root transformation



(Storage structures) **(Lac traders)**

Fig 2: Stored lac pests population (Larvae + Pupae) influenced by storage structures and lac traders in October 2015

3.4.3 Stored lac pests population in November 2015

a. Storage structures

i. *P. pulverea*

The mean monthly population (larvae + pupae) of *P. pulverea* /50 g of stored lac samples significantly differed among all the three storage structures collected in November 2015 (Table 4). It was highest (14.67) in Kuchcha storage structures (S_3) followed by that (9.00) in Semi-pucca (S_2) and (7.67) in Pucca storage structures (S_1).

ii. *E. amabilis*

The mean monthly population (larvae + pupae) of *E. amabilis* per 50 g of stored lac samples significantly differed among all the three storage structures collected in November. It was highest (15.33) in Kuchcha storage structures (S_3) followed by that (9.00) in Semi-pucca (S_2) and (7.00) in Pucca storage structures (S_1).

b. Lac traders

i. *P. pulverea*

Among the lac traders mean monthly population (larvae + pupae) of *P. pulverea* per 50 g of stored lac samples was highest (11.00) in Small traders (T_3) and was lowest (10.00) in Big traders (T_1). The mean monthly population of *P. pulverea* recorded among Big traders were significantly less than that found in Small traders (S_3) (11.00) and Medium traders (S_2) (10.35), however the mean monthly population of *P. pulverea* among Big and Medium traders was at par.

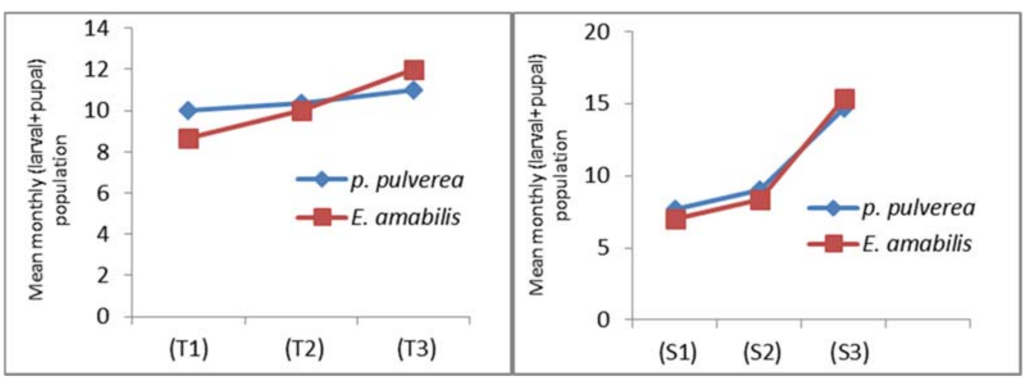
ii. *E. amabilis*

Among the lac traders mean monthly population (larvae + pupae) of *E. amabilis* /50 g of stored lac samples significantly differed among all the three lac traders. It was highest (12.00) in Small lac traders (T_3) followed by that (10.00) in Medium traders (T_2) and (8.67) in Big traders (T_1).

Table 4: Mean monthly population of storage pests of lac (Larvae + Pupae) in different storage structures and lac traders in November 2015

Mean population (larvae + pupa) of storage pests of lac in November 2015		
Main plot (Storage structures)	***P. pulverea***	***E. amabilis***
Pucca (S_1)	7.67(5.14)	7.00(4.98)
Semi pucca (S_2)	9.00(5.55)	8.33(5.35)
Kuchcha (S_3)	14.67(6.90)	15.33(7.08)
SEm±	0.06	0.05
CD 5%	0.23	0.19
Sub plot (Lac traders)		
Big trader (T_1)	10.00(5.62)	8.67(5.41)
Medium trader (T_2)	10.35(5.87)	10.00(5.67)
Small trader (T_3)	11.00(6.09)	12.00(6.24)
SEm±	0.09	0.07
CD 5%	0.29	0.22
Interaction (SxT)		
S_1T_1	1.67(1.44)	1.67(1.44)
S_1T_2	2.67(1.76)	2.00(1.58)
S_1T_3	3.33(1.94)	3.33(1.95)
S_2T_1	2.00(1.58)	2.67(1.77)
S_2T_2	3.33(1.93)	4.00(2.11)
S_2T_3	3.67(2.04)	1.67(1.46)
S_3T_1	6.33(2.60)	4.33(2.20)
S_3T_2	4.33(2.18)	6.00(2.54)
S_3T_3	4.00(2.11)	5.00(2.34)
SEm±	0.16	0.12
CD 5%	0.50	0.37

Figures in parenthesis () are √x square root transformation



(Storage structures) **(Lac traders)**

Fig 3: Stored lac pests population (Larvae + Pupae) influenced by storage structures and lac traders in November 2015

c. Interaction of Storage structures x Lac traders (SxT)

i. *P. pulverea*

In the interaction of storage structures x lac traders (SxT), mean monthly population (larvae + pupae) of *P. pulverea* per 50 g stored lac samples was recorded highest (6.33) in S_3T_1 followed by (4.33) in S_3T_2, and (4.00) in S_3T_3. It was least (1.67) in S_1T_1.The mean monthly population (larvae + pupae) of *P. pulverea* was significantly highest (6.33) in S_3T_1 over all other interactions, but it was at par with S_3T_2 (4.33), and S_3T_3 (4.00).(Table 4.6)

ii. *E. amabilis*

The interaction of storage structures x lac traders (SxT), mean monthly (larvae + pupae) population of *E. amabilis* per 50 g stored lac samples was recorded highest (6.00) in S_3T_2 followed by (5.00) in S_3T_3, and (4.33) in S_3T_1. It was least

(1.67) in S_1T_1. The mean monthly (larvae + pupae) population of *E. amabilis* was significantly highest (6.00) in S_3T_2 over all other interactions, but it was at par with S_3T_3 (5.00) and S_3T_1 (4.33). (Table 4.6)

4.3.4 Stored lac pests population in December 2015

a. Storage structures

i. *P. pulverea*

The mean monthly population (larvae + pupae) of *P. pulverea* per 50 g of stored lac samples significantly differed among all the three storage structures collected in December 2015. It was highest (16.33) in Kuchcha storage structures (S_3) followed by that (9.33) in Semi-pucca (S_2) and (7.33) in Pucca storage structures (S_1).

ii. *E. amabilis*

The mean monthly population (larvae + pupae) of *E. amabilis* per 50 g of stored lac samples was significantly difference among all the three storage structures collected in December 2015. It was highest (13.00) in Kuchcha storage structures (S_3) followed by that (9.00) in Semi-pucca (S_2) and (7.31) in Pucca storage structures (S_1).

b. Lac traders

i. *P. pulverea*

Among the lac traders mean monthly population (larvae + pupae) of *P. pulverea* per 50 g of stored lac samples was highest (12.67) in Small traders (T_3) and was lowest (7.67) in Big traders (T_1). The mean monthly population of *P. pulverea* recorded among Big traders were significantly less than that found in Small traders (S_3) (12.67) and Medium traders (S_2) (12.67), however the mean monthly population of *P. pulverea* among Small and Medium traders was at par.

ii. *E. amabilis*

Among the lac traders mean monthly population (larvae + pupae) of *E. amabilis* per 50 g of stored lac samples significantly differed among all the three lac traders. It was highest (11.67) in Small lac traders (T_3) followed by that (9.67) in Medium traders (T_2) and (8.00) in Big traders (T_1).

c. Interaction of Storage structures x Lac traders (SxT)

i. *P. pulverea*

In the interaction of storage structures x lac traders (SxT), mean monthly population (larvae + pupae) of *P. pulverea* per 50 g stored lac samples was recorded highest (6.67) in S_3T_3 followed by (6.00) in S_3T_2, and (4.00) in S_2T_2. It was least (1.67) in S_1T_1.The mean monthly population (larvae + pupae) of *P. pulverea* was significantly highest (6.67) in S_3T_3 over all other interactions, but it was at par with S_3T_2 (6.00), and S_2T_2 (4.00). (Table 4.7)

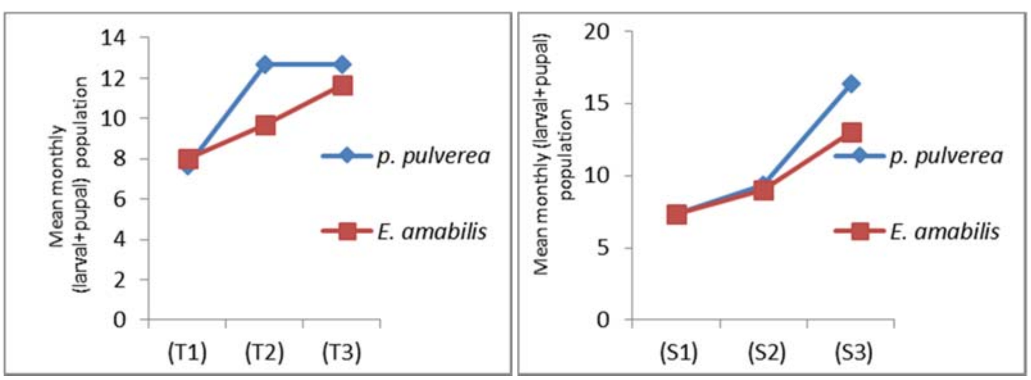
ii. *E. amabilis*

In the interaction of storage structures x lac traders (SxT), mean monthly population (larvae + pupae) of *E. amabilis* per 50 g stored lac samples was recorded highest (5.33) in S_3T_3 followed by (4.00) in S_3T_1, and (3.67) in S_3T_2. It was least (1.33) in S_1T_1. The mean monthly (larvae + pupae) population of *E. amabilis* was significantly highest (5.33) in S_3T_3 over all other interactions, but it was at par with S_3T_1 (4.00) and S_3T_2 (3.67). (Table 5).

Table 5: Mean monthly population of storage pests of lac (Larvae + Pupae) in different storage structures and lac traders in December 2015

Mean population (larvae + pupa) of storage pests of lac in December 2015		
Main plot (Storage structures)	***P. pulverea***	***E. amabilis***
Pucca (S_1)	7.33 (5.06)	7.31 (5.04)
Semi pucca (S_2)	9.33 (5.65)	9.00 (5.59)
Kuchcha (S_3)	16.33 (7.24)	13.00 (6.56)
SEm±	0.05	0.06
CD 5%	0.19	0.23
Sub plot (Lac traders)		
Big trader (T_1)	7.67 (5.16)	8.00 (5.23)
Medium trader (T_2)	12.67 (6.42)	9.67 (5.75)
Small trader (T_3)	12.67 (6.37)	11.67 (6.23)
SEm±	0.11	0.08
CD 5%	0.33	0.24
Interaction (SxT)		
S_1T_1	1.67 (1.44)	1.33 (1.34)
S_1T_2	2.67 (1.76)	3.00 (1.86)
S_1T_3	3.00(1.86)	3.00 (1.86)
S_2T_1	2.33 (1.68)	2.67 (1.77)
S_2T_2	4.00 (2.11)	3.00 (1.86)
S_2T_3	3.00 (1.86)	3.33 (1.95)
S_3T_1	3.67 (2.04)	4.00 (2.11)
S_3T_2	6.00 (2.54)	3.67 (2.04)
S_3T_3	6.67(2.66)	5.33(2.41)
SEm±	0.18	0.13
CD 5%	0.57	0.40

Figures in parenthesis () are √x square root transformation



(Storage structures) (Lac traders)

Fig 4: Stored lac pests population (Larvae + Pupae) influenced by storage structures and lac traders in December 2015

4. Conclusion

It is concluded that high populations of *P. pulverea* and *E. amabilis* were found in kuchcha storage structures. The highest percentage population of *P. pulverea*was highest and *E. amabilis* were recorded during October and August, 2015, respectively.

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