INTRODUCTION
Spider mite, Tetranychidae, Seasonal fluctuation

Spider mites belonging to the family Tetranychidae are highly polyphagous in nature and live on the undersides of leaves in colonies, being protected by the silken webs and inducing damage by puncturing the leaf tissue and sucking the plant sap. A study on the seasonal fluctuation in the population density of these mites on bamboos (Bambusa bambos (L.) Voss and Bambusa vulgaris var. striata) was carried out in the Calicut University Campus from November, 2012 to October, 2013 in the Malappuram district of Kerala. Results of the study indicated that the spider mite population was generally high on B. vulgaris var. striata when compared to that of B. bambos. The average number of the spider mites present per leaf of B. vulgaris var. striata was 7 whereas it was 5.89 on B. bambos. The effects of temperature, relative humidity and rainfall on these mites were also studied.

Population density, depending on the number of individuals and the area occupied by them, represents not only a valid statistical parameter of abundance, but also an element of the biotic environment (Begon et al., 1989). Density is one of the factors regulating population abundance in arthropods (Green et al., 2002). In the present paper, seasonal fluctuations and population density of spider mites have been discussed, based on data collected during one year period of November, 2012 to October, 2013, on two species of bamboo viz. Bambusa vulgaris var. striata also known as Golden Bamboo, or Buddha’s Belly Bamboo and Bambusa bambos (L.) Voss or Indian Thorny Bamboo growing in the Calicut University Campus of the Malappuram Dt. of Kerala.

MATERIALS AND METHODS
Samples of mite infested leaves were collected randomly from the bamboo plants at periodic intervals and transported to the laboratory in polythene bags for microscopic observation. Quantitative assessment of population density of individual mite species was made following Per Leaf Counting method. The leaf samples of each plant were immersed for 5-7 minutes in a petriplate containing 70% alcohol. The leaves were thoroughly washed in 70% alcohol to extract the entire mite population from the leaf surface. The mite specimens thus extracted from the leaves in to the petriplate were then examined under the stereo zoom microscope. In order to study the population density of individual species of mites, the numbers of different life stages viz. the eggs, nymphal stages and adults, were counted separately for each species.

RESULTS
Population density of spider mites on bamboo leaves
The population density of spider mite on bamboo leaves from 2012 to 2013 was expressed as average number of mites present per leaf as shown in Fig. 1. The average number of the spider mites present per leaf was 7 on B. vulgaris var. striata where as it was 5.89 on B. bambos. In general, the maximum population density of the species was contributed by the eggs, followed by the immatures. Adults showed the lowest density. The leaves of B. vulgaris var. striata showed more number of eggs and nymphs of spider mites rather than the adult individuals. Contrary to this, the leaves of B. bambos disclosed more number of adult spider mites than their eggs and immature stages.

The number of mites present on both species of bamboos was found positively correlated to the increase in temperature ($r = 0.79$ for B. bambos and $r = 0.83$ for B. vulgaris var. striata). A weak negative correlation was found between relative humidity and mite population density on both B. vulgaris var. striata ($r = -0.29$) and B. bambos ($r = -0.16$).

Seasonal fluctuation of population density of spider mites
Table 1 shows the pattern of seasonal fluctuation of population density of the spider mite on B. vulgaris var. striata and B. bambos. As shown in the table, the mite population showed a gradual increase from November, 2012 to May, 2013 and then exhibited a drastic decline in June-July, 2013. From August onwards, the mite population density followed an increasing trend.

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Bamboo spider mites initially infest leaves along the mid-vein or edge of the leaf where a linear depression is typically found. This depression provides the proper nest building site. The first author is grateful to the UGC for extending the institutional facilities as well as fellowship under the SPECIAL ASSISTANCE PROGRAMME (SAP) & BSR. The second author is grateful to the Ministry of Minority Affairs, Government of India, for providing MOULANA AZAD NATIONAL FELLOWSHIP.

Weather parameters, affect the spider mite population directly through physiological and mechanical ways and also indirectly through host quality changes (Knapp et al. 2006). After a sharp decline of population in June, a gradual increasing trend could be observed subsequently. Probably, this increasing trend would suggest the ability of the mites to get acclimatized with the less favorable weather conditions and gradually resuming multiplication after an initial decrease in numbers (Oomen, 1982).

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**Table 1: Effect of Temperature and Relative Humidity on the number of mites on the leaves of $B. \text{ bambos}$ and $B. \text{ vulgaris \ var. striata}$**

| Year | Season | Mean Temperature ($^\circ$C) | Relative Humidity (%) | Mean | Number of Mites per leaf |
|------|--------|------------------------------|----------------------|------|-------------------------|
| 2012 | Nov    | 29.6                         | 71                   | 7    | 14                      |
|      | Dec    | 29.4                         | 71.5                 | 13   | 19                      |
| 2013 | Jan    | 29.2                         | 69.5                 | 23   | 33                      |
|      | Feb    | 31.2                         | 76.5                 | 28   | 46                      |
|      | Mar    | 31.4                         | 73                   | 49   | 52                      |
|      | Apr    | 31.1                         | 86                   | 64   | 63                      |
|      | May    | 31.35                        | 81                   | 80   | 80                      |
|      | Jun    | 29.95                        | 96                   | 2    | 2                       |
|      | Jul    | 27.2                         | 84                   | 3    | 4                       |
|      | Aug    | 27.7                         | 90                   | 4    | 7                       |
|      | Sep    | 28.1                         | 85.5                 | 5    | 6                       |
|      | Oct    | 28.2                         | 82                   | 5    | 10                      |

**DISCUSSION:**
Bamboo spider mites initially infest leaves along the mid-vein or edge of the leaf where a linear depression is typically found. This depression provides the proper nest building site (Saito, 1995). All life stages of these mites exist beneath a single web nest. This dense webbing is the main reason that these mites are difficult to control. These mites pierce individual plant cells on the underside of the leaf and suck out the cell contents causing the discoloration on the upper leaf surface (Evans, 1992). Leaf damage can impair photosynthesis and reduce plant vigor.

Seasonal changes in diversity and density of arthropods in tropical regions have been correlated with alterations in local environmental factors like temperature, rainfall and relative humidity (Klein et al., 2002; Philpott et al., 2006; Teodoro et al., 2008). A significant increase in spider mite population was observed with an increase in temperature during the present survey, thereby supporting the earlier findings of Stavrinides et al., 2010. Despite this, the mite population was not found significantly influenced by an increase in relative humidity. Boudreaux (1958) suggested that an increase in relative humidity would ensure a check in the population build up of spider mites. Though the hatching process was not found affected, the survival of newly emerged nymphs was found adversely affected by the moist atmosphere. The decrease in spider mite population observed during June and July, 2013 may be attributed to the impact of rainfall occurred during the monsoon season. Rainfall would probably lead to the washing of all the life stages of the mite from the leaf surface. Heavy rains generally exert a washing effect (Yaninek et al. 1989) on plant mites, including the spider mites, leading to a decline in their population. This is supported by the earlier findings of Onzo et al. (2005) and Hanna et al. (2005) who also reported that the abundance of mites would be decreased in periods of high rainfall. Rainfall patterns can also affect soil moisture levels, which are known to influence spider mite population levels.

**Fig 2:** Effect of Rainfall on the number of mites in the leaves of $B. \text{ bambos}$ and $B. \text{ vulgaris \ var. striata}$

Fig 2 depicts the effect of rainfall on mite population on the two bamboos. As the rainfall increased, the population of mites showed decreasing trend in both bamboo ($r = -0.44$ for $B. \text{ bambos}$ and $r = -0.55$ for $B. \text{ vulgaris \ var. striata}$).