ISSN 2348-1218 (print)
International Journal of Interdisciplinary Research and Innovations ISSN 2348-1226 (online)
Vol. 6, Issue 4, pp: (267-274), Month: October - December 2018, Available at: www.researchpublish.com

Comparative studies on the Uzi fly, *Exorista sorbillans* (W) infestation on the mulberry silkworm, *Bombyx mori* L. in Rayalaseema districts of Andhra Pradesh

[1]B. Vinayak Reddy, [2]P. Lakshminarayana Reddy, [3]G. D. V. Prasad Rao, [4]B. Sujatha, [5]S. Sankar Naik.

[1,2,4,5] Department of Sericulture, Sri Krishnadevaraya University, Anantapur -515 503, Andhra Pradesh, India
[3]Department of Zoology, S. G. S. College, Jaggaiah Pet, Krishna district, Andhra Pradesh, India

Abstract: **The Uzi fly, *Exorista sorbillans* (Wiedemann) is a major pest of the mulberry silkworm, *Bombyx mori* L. in Andhra Pradesh leading to great cocoon crop loss. It is considered that acquisition of knowledge on the infestation of uzi fly on silkworm in Rayalaseema districts of Andhra Pradesh form an important basic input for drawing silkworm cocoon crop protection strategies. Keeping the above in view, a survey was conducted to know the infestation levels of uzi fly on mulberry silkworm in three important sericulture practicing districts of Rayalaseema *i.e.*, Anantapur, Chittoor and Kurnool of Andhra Pradesh, India during three seasons (summer, rainy and winter). Results revealed that the infestation of uzi fly on commercial mulberry silkworm cocoon crop was high during rainy season (14.73 ± 5.27%) followed by that during winter (8.62 ± 4.16%) and summer (4.77 ± 4.68%). Identical trends in uzi infestation among three sericultural districts (Anantapur, Chittoor and Kurnool) were observed during three seasons studied (summer, rainy and winter). Average uzi incidence was high in Anantapur District (10.01 ± 4.56%) followed by that in Chittoor District (5.84 ± 2.20%) and Kurnool District (4.77 ± 4.68%). Average uzi fly incidence on the commercial silkworm cocoon was 9.37 ± 4.23%. Differences in uzi fly infestations among three districts surveyed and average incidence are statistically highly significant at 1% level ($p < 0.01$).**

Keywords: **Uzi fly, *Exorista sorbillans*, infestation, mulberry silkworm, *Bombyx mori*, survey, Rayalaseema districts, Andhra Pradesh.**

1. INTRODUCTION

The uzi fly, *Exorista sorbillans* (Wiedemann), traced from China, Japan, South Korea, Thailand, Myanmar and Sri Lanka, is notorious in attacking all four commercially known silkworm varieties, Tasar, Muga, Mulberry and Eri in India (Devaiah and Patil, 1994). *E. sorbillans* was reported from 22 different countries (Huchesh and Puttaraju, 2014), causing 30% cocoon crop loss. *E. sorbillans* was reported at first on mulberry silk worm, *Bombyx mori* (L) from west Bengal in 1880 itself. Since then, uzi fly continued to cause heavy damage to mulberry silkworm cocoon crop in West Bengal. It was first reported on mulberry silkworm during May 1980 in Bulenarasapura village of Hosokote Tahasil of Bangalore District in south India (Anonymous, 1981; Jolly, 1981). At present, it is well established in Karnataka, widely spread in Kolar, Tumkar, Mysore, Bangalore and Mandya Districts of Karnataka (Rajshekhargouda and Devaiah, 1983). The uzi fly spread in the entire Karnataka state by 1983 (Siddappaji, 1985) and later to other sericultural areas of Peninsular India (Channa Basavanna, 1992) like Andhra Pradesh, Tamil Nadu *etc*. There are several surveys that highlighted extent of infestation and consequent economic loss due to uzi fly attack on the commercial mulberry cocoon crop. The initial survey of the Department of Sericulture, Government of Karnataka (1981) revealed that the incidence of uzi fly on silkworms was 64.68%. However, several studies conducted on *E. sorbillans* infestation revealed varying degrees of infestation.

The survey studies were extended to different stages of silkworm. Kumar *et al*. (1990) recorded 81.30% infestation on spinning worms and 68.30% on mountages in the rearing of *B. mori* in Karnataka. Uzi fly infestation was more than 40% in some of the heavily infested areas of Karnataka (Jolly, 1987), while, in certain protected silkworm rearing, it ranged from 8.35 to 14.89% (Kumar *et. al*., 1987b).Thangavelu and Sahu (1986) reported that the maggots of uzi fly exhibited considerable variation in their body size and maggots developed within *B. mori* larvae were generally smaller in size than in *A. assamensis* larvae. According to Devaiah and Patil (1994), *E. sorbillans* copulated in air and survived on nectar of flowers and honey dew extracted by aphids, Delphacids, Jassids, Scales etc. *E. sorbillans* completed its life cycle from egg to adult within 30 to 40 days and completed 8-12 generations in a single year. All instars of mulberry silk worms were attacked by this parasitoid. Similarly, it parasitized Tasar, Muga and Eri silkworms in different traditional and nontraditional sericultural states. *E. sorbillans* is limiting factor of economics of sericulture. The eggs laid by female fly of *Exorista sorbillans*(Wiedemann) on the body of silkworm larvae hatch into small maggots which pierce the host's integument and eat greedily the body contents, resulting in the death of the host (Datta and Mukherjee, 1978; Kumar, 1987).The infestation of uzi fly on commercial mulberry silkworm cocoon crop is reported to be dependent on area (Sathe and Desai, 2014), abiotic factors (Chakraborty *et al*., 1996) and season (Kumar *et al*., 1993; Kasi Reddy *et al*., 2009; Kasi Reddy and Krishna Rao, 2009). The infestation is also reported to be dependent on adoption of integrated pest management packages (Kumar *et al*., 1993; Kasi Reddy *et al*., 2009; Kasi Reddy and Krishna Rao, 2009, Sakthivel *et al*., 2012; Gangadhar, *et al*., 2012; Priyadarshini and Vijaya Kumari, 2013; Sujatha *et al*., 2015a; 2015b). Comparative survey studies on uzi infestation in Rayalaseema, including Kurnool the virgin district are not available. The present communication deals with comparative uzi fly infestation on the mulberry silkworm commercial cocoon crop during three different seasons, summer, rainy and winter in three study districts of Rayalaseema *viz*., Anantapur, Chittoor and Kurnool.

2. MATERIAL AND METHODS

All the four districts of Rayalaseema, Anantapur, Chittoor, Kurnool and Kadapa are known for practicing sericulture of which, Anantapur and Chittoor districts are known as 'traditional sericultural districts'. The other two districts, Kurnool and Kadapa have started practicing sericulture recently. Therefore, all the four districts of Rayalaseema were selected for the survey studies. However, the preliminary studies on the availability of uzi fly pupae in different environs of silkworm rearing in Kadapa district revealed very low or negligible quantum of uzi fly pupa. Added, the Kadapa district experienced very dry environment (high temperature and low humidity) that does not allow uzi fly. Therefore, the district of Kadapa was discarded from the survey studies, keeping the other three districts, Anantapur, Chittoor and Kurnool. From each selected district (Anantapur, Chittoor and Kurnool), one hundred farmers were randomly selected, emphasizing nearly equal representation of sericultural farmers of each sericultural Mandal of districts.A simple survey proforma was developed for data collection through personal interview and observations on silkworm larvae with uzi scars in 1 m^2 area. Data was collected on the fifth/sixth day of fifth instar silkworm crop during three unique seasons; summer (March to June), rainy (July to October) and winter (November to February).Macroscopic data were computed for average ± SD. The microscopic data were represented as graphs. The macroscopic data further were computed and treated statistically, ANOVA to indicate its statistical authenticity.

3. RESULTS

The presentation of results on incidence of uzi fly on silkworm cocoon crop is divided into two parts *viz*., 1. Season-wise average uzi fly infestation on silkworm cocoon crop of three districts (Anantapur, Chittoor and Kurnool) during three seasons (summer, rainy and winter) and 2. District-wise average uzi fly infestation on silkworm cocoon crop in three districts (Anantapur, Chittoor and Kurnool) during three seasons (summer, rainy and winter).

I. Season-wise average uzi fly infestation on silkworm cocoon crop of three districts:

The recorded data on uzi fly infestation in three seasons (summer, rainy and winter) with three districts (Anantapur, Chittoor and Kurnool) was pooled and treated for average infestation and presented in Figure 1. Uzi fly infestation on the commercial silkworm cocoon crop has registered a definite trend in different seasons. Maximum uzi infestation was recorded during rainy season (14.66 ± 4.57%), followed by winter, with average infestation of 10.64 ± 4.20%. Least uzi infestation was recorded in summer, with average infestation of 6.87 ± 4.57%. The differences in uzi fly infestation on the commercial silkworm cocoon crop during three seasons studied were statistically highly significant at 1% level ($p < 0.01$).

ISSN 2348-1218 (print)
International Journal of Interdisciplinary Research and Innovations ISSN 2348-1226 (online)
Vol. 6, Issue 4, pp: (267-274), Month: October - December 2018, Available at: www.researchpublish.com

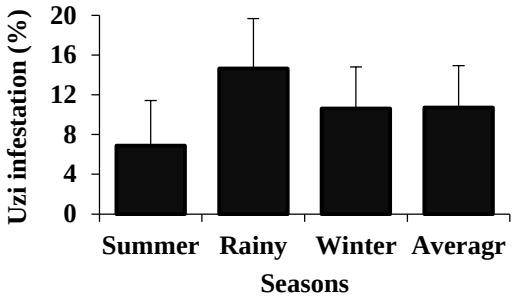


Figure 1: Graphical representation of average uzi fly infestation in three districts, Anantapur, Chittoor and Kurnool (average ± SD, n = 3 x 100 = 300). Note highest uzi fly infestation during rainy season followed by winter and summer seasons. The differences in uzi fly infestations among three different seasons (summer, rainy and winter) are statistically highly significant at 1% level ($p < 0.01$).

a. ***Average uzi fly infestation on silkworm cocoon crop in three districts (Anantapur, Chittoor and Kurnool) during summer season*:** The average of uzi fly infestation on the commercial silkworm cocoon crop during summer season is presented in Figure 2.Surprisingly, the average uzi fly infestation on the commercial cocoon crop during summer season was high in Anantapur District (10.01 ± 4.56%) followed by that in Chittoor District (5.84 ± 2.20%) and Kurnool District (4.77 ± 4.68%). The average infestation during summer season was 6.87 ± 4.57% (Figure 2). The differences in average uzi fly infestation on the commercial cocoon crop during summer season in three sericultural districts were statistically highly significant at 1% level, ($p < 0.01$).

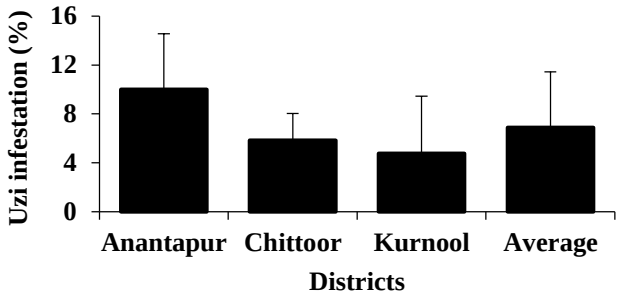
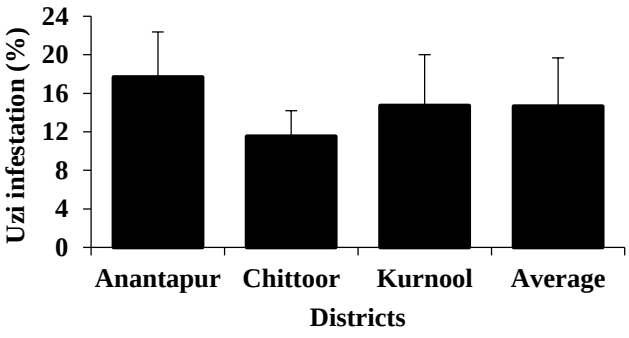


Figure 2: Graphical representation of uzi fly infestation during summer in three districts, Anantapur, Chittoor and Kurnool (average ± SD; n = 100). Note high infestation recorded in Anantapur District followed by that in Chittoor and Kurnool. The differences in uzi fly infestations during summer season among three different districts are statistically highly significant at 1% level ($p < 0.01$).

b. ***Average uzi fly infestation on silkworm cocoon crop of three districts (Anantapur, Chittoor and Kurnool) during rainy season*:** Average uzi fly infestation on the commercial silkworm cocoon crop during rainy season is presented in Figure 3.The average uzi fly infestation did not follow the trend shown by summer season. Thus, the uzi fly infestation was high in Anantapur District (17.70 ± 4.68%) followed by Kurnool District (14.73 ± 5.27%) and Chittoor District (11.54 ± 2.66%), average uzi fly infestation during summer season was 14.66 ± 5.017%. The differences in uzi fly infestation were statistically highly significant at 1% level ($p < 0.01$).



ISSN 2348-1218 (print)
International Journal of Interdisciplinary Research and Innovations ISSN 2348-1226 (online)
Vol. 6, Issue 4, pp: (267-274), Month: October - December 2018, Available at: www.researchpublish.com

Figure 3: Graphical representation of uzi fly infestation during rainy season in three districts, Anantapur, Chittoor and Kurnool (average ± SD; n = 100). Note high uzi fly infestation during rainy season in Anantapur District followed by Kurnool and Chittoor Districts, differences in uzi fly infestations are statistically highly significant at 1% level ($p < 0.01$).

c. ***Average uzi fly infestation on silkworm cocoon crop of three districts (Anantapur, Chittoor and Kurnool) during winter season***: The average uzi fly infestation on the commercial silkworm cocoon crop during winter season is presented in Figure 4. The uzi fly infestation on the commercial silkworm cocoon crop during rainy season followed the same trend as observed for summer season. Thus, uzi fly infestation during rainy season was high in Anantapur District (13.92 ± 3.59%) followed by that in Chittoor District (9.38 ± 2.37%) and Kurnool District (8.62 ± 4.16%). The average uzi fly infestation on the commercial silkworm cocoon crop during summer season was 10.64 ± 4.16%. The differences in uzi fly infestation on the commercial silkworm cocoon crop were statistically highly significant at 1% level ($p < 0.01$).

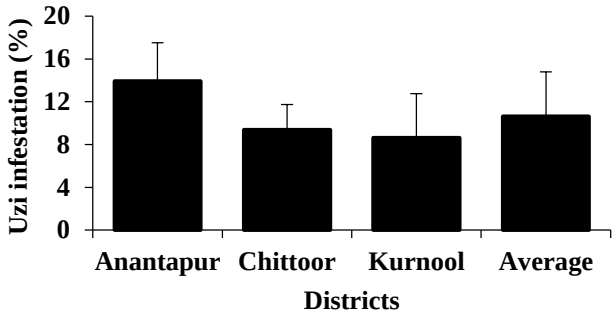


Figure 4: Graphical representation of uzi fly infestation recorded during winter season in three districts, Anantapur, Chittoor and Kurnool (average ± SD; n = 100). Note high infestation during winter season in Anantapur District followed by Chittoor and Kurnool, differences among three different districts are statistically highly significant at 1% level ($p < 0.01$). Differences between average winter season uzi infestation and that of Chittoor District are not significant.

II. District-wise average uzi fly infestation on silkworm cocoon crop: Data on the uzi fly infestation (average of three seasons; summer, rainy and winter) of three sericultural districts of Rayalaseema, Anantapur, Chittoor and Kurnool are presented in Figure 5. Very high uzi fly infestation on commercial silkworm cocoon crop was recorded in Anantapur District (13.88 ± 3.96%) followed by Kurnool District (9.37 ± 4.23%) and Chittoor District (8.92 ± 2.16%). The average uzi infestation of all the three districts was 10.72 ± 4.20%. The differences in uzi fly infestations among three different districts and average incidence are statistically highly significant at 1% level ($p < 0.01$).

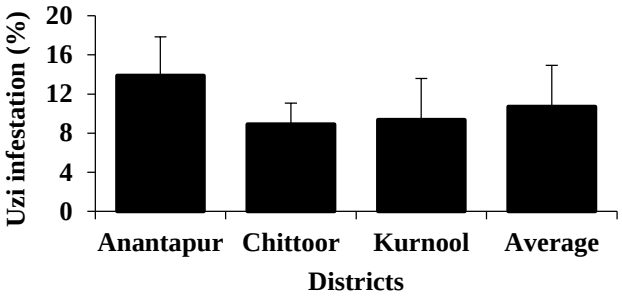


Figure 5: Graphical representation of uzi fly infestation recorded in three districts, Anantapur, Chittoor and Kurnool (average ± SD; n = 100). Note high uzi fly infestation recorded in Anantapur District followed by Kurnool and Chittoor. Differences in uzi fly infestations among three districts and average incidence are statistically highly significant at 1% level ($p < 0.01$).

a. **Uzi fly infestation on silkworm cocoon crop in Anantapur District:** The data on uzi fly infestation on the commercial cocoon crop in Anantapur during three seasons (summer, rainy and winter) and its average infestation is depicted in Figure 6. The trend notices was; the infestation of uzi fly on the commercial silkworm cocoon was highest during rainy season (17.70 ± 4.68%) followed by that during winter season (13.92 ± 3.59%) and summer season (10.01 ± 4.56%). The average uzi fly incidence on the commercial silkworm cocoon was 13.88 ± 3.93%). The differences in uzi fly infestations among three different districts and average incidence are statistically highly significant at 1% level ($p < 0.01$).

ISSN 2348-1218 (print)
International Journal of Interdisciplinary Research and Innovations ISSN 2348-1226 (online)
Vol. 6, Issue 4, pp: (267-274), Month: October - December 2018, Available at: www.researchpublish.com

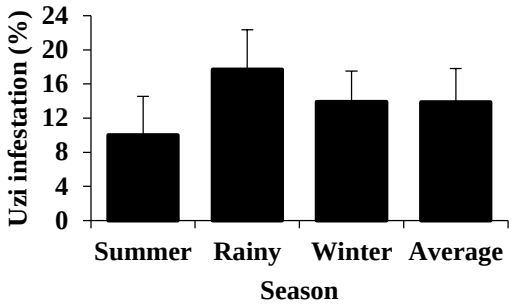


Figure 6: Graphical representation of uzi fly infestation during three seasons, summer, rainy and winter (average ± SD; n = 100) in Anantapur District. Note high uzi fly infestation during rainy season followed by winter and summer. The differences among three seasons and average incidence are statistically highly significant at 1% level ($p < 0.01$).

b. **Uzi fly infestation on silkworm cocoon crop in Chittoor District:** Data on uzi fly infestation on the commercial cocoon crop in Chittoor during three seasons (summer, rainy and winter) and its average infestation is depicted in Figure 7. The infestation trend followed that observed for cocoon crops in Anantapur District. Thus, the infestation of uzi fly was highest during rainy season (11.54 ± 2.66%) followed by that during winter (9.38 ± 2.37%) and summer (5.84 ± 2.20%) and average uzi fly incidence was 8.92 ± 2.16%). The differences in uzi fly infestations among three different seasons and average incidence were statistically highly significant at 1% level ($p < 0.01$).

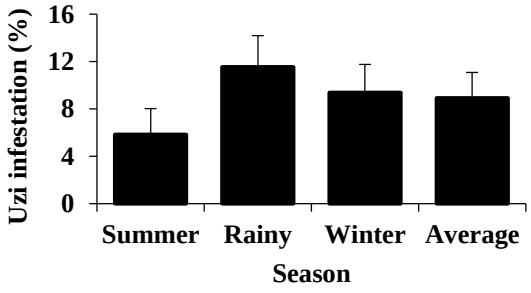


Figure 7: Graphical representation of uzi fly infestation recorded in three seasons (summer, rainy and winter) ± SD (n = 100) bin Chittoor District. Note high uzi fly infestation recorded during rainy season in Chittoor District followed by winter and summer. The differences among three seasons and average incidence are statistically highly significant at 1% level ($p < 0.01$).

c. **Uzi fly infestation on silkworm cocoon crop in Kurnool District:** Data on uzi fly infestation on the commercial cocoon crop in Kurnool during three seasons and the average infestation is depicted in Figure 8. The infestation trend followed that observed for cocoon crops in Anantapur and Chittoor Districts. This, the infestation of uzi fly was highest during rainy season (14.73 ± 5.27%) followed by that during winter season (8.62 ± 4.16%) and summer season (4.77 ± 4.68%). The average uzi fly incidence on was 9.37 ± 4.23%. The differences in uzi fly infestations among three different seasons and average incidence were statistically highly significant at 1% level ($p < 0.01$).

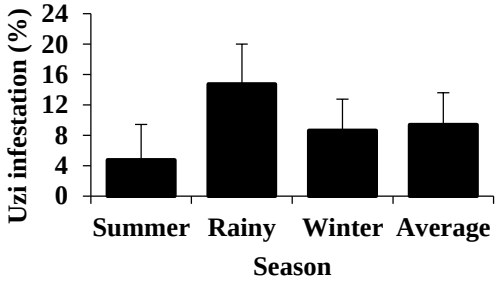


Figure 8: Graphical representation of uzi fly infestation during three seasons, summer, rainy and winter (average ± SD; n = 100) in Kurnool District. Note high uzi infestation recorded during rainy season followed by winter and summer. Differences in uzi fly infestations among three different districts and average incidence were statistically highly significant at 1% level ($p < 0.01$).

4. DISCUSSION

The Indian uzi fly, *Exorista sorbillans* (Wiedemann) is an endoparasitoid of *Bombyx mori* (Mukherji, 1919; Jameson, 1922). The female fly lays eggs on the body of silkworm larvae, eggs hatch into small maggots to pierce into the host's integument and devour the body contents, resulting in the death of the host (Datta and Mukherjee, 1978; Kumar, 1987; Sengupta *et al*., 1990). Vinayak Reddy *et al*., (2015) reported the patterns of uzi fly egg laying on the silkworm, *Bombyx mori*. Uzi fly prefers to deposit eggs on older silkworm larvae, particularly the fourth and fifth instar (Siddappaji, 1985; Vinayak Reddy *et al*., 2015) with less egg laying on the silkworm larvae of second instar, increase in number of eggs laid on the third instar silkworm larvae and further increase on fourth instar silkworm larvae (Vinayak Reddy *et al*., 2015). Further, there are reports that uzi fly can lay eggs on the first instar silkworm larval body (Gangwar and Thangavelu, 1989). However, the case need not be taken seriously as it is of extreme in nature and only in certain forced conditions.

Availability of uzi pupae in the environs of silkworm rearing (Vinayak Reddy, 2015) revealed around 10 uzi pupae per m^2 in the three districts of Rayalaseema (except Kadapa District). Also, the availability of uzi pupae was high during rainy (Vinayak Reddy, 2015), hinting at recurrence of uzi infestation on silkworm cocoon crop and situation to be further alarming. The uzi fly, *E. sorbillans* infestation was more in rainy season followed by winter and summer (Kumar *et al*., 1993; Kasi Reddy *et al*., 2009; Kasi Reddy and Krishna Rao, 2009). The survey studies were extended to infestation of uzi fly on the different stages of commercial silkworm larvae by Kumar *et al*., (1990). Interestingly, they (Kumar *et al*., 1990) reported 81.30% infestation on spinning worms and 68.30% on mountages in the rearing of *B. mori* in Karnataka. In the present study, however, infestation studies were restricted to the $5^{th}/6^{th}$ day of fifth instar silkworm larvae to avoid confusion in the study.

It is evident that uzi infestation is high during rainy season, followed by winter and summer seasons (Figures 1, 6 to 8). The infestation is reported to be area dependent (Sathe and Desai, 2014). Thus, Sathe and Desai (2014) reported high uzi fly infestation in the intensive sericultural zones like Karnataka, West Bengal *etc*. In Andhra Pradesh also, differences in uzi fly infestation on commercial silkworm were reported (Kasi Reddy *et al*., 2009; Kasi Reddy and Krishna Rao, 2009, Vinayak Reddy, 2015). Therefore, high uzi fly infestation on the commercial cocoon crop in Anantapur (Figure 5), the intensive district of sericulture is adequately justified. Though Chittoor is also an intensive sericultural districts of Andhra Pradesh, less percentage of uzi infestation (Figure 5) is observed which is attributed to the best adoption of different integrated technology components IPM on uzi fly control (Vinayak Reddy, 2015).

Increase in uzi infestation from the onset of monsoon (from June) was ascribed to the changes in climatic conditions like increase in temperature, humidity rainfall (Kasi Reddy and Krishna Rao 2009; Kasi Reddy *et al*., 2009; Vinayak Reddy, 2015). Chakraborty *et al*. (1996) further extended the studies on uzi infestation correlating to the abiotic factors and reported that the uzi infestation on commercial cocoon crop is highly dependent on abiotic factors such as temperature, humidity and rainfall. Another probable reason put forth by Kasi Reddy and Krishna Rao (2009) and Kasi Reddy *et al*., (2009) was that the increase in uzi fly infestation during rainy season might be due to scarcity of its alternative hosts. They (Kasi Reddy and Krishna Rao, 2009; Kasi Reddy *et al*., 2009) discussed that at the onset of monsoon, most of 'kharif' crops get harvested and the availability of alternative host for uzi is questioned. Continuous silkworm rearing in the area attracts uzi fly and causes heavy loss to the silkworm cocoon crop. In such continuous silkworm rearing conditions, the uzi fly continues in those sericultural villages when the host, the silkworm larvae are readily and sufficiently available in the same village (Kasi Reddy and Krishna Rao, 2009; Kasi Reddy *et al*., 2009). Further, the uzi cannot travel more than 2 km of distance (Narayanaswami *et al*., 1994a).Thite*et al*. (2005) also reported that uzi infestation is low during November to February, gradually increased with rise in temperature, humidity and rainfall and high in June to August. The present results are in agreement with the results of Sathe and Jadhav (2001) and Vinayak Reddy (2015).

The uzi fly infestation on the commercial silkworm larvae is also reported to be dependent on adoption of integrated pest management packages (Kumar *et al*., 1993; Kasi Reddy *et al*., 2009; Kasi Reddy and Krishna Rao, 2009, Sakthivel *et al*., 2012; Gangadhar, *et al*., 2012; Priyadarshini and Vijaya Kumari, 2013; Sujatha *et al*., 2015a, b; Vinayak Reddy, 2015). Sujatha *et al*. (2015a) reported that the technology adoption levels in Chittoor District of Andhra Pradesh are on higher side compared to Anantapur District. The results are also endorsed by Priyadarshini and Vijaya Kumari (2013). However, such studies on the adoption of new sericulture technologies by the farmers of Kurnool District are not available. Low uzi fly infestation on the commercial silkworm larvae in Kurnool District can be attributed to the fact that the Kurnool District is an upcoming area in sericulture and the adoption levels will be high with fresh farmers rather than the traditional farmers.

Thus, the uzi fly infestation on the commercial silkworm cocoon crop is 1. high during rainy season followed by winter and summer seasons and 2. high in Anantapur District, followed by Kurnool and Chittoor (with no statistical differences in between, however).

REFERENCES

[1] Anonymous (1981) Uzi fly control (In Kannada), *Reshmekrishi*, **3:** 11.

[2] Chakraborty, N.; Bhattacharya, S. S.; Das, N. K.; Sen, S. K.; Pavan Kumar, T. (1996) Studies on incidence of uzi fly infestation on silkworm and assessment of cocoon crop loss in Murshidabad District. *Entomon*., **21(1):** 29-35.

[3] Channa Basavanna, G. P. (1992) Integrated management of the Uzi fly. Key note address delivered at *Nat. semi. On Uzi fly and its control*, January 16-17, 1992, Bangalore, pp 10.

[4] Datta, R. K. and Mukharjee, P. K. (1978) Life history of *Tricholyga bombycis* (Diptera: tachinidae), a parasite of *Bombyx mori* (Lepidoptera: Bombycidae), *Ann. ent. soc. America*, **71:** 767-770.

[5] Devaiah, M. C. and Patil, G. M. (1994) *Indian uzi and its management*. Lectures on Sericulture. Edt. G. Boraiah, p 97-101.

[6] Gangadhar, B.; Kumaresan, P.; Somaprakash, D. S. and Qadri, S. M. H. (2012) Adoption of biocontrol methods for the control of mealy bug and uzi fly in sericulture, *J. Biopest*., **5:** 199-201.

[7] Gangwar, S. K. and Thangavelu, K. (1989) Uzi fly infestation on young age silkworms of *Bombyx mori* L. in Tamil Nadu india. *Entomon*, **14(3-4):** 361-362.

[8] Huchesh, H. C. and Puttaraju, (2014) Overview of distribution and diversity of wolbachia endosymbiont among the different geographical population of Indian uzi fly *Exorista sorbillans* (Diptera: Tachinidae). *J. ent & zool. stidues*, **2(2):**119-124.

[9] Jameson, A. P. (1922) *Report on the Diseases of Silkworm in India* (New Delhi, India: International Books and Periodicals Supply Service), 165 pp.

[10] Jolly, M. S. (1981) *Uzi Fly, its Identification, Prevention and Control.* CSRTI Bulletin 4, Mysore, India, 4, 8.

[11] Jolly, M. S. (1987) *Appropriate sericultural techniques*. Int. cent. Trg. and Res. Trop. Seric., Mysore, pp176.

[12] Kasi Reddy, B. and Krishna Rao, J. V. (2009) Seasonal Occurrence and Control of Silkworm Diseases, Grasserie, Flacherie and Muscardine and Insect Pest, Uzi fly in Andhra Pradesh, India, *Int. J. Indust. Entomol*., **18(2):** 57-61.

[13] Kasi Reddy, B.; Kishore, S. and Reddy, P. S. (2009) Seasonal occurrence of silkworm diseases and pests in mulberry silkworms and their control measures in the districts of Anantapur and Chittoor, A. P., *Indian Journal of Comparative Animal Physiology*, **27(1):** 71-76.

[14] Kumar, P. (1987) Contribution to our knowledge on *Tricholyga bombycis* Beck. - a serious parasite of *Bombyx mori* L. and its control. Ph. D., thesis, University of Mysore, Mysore, India.

[15] Kumar, P.; Jolly, M. S.; Sinha, S. S.; Samson, M. V. and Rema Devi, O. K. (1987b) Physical control of uzi fly. *Tricholyga bombycis* Beck, and its impact on population. *Indian J. Seric.*, **26:** 5-7.

[16] Kumar, P.; Kishore, R. and Sengupta, K. (1990) Studies on the alternate host of uzi fly *Exorista sorbillans* (Diptera: Tachinidae). *Indian J. Seri*., **29:** 193-199.

[17] Kumar, P.; Manjunath, D.; Satya Prasad, K; Ram Kishore; Vinod Kumar and Datta, R. K. (1993) Integrated management of the uzi fly, *Exorista bombycis* (Louis) (Diptera: Tachinidae), a parasitoid of the silkworm, *Bombyx mori* L. *International Journal of Pest Management*, **39(4):** 445-448.

[18] Mukherjee, N. G. (1919) *Handbook of Sericulture*. BS Book Depot, Kolkata, India. p 296.

[19] Narayanaswamy, K. C.; Devaiah, M. C. and Govindan, R. (1994a) Ovipositional preference and biology of uzi fly, *Exorista bombysis* (Louis) on some races and hybrids of silkworm, *Bombyx mori* L., *Karnataka J. Agric. Sci*., **7(1):** 32-35.

[20] Priyadarshini, M. B. and Vijaya Kumari, N. (2013) A study on the knowledge and adoption level of improved sericulture practices by the farmers of Chittoor district, *International Journal of Agricultural Science and Research (IJASR)*, **3(2):** 43-46.

[21] Rajshekhargouda, R. and Devaiah, M. C. (1983) Occurrence of Uzi fly *Exorista sorbiollans* Wied. (Diptera: Tachinidae) in northern districts of Karnataka, *Nat. Sem. Silk. Res. Devp*, Bangalore, 113.

[22] Sathe T. V. and Jadhav, A. D. (2001) *Sericulture and pest management*. Daya public. House, New Delhi, pp 1-197.

[23] Sathe, T. V. and Desai, A. S. (2014) Economical and distributional status of uzi fly *Exorista sorbillans* Wied (Diptera: Tachinidae) in sericulture in India, *Indian Journal of Applied Research*, **4(8):** 10-13.

[24] Sengupta, K.; Kumar, P.; Baig, M. and Govindaiah (1990) Pests of mulberry silkworm and their control. In *Hand book of pests and disease control of mulberry and silkworm*, Economic and social commission for Asia and the pacific, United Nations, Bangkog, Thailand, pp. 67-77.

[25] Sakthivel, N.; Kumaresan1, P.; Qadri, S. M. H.; Ravikumar, J. and Balakrishna, R. (2012) Adoption of integrated pest management practices in sericulture – A case study in Tamil Nadu, *J. Biopest*, **5:** 212 – 215.

[26] Siddappaji, C. (1985) Bioecology and Management of the Indian Uzi fly, *Exorista sorbillans*(Wiedemann) (Diptera: Tachinidae) a parasite of mulberry silkworm. Ph.D. Thesis, University of Agricultural Sciences, Bangalore.

[27] Sujatha, B.; Lakshminarayana Reddy, P.; Babu, M. A. S.; Reddy, B. A.; Kumar, P. S. and Sankar Naik, S. (2015a) Socio-economic factors influencing the adoption levels of new sericulture technologies by different farming groups in Anantapur District of Andhra Pradesh, *Int. J. Agr. Ext*., **03(02):** 149-153.

[28] Sujatha, B.; Lakshminarayana Reddy, P.; Babu, M. A. S. and Sankar Naik, S. (2015b) Knowledge and adoption levels of organic farming in mulberry cultivation with the farmers of Chittoor District of Andhra Pradesh, *Journal of agricultural economics and sustainable development. Photon*, **104:** *170-174.*

[29] Thangavelu, K. and Sahu, A. K. (1986) Some studies on bionomics of *Exorista sorbillans* Wied. from North eastern India. *Sericologia*, **26:** 77-82.

[30] Thiate, S. H; Sathe, T. V.; Jadhav, A. D. and Kolekar, V. (2005) Incidence of Uzi fly in the silkworm *Bombyx mori* L. in Solapur district, Maharashtra. *Advances in Tropical Sericulture*, p. 389.

[31] Vinayak Reddy, B.; Lakshminarayana Reddy, P.; Shanthan Babu1, M. A.; Sujatha, B. and Sankar Naik, S. (2015) Egg laying patterns of the uzi fly, E*xorista sorbillans* (Wiedemann) on the larvae of the silkworm, B*ombyx mori* L., *G. J. B. B*., **4(1):** 175-180.

[32] Vinayak Reddy, B (2015) Infestation of uzi fly, *Exorista sorbillans* (Wiedemann) on the silkworm, *Bombyx mori* (L) cocoon crop in the Districts of Rayalaseema, Andhra Pradesh and its economical aspects, Ph. D., thesis, Sri Krishnadevaraya University, Anantapuramu.Andhra Pradesh, India.