GLOBAL JOURNAL OF BIO-SCIENCE AND BIOTECHNOLOGY

www.scienceandnature.org

LIFE TABLE OF *OLIGONYCHUS BIHARENSIS* (HIRST) (ACARI: TETRANYCHIDAE) – A PEST ON *VIGNA UNGUICULATA* (L.)WALP.

Sangeetha G Kaimal
Department of Zoology, Providence Women's College, Calicut – 673 009, Kerala, India.

ABSTRACT
Post embryonic development of *Oligonychus biharensis* (Hirst) was traced on cow pea in the laboratory at 30 ± 2°C & 70 ± 5% RH. Rearing of the life stages of the mite was carried out following leaf flotation technique. The life cycle of the species was found to comprise both sexual and parthenogenetic generations with slight variations in their respective durations. The respective durations of pre-oviposition period, oviposition period and post-oviposition period were found to be 1.5 days, 11.5 ± 0.75 days and 0.9 ± 0.25 day. Ovipositional rate of the species was observed to be 50.9 ± 4.7 eggs and 40.2 ± 1.4 eggs for mated and unmated females respectively. Total duration of sexual development and parthenogenetic development was observed to be 6.45 ± 0.05 days and 6.0 ± 0.07 days respectively. The sex ratio (male: female) was 1-2: 10.

KEY WORDS: *Oligonychus biharensis*, cow pea, oviposition, quiescence, sexual, parthenogenetic development.

INTRODUCTION

Oligonychus biharensis is a sporadic pest of vegetables, rose, camphor, litchi and many other plants of high importance. Feeding by this mite causes characteristic bronzing on leaves and severe damage to the host plant. Severe infestation and prolonged feeding results in crinkling, subsequent drying and defoliation of affected leaves. Attack by these mites normally affects the growth and vigour of host plants. *Vigna unguiculata* (L.) Walp. (Cow pea), the current host plant proved to be a potential host for the successful establishment of *O. biharensis* throughout the year. Cow pea is one of the most important tropical multi-purpose legumes with astonishing ability to fix atmospheric nitrogen through its root nodules thereby adding to soil fertility. *V. unguiculata* is cultivated for its seeds (shelled green or dried), pods, leaves that are consumed as green vegetables, grain, forage, hay, silage and green manure. The edible pods are 10-23 cm long with 10-15 seeds/pod. The seeds, pods and tender shoot apices are power houses of nutrients *viz.*, proteins, fats, carbohydrates, fibers, minerals (calcium, phosphorous, iron, sodium and potassium) and vitamins (A, B-thiamine, riboflavin, niacin and C) and are therefore a potential source of human nutrition. Cowpea seeds are believed to be medicinal to many tribes and are prescribed for treatment of sick children. Considering the nutritive value of the plant, ease of establishment and the infestation by dense populations of *O. biharensis* on it throughout the year, studies on the biology of the mite were initiated on cowpea.

MATERIALS & METHODS

Live cultures of *O. biharensis* were maintained on cow pea in the field to observe closely the mode of infestation, progressive damage symptoms induced on the host plant and also to make quantitative estimation of damage potential of the concerned species. To achieve this objective, two mite treatments (*i*) *M*–, mite free plants and (*ii*) *M*+, plants artificially infested with mites, were included in a randomized block design plots (3 m × 3 m) which was replicated four times within a season. Cultivation of host plants was done by planting stem cuttings of cow pea in enriched soils prepared for the study. The plots were irrigated regularly and the plants were made mite-free by spraying a broad-spectrum insecticide to eliminate mite pests and predators (Reddall *et al.*, 2004). Artificial infestations of *M*+ plants were done by stapling mite infested leaf bits grown in the glass house 60 days after planting. The plots were covered with fine nets to ensure protection from pest attack and to reduce the risk of cross infestation between *M*+ and *M*– plots.

Studies on the development of *O. biharensis* were initiated in the laboratory on fresh leaves of cow pea by leaf flotation technique (Sangeetha & Ramani, 2011) in an environmental growth chamber at 30 ± 2°C & 70 ± 5% relative humidity. Observations on various aspects of development were made regularly on each culture set at 6h intervals. Each culture set consisted of 2-4 leaf bits, kept in petri dishes lined with moistened cotton pads and was treated as an experimental unit. Stock cultures of the mites were also maintained in the laboratory in the same manner so as to ensure constant supply of life stages.

RESULTS & DISCUSSION

Post-embryonic developmental studies of *O. biharensis* disclosed the occurrence of a larval and 2 nymphal stage prior to attaining adulthood. Each instar was constituted by an active period followed by a quiescent period, which then moulted to successive stages of development. Adult male was slightly reddish-orange in colour with elongate orange legs and tapering hysterosoma. Sexually mature male was smaller than the female and moved very actively moving in search of quiescent female deutonymphs for copulation or engaged in feeding. Adult female was larger

than the male, red coloured with short orange legs and posteriorly rounded hysterosoma. Feeding was initiated soon after moulting and as feeding progressed, the colour changed to dark red. Ovipositing females of *O. biharensis* preferred areas close to the mid rib and major veins of the leaf though they showed no preference for the leaf surface. Such habit of laying eggs in secluded habitat may offer better chances of protection of eggs (Banu & ChannaBasavanna, 1972; Barrion & Corpuz-Raros, 1975; Sobha & Haq, 1999; Sangeetha & Ramani, 2007, 2011). Newly deposited eggs were orange coloured, spherical and shiny. The pre-oviposition period lasted for 1.5 days, oviposition period for 11.5 $\pm$ 0.75 days and post-oviposition period for 0.9 $\pm$ 0.25 day on cow pea leaves. The respective durations as recorded by Bonato *et al.* (1995a) on *O. gossypii* were 2.2$\pm$ 0.3 day, 8.3 $\pm$ 1.3 days and 0.5 $\pm$ 0.2 days. Fecundity showed an increase on successive days of oviposition, reaching the peak levels on the 4th or 5th day and a gradual decrease from the 6th day onwards under laboratory conditions. On cow pea fecundity averaged 45.55 $\pm$ 2.2 eggs when mated and virgin females laid 50.9 $\pm$ 4.7 eggs and 40.2 $\pm$ 1.4 eggs respectively. This was in support of the findings of Bonato *et al.* (1995a) on *O. gossypii*, Aponte & Mc Murtry (1997) on *O. perseae*, and Chen *et al.* (2005) on *O. biharensis*. However, fecundity of *O. biharensis* recorded by Ji *et al.* (2005) (71.6 eggs/female) were significantly much higher to that recorded in the present study. The life span of *O. biharensis* on cow pea was 10.1 $\pm$ 0.18 days. The mated females recorded comparatively shorter life span of 9.9 $\pm$ 0.3 days and virgin females lived longer (Bonato & Gutierrez, 1999) up to 10.3 $\pm$ 0.2 days. Bonato and Gutierrez (1996) also observed that unmated females of *O. gossypii* infesting cow pea lived longer than the mated ones. Mean longevity of 8.2 days was recorded for *O. gossypii* by Bonato *et al.*, (1995a), 8.88 $\pm$ 0.60 days for *O. coffeae* by Saha *et al.* (1999) and 19 $\pm$ 3.11 days for *O. biharensis* by Ji *et al.* (2005).

Increase in the size of the egg was a notable change, few hours before the hatching process was initiated. This was followed by slit formation and the separation of the egg case by the forceful movements of the emerging larva. The mouth parts and the first pair of legs protruded out of the egg shell in the beginning followed by the emergence of the last two pairs of legs. Soon after hatching the larva moved away in search of food. The hatching process was completed in about 10-12 minutes. This is in confirmation with the observations reported by earlier workers (Das & Das, 1967; Aponte & Mc Murtry, 1997).

Duration of developmental stages

Incubation period

The fresh orange coloured eggs turned brownish with age and the red eye spots clearly visible prior to hatching. Incubation period recorded was 2.66 $\pm$ 0.05 days. Ghoshal *et al.* (2006) and Sangeetha & Ramani (2007) reported 3.33 days on an average for the period on *T. neocaledonicus.*

Larval period

The newly emerged larva was hexapod, small, spherical and reddish orange in colour. Change in body colour was noted with progress in feeding to dark red with dark spots on the dorsal body surface. The larva exhibited random movements on both surfaces of the leaf actively sucking the leaf sap. On cow pea, the active larval life lasted for 0.88 $\pm$ 0.05 day. In *T. ludeni*, Mallik & ChannaBasavanna (1981) reported 32.5 hours, in *T. neocaledonicus* and Manjunatha & Puttaswamy, (1989) and Ghoshal *et al.*, (2006) reported 1 – 2.5 days and 3.33 $\pm$ 0.23 days respectively.

Protonymphal period

The protonymph was larger in size, reddish-orange coloured, octapod in nature with reddish-orange legs. Sexual dimorphism was apparent at this stage. Protonymph developed dark blotches on its dorsal surface with progress in feeding. The duration of active protonymphal period was 1.24 $\pm$ 0.02 days. Observations reported on mean protonymphal period of *T. ludeni* were 2.30 days (Puttaswamy & ChannaBasavanna, 1981) and 3.80 $\pm$ 0.17 days in *T. neocaledonicus* (Ghoshal *et al.*, 2006).

Deutonymphal period

The largest among the nymphal instars, the deutonymph was orange red coloured at the time of emergence. The colour later darkened with dark blotches on the dorsum. The hysterosoma of the male and female deutonymph showed marked differences which were tapering posteriorly in the former and rounded in the latter. The duration of deutonymphal period lasted for 1.45 $\pm$ 0.06 days. This observation is in conformity with the reports of Manjunatha & Puttaswamy (1989) and Sangeetha & Ramani (2007).

Quiescent Periods

A period of zero activity or quiescence was observed at the end of the active period of each developing stage, as observed in the case of other tetranychid species. The individual ceased all its visible life activities and became inactive. Selection of concealed or secluded areas especially near the petiole, mid rib or in between the leaf veins in order to settle down in quiescence was a notable feature. During quiescence, the body assumed oval shape, developed a pale white covering and retracted all its legs below its body with stylets in pierced state in the leaf tissues. At the end of quiescent phase, the cuticle turned transparent and developed a slit on the dorsal region preparing itself for the moulting process. The observation on the quiescence seemed to follow a common pattern as in other tetranychids as described by several authors. No significant change in the duration was recorded for the Ist, IInd and IIIrd quiescent stages of *O. biharensis* on cow pea and was completed in 0.55 day.

Moulting

Appearance of a dorsal slit marked the initiation of the process followed by widening of the slit towards either side. The division was complete and hence the moulting skins were observed as two separate pieces on the leaf surface. The individual released from the exuviae moved away from the site in order to resume its normal life activities. The entire process was completed in 15 minutes for all the quiescent stages of the mite.

Mating

During mating, the male placed its anterior pair of legs over the dorsum of quiescent female deutonymph and awaited the female's emergence. The process of moulting

was assisted by the male, helping the female to cast off its moulting skin. During the act of copulation, the male moved under the posterior ventral surface of the female, arching its opisthosomal part so as to bring its aedeagus in contact with the genital aperture of the female. These observations are in agreement with the behavioural activities observed in the case of *T. evansi* (Qureshi *et al.*, 1969), *P. citri* (Beavers & Hampton, 1971), *E. orientalis* (Banu & ChannaBasavanna, 1972), *T. urticae* (Penman & Cone, 1972), and *T. neocaledonicus* (Sangeetha & Ramani, 2008). Mating lasted for 2 minutes. A single male mated with several females, though females were receptive to a single male only (Banu & ChannaBasavanna, 1972).

Parthenogenesis and Sexual development

The female of *O. biharensis* exhibited sexual as well as parthenogenetic reproduction. As a rule, the progeny of fertilized females produced individuals of both the sexes in the ratio 3 males: 10 females whereas the progeny of unfertilized females produced males only (Manjunatha & Puttaswamy, 1989, Sangeetha & Ramani, 2007). Sex ratio therefore appeared to be female biased (Ghoshal *et al.*, 2006). The total durations recorded averaged 6.22 $\pm$ 0.06 days (Sexual - 6.45 $\pm$ 0.05 days & Parthenogenetic - 6.0 $\pm$ 0.07 days). This duration appeared to be on the lower side as compared to 13.50 $\pm$ 0.15 days in *T. neocaledonicus* (Ghoshal *et al.*,2006), 10.9 $\pm$ 0.15 days (Sangeetha & Ramani, 2007). Temperature exerted a significant effect on all developmental stages of the mite (Haque *et al.*, 2007, Sangeetha & Ramani, 2008).

The shorter developmental periods averaging 6 – 12 days enabled *O. biharensis* in successfully completing 3 – 5 generations per month and attain pest status. The temperature of 30°C proved to be most favoured by the mite because of the minimum time taken to complete the life cycle and high fecundity of both fertilized and unfertilized females (Gupta *et al*. 1974, Congdon & Logan. 1983, Bonato *et al.*, 1995a, Sangeetha & Ramani, 2011). Confirmation of this combination identified during drier and hotter months of the year in Kerala through field studies also revealed peak levels of infestation of *O. biharensis* on cow pea plants. Being one of the most valuable crops of our nutritional concern, this has to be considered seriously, as this major mite pest if not controlled would definitely cause heavy yield loss, branch die back and even death of the plant. A cognitive aspect that emerged from this study was the occurrence of the mite on cow pea, a so far unrecorded host for the species.

ACKNOWLEDGEMENTS

I am grateful to Dr. N. Ramani, Professor and Head, Department of Zoology, University of Calicut for her valuable suggestions, moral support and constant encouragement. Thanks are also due to Providence Women's College, Calicut for providing research facilities.

REFERENCES

Aponte, O. and Mc Murtry, J. A. (1997) Biology, life table and mating behaviour of *Oligonychus perseae* (Acari: Tetranychidae). *Intl. J. Acar.*, **23**(3), 199-207.

Banu, K. and ChannaBasavanna, G. P. (1972) Plant feeding mites of India I. A preliminary account of the biology of the spider mite *Eutetranychus orientalis* (Klein) (Acari: Tetranychidae). *Mysore J. Agri. Sci*., **6**(3), 253-268.

Barrion, A. T. and Corpuz-Raros, L. A. (1975) Studies on citrus mites (Acarina) : Biology of *Eotetranychus cendanai* Rimando (Tetranychidae) and population trends in *Brevipalpus obovatus* Donnadieu (Tenuipalpidae). *The Phillipine Entomol.*, **3**(1), 30-45.

Beavers, J. B. and Hampton, R. B. (1971) Growth, development and mating behaviour of the citrus red mite (Acari: Tetranychidae). *Ann. Entomol. Soc. Amer.*, **64**, 804-806.

Bonato, O. and Gutierrez, J. (1996) Reproductive strategy of two major mite pests (Acari: Tetranychidae) on cow pea in Africa. *Ann. Entomol. Soc. Amer*., **89**(5), 676-680.

Bonato, O. and Gutierrez, J. (1999) Effect of mating status on the fecundity and longevity of 4 spider mite species (Acari: Tetranychidae). *Expt. Appl. Acarol*., **23**(8), 623-632.

Bonato, O., Baumgartner, J. and Gutierrez, J. (1995a) Comparison of biological and demographic parameters for *Mononychellus progresivus* and *Oligonychus gossypii* on cow pea: influence of temperature. *Entomol. Experimentalis Appl.*, **75**, 119-125.

Bonato, O., Divassa, M. S. and Gutierrez, J. (1995b) Influence of relative humidity on life-history parameters of *Mononychellus progresivus* and *Oligonychus gossypii* (Acari: Tetranychidae). *Environ. Entomol*., **24**(4), 841-845.

Chen, W., Fu, Y., Zhang, F. and Peng, Z. (2005) Effect of different varieties of litchi on the development and reproduction of *Oligonychus biharensis* (Hirst). *Syst. Appl. Acarol*. **10,** 11-16.

Congdon, B. D. and Logan, J. A. (1983) Temperature effects on development and fecundity of *Oligonychus pratensis* (Acari: Tetranychidae). *Environ. Entomol.*, **12,** 359-362.

Das, G. M. and Das, S. C. (1967) Effect of temperature and humidity on the development of tea spider mite, *Oligonychus coffeae* (Nietner). *Bull. Entomol. Res*., **57**(3), 433-436.

Ghoshal, S., Gupta, S. K. and Mukherjee, B. (2006) Life cycle of *Tetranychus neocaledonicus* Andre on *Rhizophora mucronata* Lamk, under laboratory condition at controlled temperature. *Rec. zool. Surv. India*, **106**(2), 61-65.

Gupta, S. K., Dhooria, M S. and Sidhu, A. S. (1974) Effect of food and temperature on the development, longevity and fecundity of sugarcane red spider mite *Oligonychus indicus* (Hirst). *Acarol*., **16**(3), 436-440.

Haque, M., Wahab, A., Naher, N. and Begum, A. (2007) Developmental stages of the red spider mite, *Oligonychus coffeae* Neitner (Acari: Tetranychidae) infesting rose. *Univ. J. Zool*. Rajshahi Univ., **26,** 71-72.

Ji, J., Zhang, Y. X., Chen, X. and Lin, J. Z. (2005) Laboratory population life table of *Oligonychus biharensis* (Hirst) (Acari: Tetranychidae) at different temperatures. *Acta. Arachnol. Sinica*., **14**(1), 37-41.

Mallik, B. and Channabasavanna, G. P. (1981) Life history and life tables of *Tetranychus ludeni* and its predator *Amblyseius longispinosus* (Acari: Tetranychidae; Phytoseiidae). *Indian J. Acar*., **8,** 1-12.

Manjunatha, M. and Puttaswamy (1989) Life history of *Tetranychus neocaledonicus* under green house conditions. *J. Acar.*, **11**(1 & 2), 35-40.

Penman, D. R. and Cone, W. W. (1972) Behaviour of male two spotted spider mites in response to quiescent femaledeutonymphs and to web. *Ann. Entomol. Soc. Amer*., **65,** 1289-1293.

Puttaswamy and Channabasavanna, G. P. (1981) Influence of weather factors and predators on the populations of the spider mite *Tetranychus ludeni* (Acari: Tetranychidae). *Indian J. Acar*., **5**, 69-79.

Qureshi, A. H., Oatman, E. R. and Fleschner, C. A. (1969) Biology of the spider mite, *Tetranychus evansi* Pritchard and Baker. *Ann. Entomol. Soc. Amer.*, **62**, 898-903.

Reddall, A.., Sadras, V..O.., Wilson, L. .J. and Gregg, P.C. (2004) Physiological responses of cotton to two-spotted spider mite damage. *Crop Science*, **44,** 835-846.

Saha, K., Dey, P. K., Somchoudhury, A. K. and Sarkar, P. K. (1999) Effect of temperature and relative humidity on the rate of development, longevity and fecundity of the red spider mite *Oligonychus coffeae*. *Indian J. Acar*., **15**(1 & 2), 84-88.

Sangeetha, G. K. and Ramani, N. (2007) Biological studies of *Tetranychus neocaledonicus* Andre (Acari: Tetranychidae) infesting *Moringa oleifera* Lam., *Bull. Pure Appl. Sci*., **26A** (2), 51-57.

Sangeetha, G. K. and Ramani, N. (2008) Effect of temperature and relative humidity on oviposition and fecundity of *Tetranychus neocaledonicus* Andre (Acari: Tetranychidae) – a pest of *Moringa oleifera* Lam. *J. Exp. Zool. India*, **11**(2), 279-282.

Sangeetha, G. K. and Ramani, N. (2011) Biology of *Oligonychus biharensis* (Hirst) (Acari: Tetranychidae) on cassava. *J. Exp. Zool. India*, **14**(1), 27- 30.

Sobha, T. R. and Haq, M. A. (1999) Incidence of *Tetranychus neocaledonicus* (Acari: Tetranychidae) on *Dolichos lablab*. *J. Acarol.,* **14**(1&2), 73-76.