*Tropical Agricultural Research & Extension* 15(1): 2012

# INFLUENCE OF HUMIDITY AND TRIBOLIUM BEETLE FOOD SOUCE ON THE LIFE HISTORY CHARACTERISTICS OF PREDATOR, *XYLOCORIS FLAVIPES* (HEMIPTERA: ANTHOCORIDAE)

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*Accepted: 26 September 2011*

ABSTRACT

**Life history characteristics of the predator, *Xylocoris flavipes* reared under four regimes of RH (30, 50, 70 and 90%) on two hosts, *Tribolium castaneum* and *T. confusum* fed on three artificial diets, were studied. There were significant effects (P<0.001) of relative humidity on the oviposition period, fecundity, hatchability, developmental time, percentage mortality of immature stages and progeny/ female of the predator on both the hosts. Most of the cases the optimum level of relative humidity was recorded at 70%.**

***Key words:*** Humidity, Tribolium beetle, *Xylocoris flavipes*

## INTRODUCTION

Humidity regulates the life cycle of organisms (Andrewartha and Birch 1954), and is usually one of the most important abiotic factors affecting the population dynamics of insects in storage (Sinha 1973, Flinn and Hagstrum 1990). There are many reports available on the impact of climatic factors on the life history characteristics of insects by early workers (Binch 1945, Messenger 1968, Flinn 1991, Monge *et al*, 1995, Legna *et al*. 1991, Smith 1994, Monge *et al*. 1995 and Ouedraogo *et al*. 1996).

The effects of RH are generally estimably connected with the moisture content of the stored commodities, which essentially regulates eclosion of the pupa and expansion of the adult wings of the insects present at that niche. Hinton (1981) stated that in most insects at normal temperature, there is fairly restricted range of humidity when most eggs will be laid, humidity above or below this optimum range tend to have an adverse effect on oviposition behaviour of the insects. Food is another major factor which influences the normal population growth of the storage insects.

*Xylocoris flavipes* is associated with the stored -product insect pests in the same niche as predators. So, humidity, temperature and health quality of the prey insects govern over the growth and development of this predator.

The present paper explains the effect of a range of RH and different host (prey insect) diets and host (prey insect) species on the oviposition period and fecundity of female, hatchability of eggs, mortality of immatures, developmental time and progeny production of *X. flavipes* under the laboratory conditions.

## MATERIALS AND METHODS

**Insects used:** *X. flavipes* was used as the target insect. The prey insects were *Tribolium castaneum* and *T. confusum*.
**Host diets:** The *Tribolium* beetles were reared on three artificial diets; yeast, agar and folic acid (Kiji Brand, China) along with a control diet (whole wheat flour). The artificial host diets were mixed with the wheat flour in a ratio of 1:9, 1:9 and 0.3:9.7 respectively. These diets were grouped as I. Yeast+Flour, II. Agar+Flour, III. Folic Acid+Flour and IV. Flour (control).
**Food of the predator:** The 1st instar larvae and pupae of hosts were provided as food for *X. flavipes*.
**Experimentation:** The humidity was controlled according to Buxton and Mellanby (1934). Adults of predator (*X. flavipes*) and hosts (*T. castaneum* and *T. confusum*) were collected from the stock cultures and kept separately in three beakers. The predator was provided with *Tribolium* larvae and standard food for the beetles as their foods.
Eggs of *X. flavipes* were collected and reared

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separately on the larvae of two hosts (prey species) until adult emergence. After emergence eight healthy and mated female *X. flavipes* were taken and placed in individual 50ml glass beakers. These eight beakers were then grouped into two each containing four beakers. In each of the four beakers of one group, 15 1st instar larvae (2-3d old) of *T. castaneum* were introduced. These larvae were taken from the four rearing stocks of different (three) artificial diets and the control diet. So, that female predator of each of the beaker was supplied with host larvae which were reared on one of the artificial diet and control food. Similarly, each of the other group of four beakers was supplied with 15 1st instar larvae (2-3d old) of *T. confusum* reared on different diets. Mouth of each beaker was covered with fine cloth and rubber band to restrict escape of the insects.

These beakers were then kept in desiccators at 30% RH for 24h for allowing egg lying of the female predator. After 24h the females were replaced in separate beakers with host larvae rearing with different diets, for further egg laying and kept at same relative humidity. This procedure was maintained until the death of the female predator.

Similarly, separate experiments were carried out at 50, 70 and 90% RH in desiccators. For each host and artificial diet at each relative humidity level, 15 replications were made. These experiments were carried out at 30±1°C at CT room. From the experiments the following parameters were recorded for *X. flavipes* reared on different diet (prey species) and at different humidity levels.

1. Oviposition period of the female *X. flavipes*
2. Fecundity the female predators
3. Fertility of the predator's eggs
4. Egg to adult developmental time
5. Mortality of immature stages of *X. flavipes*
6. Progeny production of the adult *X. flavipes*

## RESULTS AND DISCUSSION

**Oviposition period:** The relationship between different supplement foods and oviposition period of *X. flavipes* reared on *T. castaneum* and *T. confusum* at different humidity varied remarkably (Figure 1) and it was significant (P<0.001) (Table 1). The longest oviposition period of the female predators feeding on *T. castaneum* was 18.07±0.18 at 70% RH reared on diet II, and the shortest was 5.53±0.49 at 90% RH reared on diet IV. The longest and the shortest oviposition periods of *X. flavipes* while feeding on *T. confusum* was 17.87±0.17 days at 70% RH and 5.07±0.15 days at 30% RH, when the diets were II and IV respectively (Figure 2). The optimum RH for longer oviposition time was recorded as 70% for all diets and on both host species.

**Fecundity:** It was found that *X. flavipes* reared on *T. castaneum* or *T. confusum* feeding on different artificial diets produced higher number of eggs than when the hosts were reared on control food irrespective of four RH (Figures 3 and 4). The relationships indicate that food supplements to the prey enhanced egg production in *X. flavipes.* Maximum number of eggs laid by a female on *T. castaneum* (40.13±0.19) reared on diet II and on *T. confusum* (38.87±0.22) at 70% RH. Minimum number of eggs was obtained when the predator preyed on both of the species which were fed on control diet. Both diets and RH levels, significantly (P<0.001) increased egg

**Table 1: F-values and level of significance calculated for different life history parameters of *X. flavipes* reared on artificial-diet fed *T. castaneum* and *T. confusum***

| Parameters | Factors | *T. castaneum* | *T. confusum* |
|---|---|---|---|
| Oviposition period (day) | Diet | 5.7315, P<0.001 | 787.71, P<0.001 |
| | RH | 1162.27, P<0.001 | 1566.92, P<0.001 |
| | Diet x RH | 50.04, P<0.001 | 71.44, P<0.001 |
| Fecundity (No. eggs) | Diet | 9539.35, P<0.001 | 8719.19, P<0.001 |
| | RH | 1703.53, P<0.001 | 1458.96, P<0.001 |
| | Diet x RH | 90.21, P<0.001 | 75.61, P<0.001 |
| Hatchability of eggs (No) | Diet | 8219.25, P<0.001 | 6957.32, P<0.001 |
| | RH | 4858.21, P<0.001 | 4190.32, P<0.001 |
| | Diet x RH | 467.98, P<0.001 | 394.85, P<0.001 |
| Dev. time (day) | Diet | 184.68, P<0.001 | 176.56, P<0.001 |
| | RH | 356.94, P<0.001 | 292.42, P<0.001 |
| | Diet x RH | 2.28, NS | 5.03, P<0.1 |
| Mortality of immature stages (%) | Diet | 23.47, P<0.001 | 8.68, P<0.1 |
| | RH | 1314.08, P<0.001 | 604.94, P<0.001 |
| | Diet x RH | 2.87, NS | 3.34, P<0.1 |
| $F_1$ progeny/ female | Diet | 1905.97, P<0.001 | 1212.62, P<0.001 |
| | RH | 4150.94, P<0.001 | 2736.71, P<0.001 |
| | Diet x RH | 156.96, P<0.001 | 106.51, P<0.001 |

production (Table 1).

**Hatchability:** The maximum and minimum percentages of hatchability of *X. flavipes* eggs on *T. castaneum* were recorded as 36.47±0.22 (reared on diet II) and 8.27±0.15 (reared on diet IV) at 70% and 30% relative humidity respectively (Figures 5 and 6). The maximum and minimum percentages hatchability of eggs of the predator on *T. confusum* was 36.20±0.26 and 7.60±0.19 when reared on diet II and IV. The diet III (folic acid+flour) was found to be ineffective in increasing the egg hatchability of the predator. Humidity and diets played significant role in completing embryogenesis and hatching mechanism of the eggs laid by the predator (Table 1).

**Developmental Time:** Mean development time from egg to adult emergence of *X. flavipes* at different humidity levels took minimum 11.13±0.13 days when *T. castaneum* fed on diet II at 70% RH but maximum was 16.40±0.13 days fed on diet IV and 16.53±10.17 days on diet II at 30% RH. Humidity levels affected the developmental time significantly (Table 1). The relationships between the humidity and the developmental time of *X. flavipes* are shown in Figures 7 and 8.

**Mortality (%) among immature stages:** Minimum percentage of mortality (25.74±0.79) of the immature stages of *X. flavipes* was observed when they were reared on *T. castaneum* and (25.88±1.05) on *T. confusum* on diet II at 70%RH. Mortality was inversely related with the relative humidity irrespective of diets and host species (Figures 9 and 10). Mortality (%) of *X. flavipes* differed significantly (Table 1).

**Progeny/female predator:** Minimum number of $F_1$ progeny production on two hosts differed

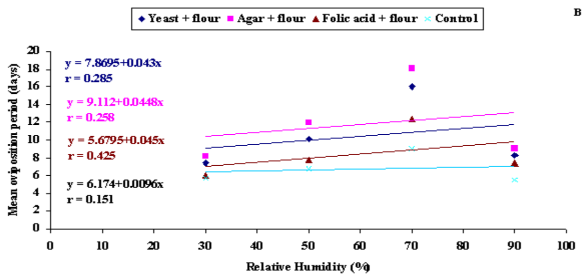


**Figure 1. Oviposition period of *X. flavipes* feeding on *T. castaneum* at different relative humidity (%).**

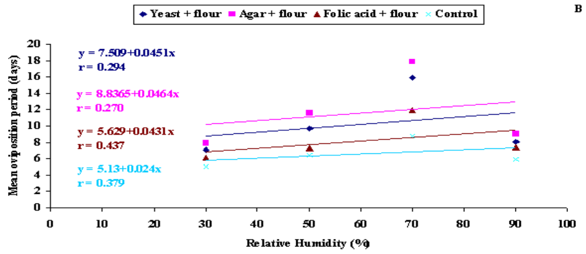


**Figure 2. Oviposition period of *X. flavipes* feeding on *T. confusum* at different relative humidity (%).**

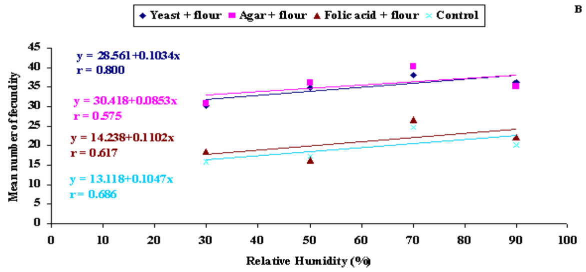


**Figure 3. Fecundity of *X. flavipes* feeding on *T. castaneum* at different relative humidity (%).**

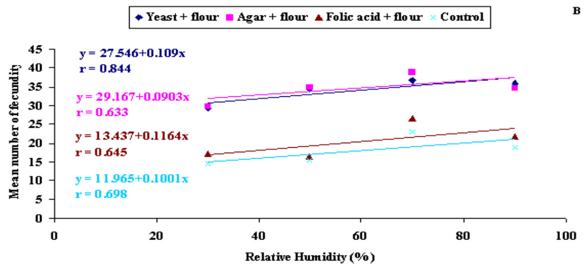


**Figure 4: Fecundity of *X. flavipes* feeding on *T. confusum* at different relative humidity (%).**

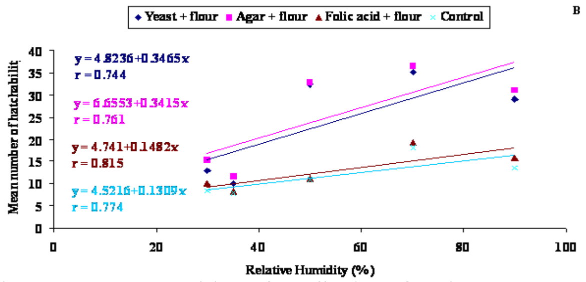


**Figure 5. Hatchability of *X. flavipes* feeding on *T. castaneum* at different relative humidity (%) level.**

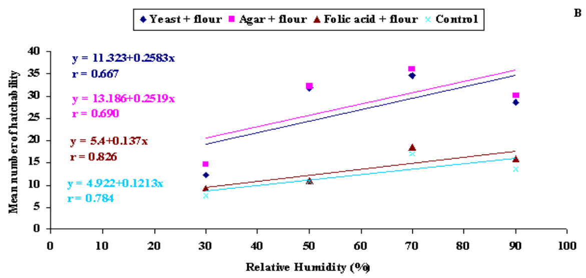


**Figure 6. Hatchability of *X. flavipes* feeding on *T. confusum* at different relative humidity (%) level.**

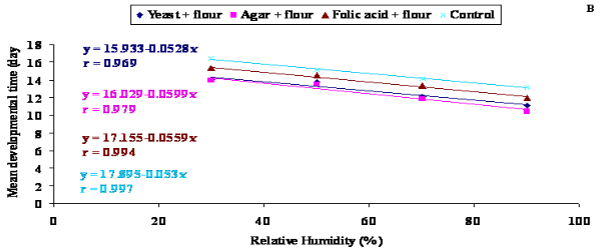


**Figure 7. Mean developmental time (day) of *X. flavipes* feeding on *T. castaneum* at different relative humidity (%).**

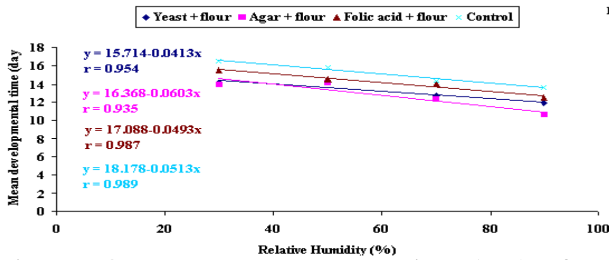


**Figure 8. Mean developmental time (day) of *X. flavipes* feeding on *T. confusum* at different relative humidity (%).**

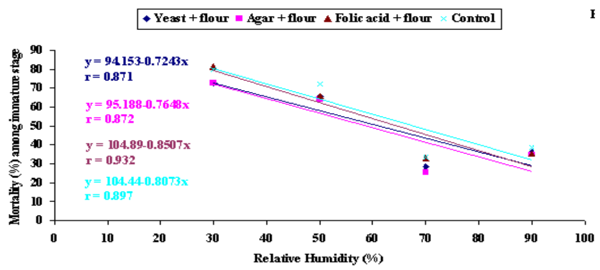


**Figure 9. Mortality (%) among immature stage of *X. flavipes* feeding on *T. castaneum* at different relative humidity (%).**

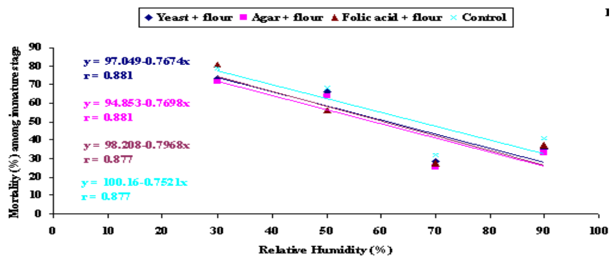


**Figure 10.Mortality (%) among immature stage of *X. flavipes* feeding on *T. confusum* at different relative humidity (%)**

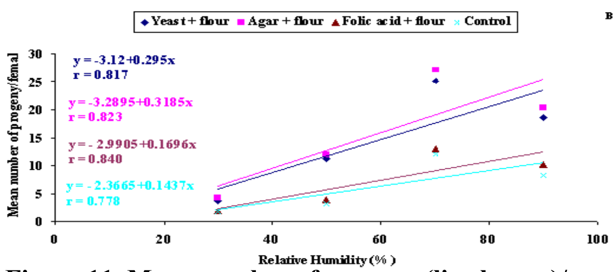


**Figure 11. Mean number of progeny (live larvae)/ female of *X. flavipes* feeding on *T. castaneum* at different relative humidity (%).**

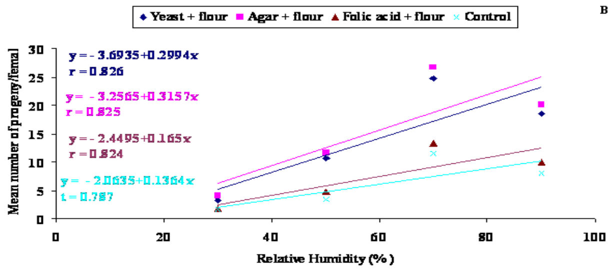


**Figure 12. Mean number of progeny/female of *X. flavipes* feeding and *T. confusum* at different relative humidity (%).**

significantly (P<0.001) in relation to different foods (Table 1). The most effective food supplement was diet II, which enhanced offspring production in *X. flavipes* on both hosts, and diet IV was least effective in progeny production of the predator. The maximum number of progeny produced on *T. castaneum* reared on diet II was as 27.07±0.25 at 70% RH, and there were no significant differences of progeny production in between diets III and IV, at any level of humidity (Table 1, Figures 11 and 12).

From the present investigation, it is evident that the population of the predator, *X. flavipes* feeding on *T. castaneum* and *T. confusum* has an optimum level of relative humidity at which the progeny production was the maximum at a minimum developmental time at a constant temperature (30±1°C). This result has an importance in mass culture technique for the production of *X. flavipes* when used as a biological control measure in the stores.

The results revealed that life history characters of *X. flavipes* were optimized at 70% RH irrespective of host species and host's diet types. RH at high (96-98%) and low (33.35%) levels have been reported to shorten the egg laying period of the female *X. flavipes* (Arbogast 1975). In the present experiment, oviposition period was only about five days at both highest (90%) and lowest (30%) levels of RH, irrespective of the host species and their diet type. Longer oviposition period of *X. flavipes* was recorded when the hosts were reared on the diet II (agar+flour) at 70% RH.
Fecundity (total eggs laid) by the predator was adversely affected by low and high RH. The mean number of eggs laid by a single female *X. flavipes* in her life time ranged from 38-40 when reared on *Tribolium* host feeding on diet

II at 70% RH. Whereas, when the predator was reared on *Plodia interpunctella,* its fecundity adversely affected by high RH (Arbogast 1975).
Diet II increased the egg hatchability of the predator on both hosts. However, maximum (%) hatching at 70% RH, but the minimum (%) hatching was at 30% RH when the two hosts were reared on diet IV. The hatching (%) was positively related with the RH when the predator was reared on either of two host species. Parajulee *et al*. (1995) reported that the eclosion rate of *Lyctocoris campestris* (Hemiptera: Anthocoridae) at 43% RH was slightly lowered (70-79%) than at 58 and 75% RH.

Developmental time of the predator was not significantly affected by host diets but was negatively related with the humidity. Mortality (%) among the immature stages of the predator on *T. castaneum* or *T. confusum* was highest at 30% RH, when the two hosts were reared on diet III. Mortality (%) was related with the increase of humidity and on diet II. Arbogast *et al*. (1975) reported that the mortality (%) among immature stages of *X. flavipes* become relatively high at 35 and 96% RH.

It was also observed that the total progeny production was linearly increased with the increase RH from 30-70%, but it decreased at 90%. There were significant differences between RH in progeny production. Okamoto (1972) observed maximum number of progeny of *Anisopteromalus calandrae* emerged from the host, *Callosobruchus chinensis* at 70% RH, which supports the present findings. Cave and Gaylor (1988) noted that in *Telenomus reynoldsi* (Hymenoptera: Scelionidae) development and progeny emergence were higher at 75% RH at a temperature of 28°C. These results are more or less similar to the present findings.

Maintenance of optimum RH and temperature is essential for mass production of *X. flavipes.* The results indicated that temperature around 30°C and 70% RH enhance population build up of this predator while feeding on *Tribolium* larvae. However, host larval diet also play significant role in the culture of *X. flavipes* along with the physical factors of the laboratory.

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