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An Age-Stage, Two-Sex Life Table for *Megalurothrips usitatus* Feeding on Eight Different Crop Plants

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Abstract: *Megalurothrips usitatus* (Bagnall) feeds on the young tissues of plants, causing wilting and deformity of leaves as well as damage to flowers and fruits, thereby seriously affecting plant yield. Due to its small size and difficulty of control, the species is one of the most important pests in the legume family. To clarify the occurrence and damage pattern of *M. usitatus* on field crops, a study was conducted using eight different crops as experimental materials, and an age-stage, two-sex life table was constructed. The population density of *M. usitatus* was the highest on cowpeas (*Vigna unguiculata* L. Walp.), followed by green beans (*Phaseolus vulgaris* L.) and *Vigna cylindrica* (*Vigna unguiculata* subsp. *cylindrica* (L.) Verdc.) in terms of net reproductive rate and the intrinsic rate of increase. In terms of reproductive capacity, cowpeas and *V. cylindrica* were more suitable for *M. usitatus* growth and reproduction, followed by green beans. *M. usitatus* could develop into adults on courgettes (*Cucurbita pepo* L.), wax gourds (*Benincasa hispida* Thunb. Cogn.), *Momordica charantia* (*Momordica charantia* L.), and soybeans (*Glycine* max L. Merr.) but had difficulty reproducing on those plants. Cucumber (*Cucumis sativus* L.) was the least suitable for the survival of *M. usitatus*. Population parameter analysis showed that the cowpea was the most suitable host plant for *M. usitatus*, followed by green beans and *V. cylindrica*. *M. usitatus* had difficulty reproducing on courgette, wax gourd, *M. charantia*, and soybeans, and feeding on cucumbers inhibited *M. usitatus* development and reproduction.

Keywords: *Megalurothrips usitatus* (Bagnall); survival; population dynamics; male and female lifespan table

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1. Introduction

The thrips *Megalurothrips usitatus* is an omnivorous pest that harms plants by feeding on the sap of young plants with their unique file-and-sucking mouthparts. Currently, these thrips have been reported to feed on 28 species of host plants, 16 of which are legumes [1]. In Asia, *M. usitatus* is a major pest of cultivated cowpeas [2–6]. To cope with the threat of *M. usitatus*, farmers use chemical pesticides that can seriously affect food safety [7]. This is also the main reason for excessive pesticide residues in cowpeas, the most notable example being the 2010 poisoned cowpea incident in Hainan [8–10].

A life table is a biological model that describes the entire process of growth, development, reproduction, and death of a species. Life tables can accurately analyze the impact of changes in a single external factor on the dynamics, life cycle, and reproductive ability of insect populations [11]. In recent years, age-stage, two-sex life tables have played crucial roles in population ecology and pest management and have been widely used in the formation of insect life tables [12,13]. Abbes et al. [14] analyzed the adaptability of *Phenacoccus solenopsis* in three solanaceous host plants using age-stage, two-sex life tables, and found that tomatoes, potatoes, and eggplants were all suitable hosts for this pest. Park et al. [15] used life tables to analyze the population characteristics of *Gaeolaelaps aculeifer* and *Stratiolaelaps scimitus* (Acari: Laelapidae), providing important information for the practical application of predatory soil mites in controlling agricultural pests. Keerthi et al. [16] studied the biological potential of *Plutella xylostella* (L.) on cruciferous plants by using age-stage, two-sex life tables. The results showed that broccoli > mustard > cauliflower > knol khol > cabbage. Farhadi et al. [17] found that compared with female-specific age-specific life tables, the use of age-stage, two-sex life tables can accurately describe the survival, development, and predation capabilities of predators.

To better understand the growth and reproduction of *M. usitatus*, this study used eight species of indigenous crops in Guangxi Province to develop an age-stage, two-sex life table. Understanding the growth, development, reproductive potential, and population dynamics of *M. usitatus* on different crops is of theoretical and practical significance for the formulation of effective control strategies for the pest population. Moreover, the research also provides a scientific basis for agricultural production and pest management.

2. Materials and Methods

2.1. Materials

2.1.1. Test Insects

Thrips were harvested from cowpea fields in Beihai, Guangxi and cultured to produce an F1 generation by feeding with cowpea. The feeding conditions were as follows: temperature (28 ± 2) °C, relative humidity 65% ± 5%, and photoperiod 14 L:10 D.

2.1.2. Test Plants

Eight common plant species (cowpea (*Vigna unguiculata* L. Walp.), courgetti (*Cucurbita pepo* L.), green beans (*Phaseolus vulgaris* L.), wax gourd (*Benincasa hispida* Thunb. Cogn.), *M. charantia* (*Momordica charantia* L.), soybean (*Glycine* max L. Merr.), *V. cylindrica* (*Vigna unguiculata* subsp. *cylindrica* (L.) Verdc.), and cucumber (*Cucumis sativus* L.)) were selected and sown in seedling trays/nutrient soil, the leaves were harvested for the experiments. The seeds of eight plants were purchased from the Guinongke Seedlings Shop in Nanning, Guangxi Zhuang Autonomous Region. The seedlings of the eight plants were free from insect pests and plant viruses. When the seedlings of the eight plant species had grown to the stage of 4 to 6 true leaves, the fresh leaves of true leaves were harvested for the experiment. The eight species of plant fruits used in the experiment were purchased from the vegetable market of the Guangxi Academy of Agricultural Sciences.

2.2. Methods

In this experiment, 5-mL centrifuge tube lids were punched and sealed with 250 mesh gauze to maintain air permeability according to the method of Yuan J J et al. [18] with several modifications. One milliliter of agar at a concentration of 2.5% was poured into a centrifuge tube to produce a smooth plane. The leaves of the experimental plants were cut into leaf discs (diameter: 1 cm) and placed on the agar inside the centrifuge tube. A large number of (about 3500) male and female thrips of the F1 generation were placed into fresh cowpea pods for 12 h and allowed to lay eggs. The eggs hatched into the first instar after 2.5 days, and thus the egg stage was recorded as 2.5 days. Using a small brush, the first instar was placed in the leaf trays for individual rearing. The number of experimental larvae was 450, comprising 100 reared on cowpea leaves and 50 reared on each of the other plant species. The leaves were replaced with fresh leaves at 8:00 and 20:00 every day, and the growth (the age of thrips at 8:00 and 20:00 was recorded, like first instar larva/second instar larva/Prepupa duration/Pupa duration/adult.) and survival of the larvae in the pre-adult stages were recorded. The replaced fresh leaves are the tender parts of the true leaves picked at 7:50 and 19:50 every day, twice a day. We recorded the age of the thrips while changing the leaves. When the thrips had developed into adults, the males and females were paired. The individually reared adults were then transferred to agar-free centrifuge tubes, where fresh plant fruits were provided for the thrips to survive and reproduce. One female and one male thrip were assigned to each centrifuge tube. Fresh plant fruits (bought from the vegetable market every day, cleaned and put in the refrigerator at 4 °C for freshness) were replaced at 8:00 and 20:00 every day, and adult survival was recorded. Females that could not be paired were supplemented with males. The fecundity of the F1 generation adults was expressed by the hatching of the F2 generation into the first instar.

2.3. Data Processing

Data on the developmental duration, survival, and oviposition of thrips at each age were analyzed by univariate analysis of variance using IBM SPSS Statistics 26. Multiple comparisons were performed using the Minimal Difference Significant (LSD) method, and the significance level was set to 0.05. The basic parameters of thrips' life history life tables were analyzed by TWOSEX-MSChart 2022 [19,20]. The software calculates the age-stage specific survival rate (S_{xj}), age-specific survival rate (l_x, $l_x = \sum_{j=1}^{k} S_{xj}$), age-stage fecundity ($f_{xj}$), age-specific fecundity (m_x, $m_x = \frac{\sum_{j=1}^{k} S_{xj} f_{xj}}{\sum_{j=1}^{k} S_{xj}}$), age-specific fecundity of the population ($l_x m_x$), the intrinsic rate of increase (r, $\sum_{x=0}^{\infty} e^{-r(x+1)} l_x m_x = 1$), the finite rate of increase (λ, $\lambda = e^r$), the net reproductive rate (R_0, $R_0 = \sum_{x=0}^{\infty} l_x m_x$), and the mean generation time (T, $T = \frac{(\ln R_0)}{r}$). Here, l_x refers to the probability of a population developing from stage j ($j = 1$, egg) to age x, with k being the number of experiments. S_{xj} represents the probability of an initially laid egg surviving to age x and developing to stage j. m_x is the average number of eggs laid by the population at age x. f_{xj} denotes the number of eggs laid by a female adult individual at age x. r is the maximum instantaneous growth rate of a population with a stable age structure under given physical and biological conditions. $l_x m_x$ represents the net fecundity of the thrips population at age x. λ indicates the average number of offspring that each individual in the population can produce without resource constraints. R_0 is the multiplication factor of the insect population after one generation under certain conditions. T is the average time required from one generation to the next. The means and standard errors of the various group parameters were calculated by the bootstrap method in TWOSEX-MSchart (bootstrap with 100,000 replicates). Finally, OriginPro 2023 software was used for mapping.

3. Results

3.1. M. usitatus Growth and Development on Eight Crop Species

The results (Table 1) showed that the factors affecting the duration of thrips larvae, pupae, and adults showed different patterns when feeding on the various host plants. The first instar of *M. usitatus* had the shortest development time when fed on soybean and the longest development time when fed on wax gourd. The second instar fed on *V. cylindrica* developed the fastest, 2.5 times that of the slowest growth rate on courgette. During the prepupal stage, feeding on different plants had little effect on the development time of the thrips. When feeding on courgette, the duration of the pupal stage of *M. usitatus* was the lowest (1.26 days), while that of the group fed on *M. charantia* was the longest (1.90 days). Under a rearing temperature of 28 °C, the development time of *M. usitatus* was the shortest (8.91 days) when the thrips were fed on soybeans, but it was slightly longer for the groups fed on the other crops. When fed green beans, *M. charantia*, *V. cylindrica*, and cowpeas, the mean development times were 9.48, 9.51, 9.51, and 9.87 days, respectively. However, the thrips had significantly longer development times when fed on courgettes and wax gourds, at 12.23 days and 13.12 days, respectively. It is noteworthy that the larvae of *M. usitatus* did not successfully develop on cucumbers.

Soybean was the food associated with the shortest development time, and wax gourd was the crop associated with the longest development time. This suggests that different foods had varied effects on development time. Different foods provide thrips with different amounts of nutrients, and this may affect their metabolic rate. Their inability to develop successfully on cucumbers may be related to the fact that thrips cannot adapt to certain components of cucumbers or that the insects react negatively to this host species.

Table 1. Effects of host feeding on the developmental period of *Megalurothrips usitatus*.

Host Plant	Developmental Duration/Days					
	Egg	1st Instar	2nd Instar	Prepupa	Pupa	Egg-Adult
Cowpea	2.50 ± 0.00 a (100)	1.66 ± 0.06 d (100)	3.23 ± 0.08 c (100)	0.86 ± 0.04 a (100)	1.63 ± 0.04 bcd (100)	9.87 ± 0.11 c (100)
Courgette	2.50 ± 0.00 a (50)	2.00 ± 0.00 c (50)	5.61 ± 0.20 a (50)	0.86 ± 0.06 a (50)	1.26 ± 0.06 e (50)	12.23 ± 0.21 b (50)
Green bean	2.50 ± 0.00 a (50)	2.06 ± 0.06 c (50)	2.72 ± 0.15 cd (50)	0.75 ± 0.04 a (50)	1.45 ± 0.06 d (50)	9.48 ± 0.13 c (50)
Wax gourd	2.50 ± 0.00 a (50)	3.39 ± 0.17 a (50)	4.85 ± 0.36 ab (49)	0.85 ± 0.07 a (49)	1.5 ± 0.08 cd (49)	13.12 ± 0.29 a (49)
Momordica charantia	2.50 ± 0.00 a (50)	1.45 ± 0.08 de (50)	2.74 ± 0.21 cd (49)	0.85 ± 0.04 a (47)	1.90 ± 0.07 a (46)	9.51 ± 0.23 c (46)
Soybean	2.50 ± 0.00 a (50)	1.31 ± 0.06 e (50)	2.70 ± 0.08 cd (49)	0.73 ± 0.04 a (49)	1.65 ± 0.05 bc (49)	8.91 ± 0.11 d (49)
Vigna cylindrica	2.50 ± 0.00 a (50)	2.01 ± 0.04 c (50)	2.23 ± 0.06 d (50)	0.99 ± 0.02 a (45)	1.76 ± 0.05 ab (38)	9.51 ± 0.08 c (37)
Cucumber	2.50 ± 0.00 a (50)	2.48 ± 0.21 b (33)	4.33 ± 0.93 b (3)	0.75 ± 0.25 a (2)	-	-
Degrees of freedom (df)	7.00	7.00	7.00	7.00	6.00	6.00
Mean square (ms)	0.00	22.16	70.29	0.29	2.16	129.11
F	0.00	48.39	43.35	2.41	11.06	77.95
P	<0	<0	<0	<0.02	<0	<0

Note: Data in the table are mean ± standard error. Values in the same column followed by different letters are significantly different (LSD test, $p < 0.05$). Parentheses () list the number of thrips that survived during that period. The egg duration of the eight different crop plants is the time for the male and female thrips of the F1 generation to be put into the cowpea pods and hatched into the first-instar larva.

3.2. Adult Longevity and Fecundity of M. usitatus on Eight Plant Species

From the results of Table 2 and Figure 1, there were significant differences in the feeding lifespan of adult thrips on different plants. When fed cowpeas, the lifespans of female and male adults were 21.34 days and 18.08 days, respectively, significantly higher than that of other host plants. However, when fed on *M. charantia*, the lifespan of females was significantly shortened (at only 8.92 days), and the lifespan of male adults was only 7.86 days, values that were the lowest among all plant species. The lifespans of both female and male adults also varied, with females having a longer average lifespan than males. When fed on soybeans, the difference in the lifespan of male and female thrips was the largest, with female adults living 1.36 times longer than male adults. The second largest difference was associated with wax gourd, with the ratio of male to female life expectancy being 1.23. The ratios for cowpea and *V. cylindrica* were both 1.17; and for green beans and *M. charantia*, the ratios were 1.12. The difference in lifespan between males and females fed on courgette was the least (at 1.08).

There were also significant differences in the fecundity and number of eggs that were hatched in the first instar by female thrips after feeding on different host plants. Thrips produced the highest number of eggs (122.56) on cowpeas, followed by *V. cylindrica* and green beans (111.20 and 98.8). However, thrips fed on courgette, wax gourd, *M. charantia*, and soybean laid fewer eggs, with mean numbers being 7.35, 6.71, 3.20, and 3.91, respectively, values that could not sustain the population.

Table 2. Effect of host feeding on the longevity and fecundity of *Megalurothrips usitatus*.

Host Plant	Longevity/d Female Adult	Longevity/d Male Adult	Sex Ratio F/M	Fecundity
Cowpea	21.34 ± 0.47 a (52)	18.08 ± 0.43 a (48)	52:48	122.56 ± 6.47 a (52)
Courgette	15.54 ± 1.02 c (26)	14.21 ± 0.67 b (24)	26:24	7.35 ± 1.09 c (26)
Green bean	19.88 ± 0.92 ab (25)	17.02 ± 0.65 a (25)	25:25	98.8 ± 10.54 b (25)
Wax gourd	16.87 ± 1.32 c (24)	13.76 ± 0.98 b (25)	24:25	6.71 ± 1.36 c (24)
Momordica charantia	8.92 ± 0.91 d (25)	7.86 ± 0.74 c (21)	25:21	3.20 ± 0.68 c (25)
Soybean	9.89 ± 1.18 d (23)	7.19 ± 0.56 c (26)	23:26	3.91 ± 0.74 c (23)
Vigna cylindrica	17.3 ± 0.91 bc (15)	14.93 ± 0.46 b (22)	15:22	111.20 ± 12.47 ab (15)
Cucumber	-	-	-	-
Degrees of freedom (df)	6.00	6.00	-	6.00
Mean square (ms)	663.25	507.69	-	95,361.42
F	29.39	45.95	-	81.95
P	<0	<0	-	<0

Note: Data in the table are mean ± standard error. Values in the same column followed by different letters are significantly different (LSD test, $p < 0.05$). The parentheses () indicate the number of thrips.

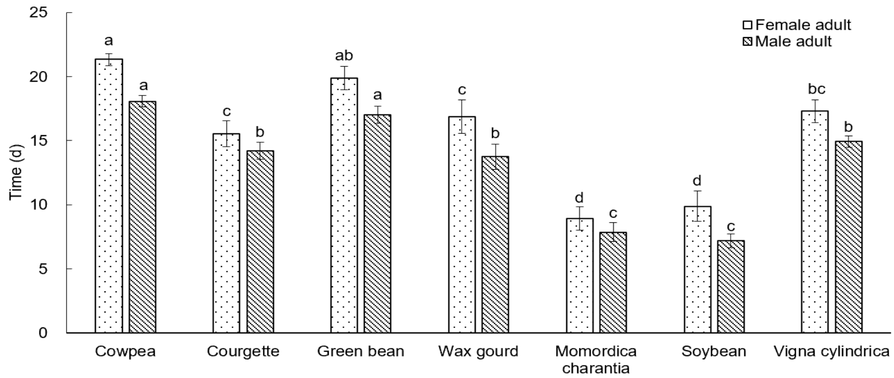

Figure 1. The results in lifespan of *M. usitatus* adults feeding on different host plants. Data are mean ± standard error. The different lowercase letters indicate that there are significant differences at the $p < 0.05$ level in the survival time of female/male adults feeding on different crops, as tested by the LSD method.

In terms of the lifespan and oviposition of adult thrips, the average lifespan of females was longer than that of males when feeding on different host plants. This suggests that female thrips are the dominant sex in the survival strategy. The females can thus lay more eggs to achieve rapid population growth. The numbers of eggs laid by thrips feeding on cowpeas, *V. cylindrica*, and green beans were stable, indicating that these three plants could sustain the thrips population. Feeding on courgette, wax gourd, *M. charantia*, soybean, and cucumber was insufficient to sustain the thrips population.

3.3. Age-Stage Specific Survival Rate of M. usitatus

Age-stage specific survival rate (S_{xj}) refers to the likelihood of an individual surviving to age x and developmental stage j, and there is generally some overlap [21]. The curve shown in Figure 2 depicts the differences in the survival and development rate of thrips after feeding on different plants at different stages. Due to the differences in the development rate among individuals, there was a significant overlap in the growth curves of thrips after feeding on the eight crop plants. There was an initial increasing trend and then a decreasing trend at all developmental stages. From the figure, the second instar of thrips fed on courgette reached the earliest peak at 4 days. This was followed by soybean (4.5 days), cowpea (5 days), *M. charantia* (5 days), *V. cylindrica* (5 days), and green beans (5.5 days). The thrips fed on wax gourd reached a peak at 8 days. The peak prepupal duration varied. The peak time for *V. cylindrica* was the shortest (5 days), and the longest peak time was on wax gourd, with a difference of 6 days (11 days). The peak pupal duration when fed on different host plants was concentrated around 8 to 9 days for cowpea, *M. charantia*, soybean, and *V. cylindrica*. The times for courgette and wax gourd were longer (11 days and 11.5 days, respectively).

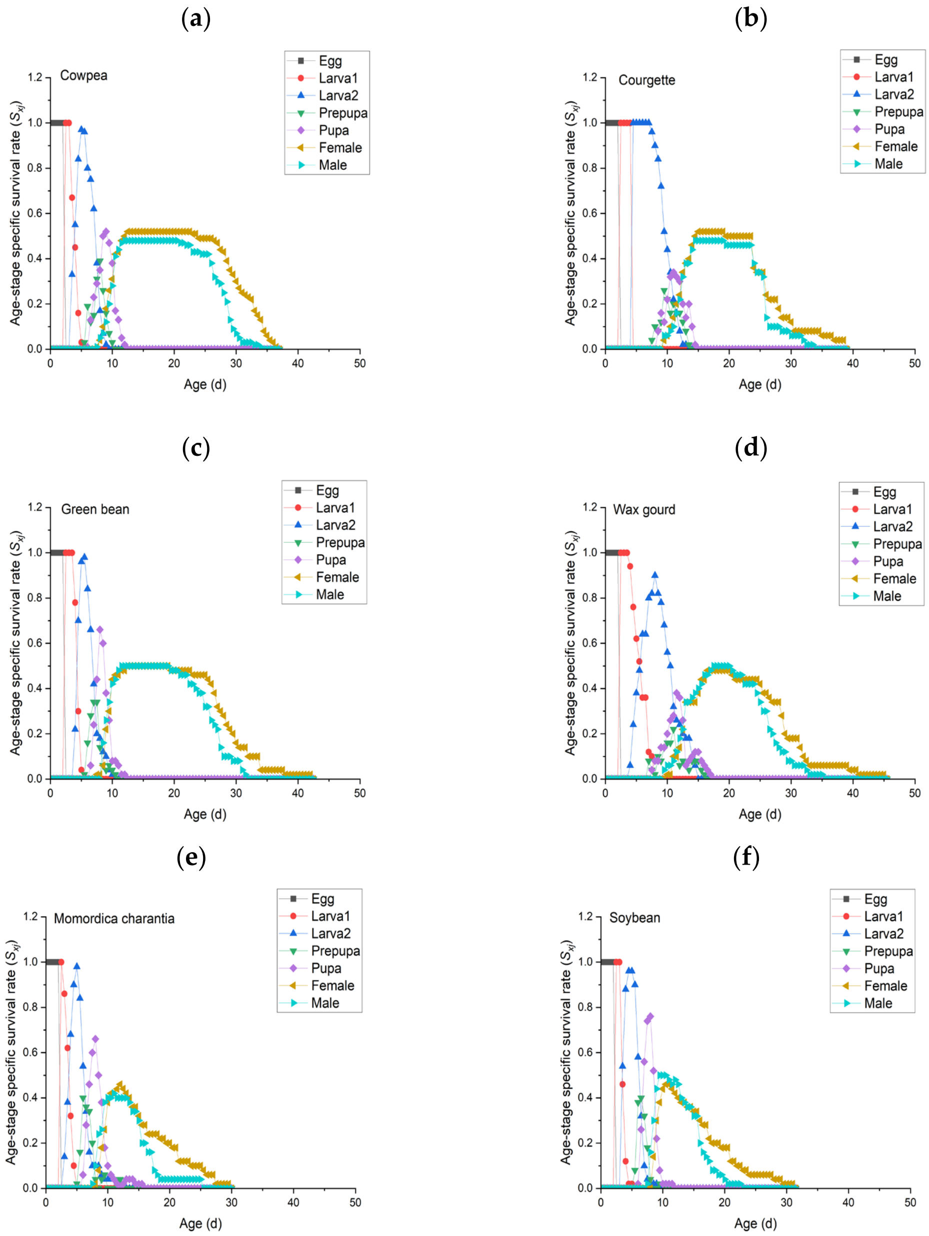

Figure 2. *Cont*.

(**g**) (**h**)

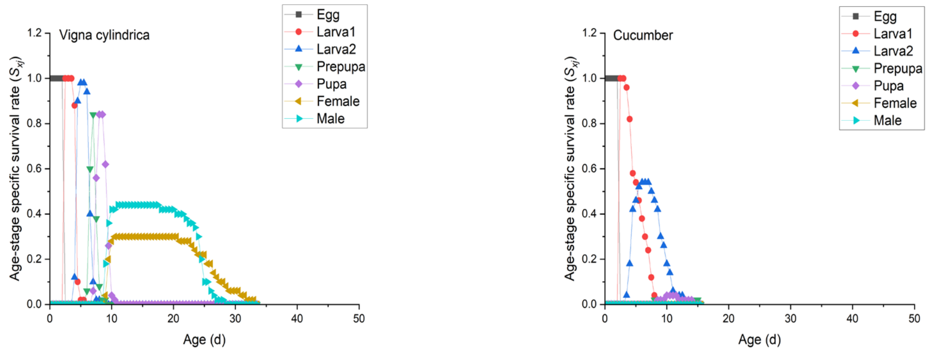

Figure 2. Age-stage specific survival rates of *Megalurothrips usitatus* on eight host plants. Note: (**a**) Cowpea; (**b**) Courgette; (**c**) Green bean; (**d**) Wax gourd; (**e**) *Momordica charantia*; (**f**) Soybean; (**g**) *Vigna cylindrica*; (**h**) Cucumber.

The thrips that were fed on courgette reached the peak time the earliest, while those that were fed on wax gourd reached the peak time the latest. This could mean that *M. usitatus* has a preference for courgette or that it is more adapted to surviving on courgette, while wax gourd is less attractive to *M. usitatus*. The shortest peak time of the prepupal stage occurred on *V. cylindrica*, while the longest peak time of the prepupal stage occurred on wax gourd, with a difference of 6 days. This further illustrates the variation in the growth and development of *M. usitatus* on different plants. The similar peak times of pupal duration for thrips that were fed cowpea, *M. charantia*, soybean, and *V. cylindrica* suggest that these plants may provide similar growth components or nutritional value.

3.4. M. usitatus Age-Specific Survival and Fecundity

The curve in Figure 3 shows that the age-specific survival rate (l_x) curves for thrips feeding on seven host plants had similar downward trends. Wax gourd and green bean produced the longest survival (at 45 days and 42 days, respectively). Cowpea (36.5 days), courgette (38.5 days), soybean (31 days), and *V. cylindrica* (33 days) groups decreased to 0 before 39 days. The survival of *M. charantia* was the shortest, with this group decreasing to 0 at 29.5 d. The age-stage fecundity (f_{xj}) curves of females for thrips feeding on cowpeas, green beans, *M. charantia*, soybean, and *V. cylindrica* showed patterns of increase-decrease-increased-decrease and reached the highest values at 6.3, 18, 1, 0.8, and 14.4 days, respectively. The curves for courgette and wax gourd showed initial increases and then decreases, with peaks of 2.4 and 1.6 days, respectively. The age-specific fecundity (m_x) and the population-specific reproductive value ($l_x m_x$) of the seven plants fed on by thrips showed a large overlap before 20 days, and the m_x curves were higher than the $l_x m_x$ curves after 20 days. The curves for cowpeas, green beans, and *V. cylindrica* were significantly higher than those for other plants.

(**a**) (**b**)

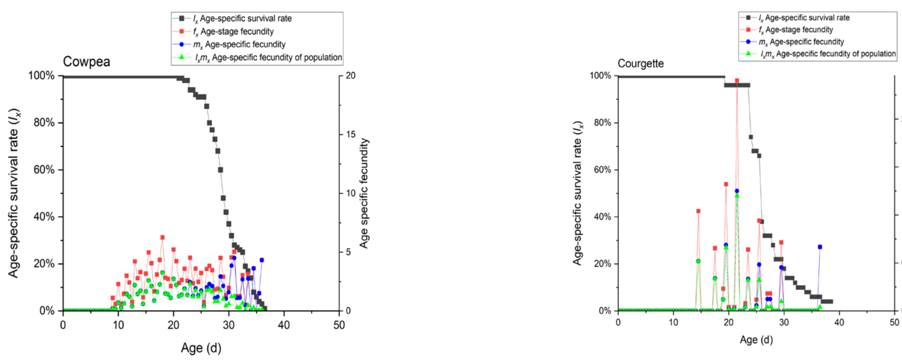

Figure 3. *Cont.*

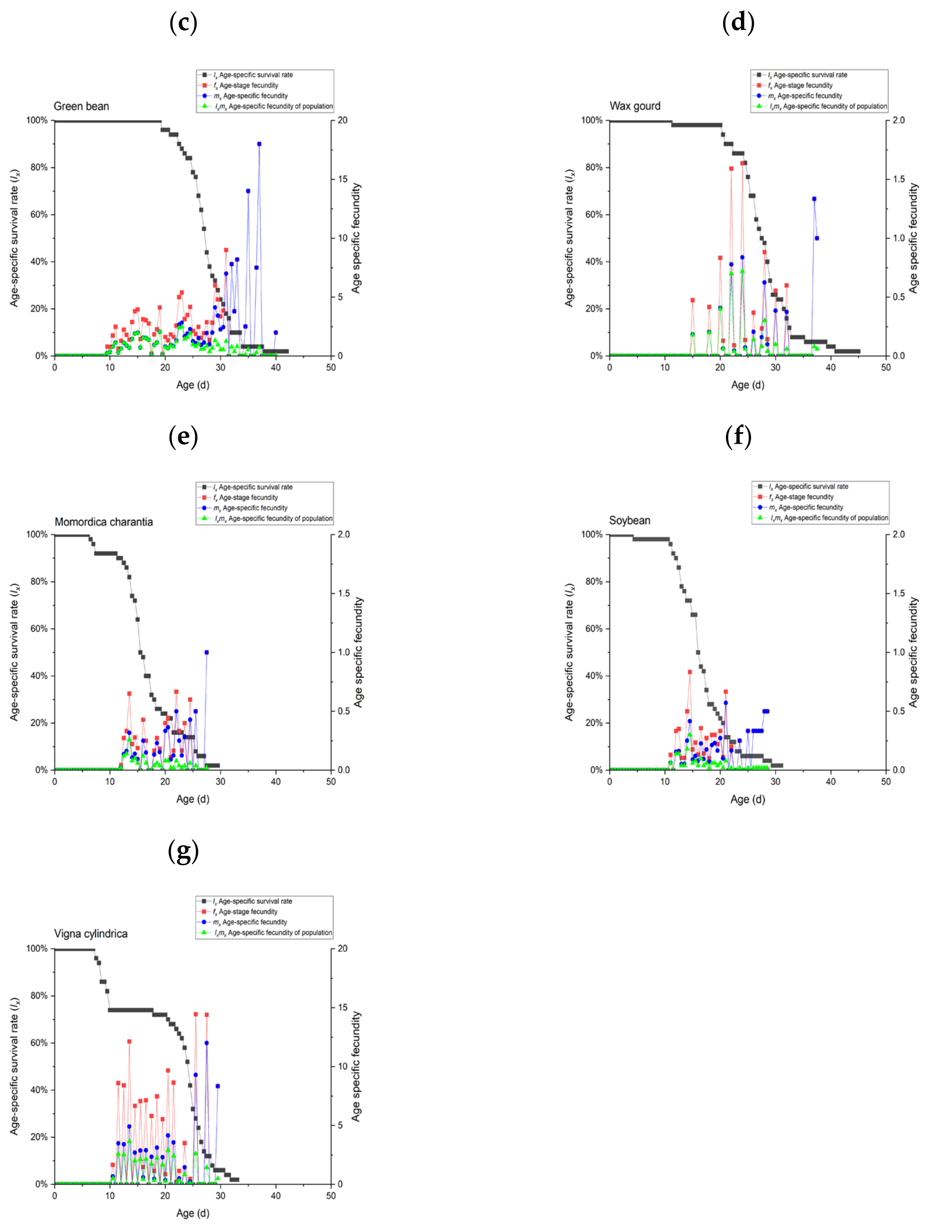

Figure 3. Age-stage specific survival rate and fecundity curves of *Megalurothrips usitatus* after feeding on different host plants. Note: (**a**) Cowpea; (**b**) Courgette; (**c**) Green bean; (**d**) Wax gourd; (**e**) *Momordica charantia*; (**f**) Soybean; (**g**) *Vigna cylindrica*.

After *M. usitatus* fed on seven different host plants, the l_x curves showed downward trends, indicating that the survival of thrips gradually decreased over time. After the thrips were fed on different plants, the f_{xj} curve fluctuated. Thrips' reproductive ability began to decline after reaching a peak.

3.5. M. usitatus Population Life Table Parameters

The parameters of the life table of the experimental *M. usitatus* population are listed in Table 3. There was significant variation in the net reproduction rate (R_0) of thrips after being cultured on eight different host plants. *M. usitatus* fed on cowpeas had the highest net replacement rate of 63.87 among all crops. This was followed by thrips fed on green beans, with an R_0 value of 49.41, and *V. cylindrica* at 33.37. The R_0 values of *M. usitatus* fed on courgette, wax gourd, *M. charantia*, and soybean were lower (3.82, 3.22, 1.6, and 1.8, respectively). *M. usitatus* fed on different plants also had significantly different mean generation times (T). When fed cowpeas, green beans, *M. charantia*, soybeans, and *V. cylindrica*, the *T* of thrips was similar at 16.5–18.2 days. However, thrips fed on courgettes and *M. charantia* had longer average generation times of 20.84 days and 23.62 days, respectively. There were significant differences in the intrinsic rate of increase (*r*) of thrips after feeding on different host plants. The value of *r* was the highest for cowpeas (0.23), followed by green beans and *V. cylindrica* (0.21). The *r* values for courgettes, wax gourds, *M. charantia*, and soybeans were significantly lower than those of the first three plants, being 0.06, 0.05, 0.03, and 0.04, respectively. There were also significant differences in the finite rate of increase (λ), and the thrips fed on cowpeas had the highest weekly growth rate of 1.26, which was significantly higher than those of other plants. The thrips that were fed *M. charantia* had the lowest λ value of 1.03. The λ values for other plants were 1.07 (green beans), 1.24 (courgettes), 1.05 (soybeans), 1.04 (wax gourds), and 1.24 (*V. cylindrica*).

Table 3. Population parameters of *Megalurothrips usitatus* on eight host plants.

Host Plant	(R_0) Net Reproductive Rate	(r) Intrinsic Rate of Increase/d^{-1}	(λ) Finite Rate of Increase/d^{-1}	(T) Mean Generation Time/d
Cowpea	63.87 ± 6.95 a	0.23 ± 0.01 a	1.26 ± 0.01 a	17.86 ± 0.36 c
Courgette	3.82 ± 0.76 c	0.06 ± 0.01 b	1.07 ± 0.01 b	20.84 ± 0.62 b
Green bean	49.41 ± 8.68 ab	0.21 ± 0.01 a	1.24 ± 0.01 a	18.14 ± 0.59 c
Wax gourd	3.22 ± 0.80 cd	0.05 ± 0.01 bc	1.05 ± 0.01 bc	23.62 ± 0.92 a
Momordica charantia	1.6 ± 0.40 d	0.03 ± 0.02 cd	1.03 ± 0.02 cd	17.30 ± 3.32 cd
Soybean	1.8 ± 0.43 d	0.04 ± 0.02 bd	1.04 ± 0.02 bd	16.62 ± 2.40 cd
Vigna cylindrica	33.37 ± 8.06 b	0.21 ± 0.02 a	1.24 ± 0.02 a	16.46 ± 0.33 d
Cucumber	-	-	-	-

Note: Data in the table are mean ± Standard Error. Values in the same column followed by different letters are significantly different (LSD test, $p < 0.05$). R_0: Net reproductive rate; r: Intrinsic rate of increase; λ: Finite rate of increase; T: Mean generation time.

4. Discussion

M. usitatus is one of the most important pests of cowpeas [22]. The insect completes its entire life cycle on plants. Thrip development is affected by their physiological status, food plants, and environmental conditions [23]. The two-sex life table reflects the adaptability of insects to their hosts from different aspects and thus is an important component in the study of insect population dynamics [24]. In this paper, life tables of the thrips populations living on eight plant species were constructed, including the developmental duration, survival rate curve, and population parameters at each age. Among the eight plant species, thrips could achieve stable population growth by feeding on cowpeas, green beans, and *V. cylindrica*. Courgettes, wax gourds, *M. charantia*, and soybeans were suitable for the growth of thrips, but not for reproduction. There were significant differences between *M. usitatus* in different plants in terms of the first and second instar, prepupal duration, pupal duration, adult stage, and egg production. The results showed that different plants had varied degrees of influence on the growth, development, and reproduction of thrips. Based on the suitability and population growth of *M. usitatus* on eight host plants, crops such as courgettes, wax gourds, *M. charantia*, soybeans, and cucumbers, which cannot sustain the propagation of thrips populations, can be further utilized. Through ecological regulation, intercropping and crop rotation are adopted. After planting cowpeas, green beans, and *V. cylindrica*, cucumbers are planted in turn. This can suppress the number of common thrip populations in the following year. When growing courgettes, wax gourds, *M. charantia*, and soybeans, some cowpeas can be intercropped. This reduces the damage caused by *M. usitatus* to these four crops. Additionally, the root system distribution and nutrient requirements of different crops vary, and intercropping can fully utilize soil nutrients and moisture, enhancing the stability of farmland ecosystems.

The data in this paper indicate that the lifespan of female *M. usitatus* feeding on eight host crops is longer than that of males. This result is influenced by evolutionary and ecological factors. *M. usitatus* is a haplo-diploid insect. In the haplo-diploid reproductive mechanism, males are haploid and develop directly from unfertilized eggs, while females are diploid and develop normally from fertilized eggs. Haplo-diploid insects are extremely beneficial to maternal evolution, resulting in lower adaptability and viability of haploid males [25]. Lifespan is also closely related to the external environment and behavioral activities, such as geographical area, food supply, mating activity, and survival pressure. Jiang C et al. found that mating and caring for offspring would increase the lifespan of *Toxeus magnus* females, which was conducive to the extension of female adulthood [26]. In the experiment, female thrip individuals played an important role in maintaining the population and had better adaptability to the external environment. In addition, mating behavior in sexual reproduction may also be one of the reasons for the increase in female lifespan.

The insect-plant relationship has always been a core issue in the field of insect ecology [27]. The selection of host plants by insects is the result of long-term evolution based on the interactions and interdependence between insects and plants. In the life history of insects, feeding is the most critical behavioral activity [28]. Insects use their feeding preferences to screen host plants. Newman et al. [29] found that *Plutella xylostella* (L.) preferred to feed on *Lepidium sativum*, followed by *Barbarea vulgaris* (L.) and *Brassica nigra* (L.). *Spodoptera exigua* (Hübner) had a higher feeding preference for *Brassica chinensis* compared to *Apium graveolens*, *Allium fistulosum* L. *var. caespitosum* Makino, and shallots [30]. Feeding on high-quality host plants accelerates the growth of insect populations. *Phenaconium zonale*, *Hibiscus rosa-sinensis*, *Hibicus syriacus,* and *Cestrum nocturnum* are all host plants of *Phenacoccus madeirensis* Green, but when feeding on *C. nocturnum*, the larval stage of *P. madeirensis Green* developed rapidly, and the fecundities was the highest among the four plants [31]. Among the nine rainfed barley cultivars, the survival rate of *Rhyzopertha dominica* (F.) feeding on Sararod, Nader, Nimroz, and Mahoor was significantly lower than that of the other five varieties, showing relative resistance to *R. dominica* [32]. The development time of *Myzus persicae* (Sulzer) feeding on the Erciyes variety is the shortest and its fecundity is the highest. However, its fitness is the lowest in the Amiral variety [33]. The same pattern held for *M. usitatus*. Tan K et al. [34] used cowpeas, green beans, and peanuts to breed *M. usitatus* to explore the duration of development and concluded that the order of feeding adaptation was as follows: cowpea > peanut > Phaseolus vulgaris. Tang L et al. [35] used green beans, cowpeas, peas, and lima beans to construct life tables and found that lima beans were the most unsuitable for *M. usitatus* reproduction, while green beans were the most suitable. A similar life table experiment conducted using green beans, cowpeas, peas, and lima beans demonstrated that the lima beans were the least conducive for general thrips reproduction, while the former was the most favorable host. According to the experimental results of this study, *M. usitatus* prefers legume crops such as cowpeas, *V. cylindrica*, and green beans. This may be due to the fact that the leaves, flowers, and fruits of these crops provide more concealed habitats and abundant feeding sites for *M. usitatus*, enabling them to hide easily and avoid predators. The difficulty in the reproduction of *M. usitatus* on soybeans may be attributed to the hairy protection on the leaves and fruits of soybeans, which affects the attachment and feeding of thrips. *M. usitatus* may be more adapted to moving and feeding on smooth surfaces. Courgette, wax gourd, *M. charantia*, and cucumber belong to the Cucurbitaceae family. These four crops have very high water content, generally above 90%. Research by other scholars has indicated that high water content is detrimental to the reproduction of *M. usitatus* [36,37], which may explain why *M. usitatus* has difficulty reproducing on these four plants. Moreover, there are differences in the content and proportion of nutrients among different crops. Cowpeas, *V. cylindrica*, and green beans contain higher proportions of amino acids, sugars, and other nutrients, which may lead to the preference of *M. usitatus* for these bean crops. The selectivity of feeding preference may be a manifestation of the adaptation of *M. usitatus* to different ecological environments. The characteristics of insects that have evolved over a long period of time to adapt to specific plants can form recognition and utilization mechanisms to help insects survive and reproduce in changing environments, and this can have a profound impact on plant population dynamics and evolution [38,39].

Understanding the feeding preferences of *M. usitatus* can help predict its population dynamics on different host plants. The results of previous studies were consistent with the discussion concerning the effects of feeding eight different host plants on the growth and development of *M. usitatus*. This result may be due to differences in feeding preferences between host plants or differences in the content and composition of secondary biomass between host plants and varieties of the same host plant. To better understand the biology of *M. usitatus*, future research could explore how specific nutrients in food plants affect the development and reproduction of thrips. Different crop plants had significant impacts on the growth and reproduction of *M. usitatus*, a factor that should be considered when developing pest control strategies. Farmers could choose to plant foods that adversely affect the development of common thrips or could arrange the planting sequence of crops and appropriate crop rotation patterns, thereby reducing the population of *M. usitatus*.

5. Conclusions

The development and reproduction of *M. usitatus* after feeding on eight different crops were analyzed based on the age-stage, two-sex life table. The results indicated that three crops, namely cowpeas, *V. cylindrica*, and green beans, could simultaneously support the development and reproduction of *M. usitatus*. Among them, cowpea was the most suitable host crop for *M. usitatus*. The thrips could develop but not reproduce on courgettes, wax gourds, *M. charantia*, and soybeans. Moreover, *M. usitatus*. could neither develop nor reproduce on cucumbers. This study provides insights into predicting the spread and population dynamics of *M. usitatus*, thereby facilitating the formulation of effective prevention and control strategies.

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