

寄主植物对瓜蚜实验种群生命表参数的影响^{*}

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摘 要 在(25±1)℃条件下比较了5种寄主植物上瓜蚜实验种群生命表参数. 结果表明: 在不同寄主植物上, 瓜蚜各龄历期、成蚜寿命、日均产仔量、净增殖率、内禀增长率、周限增长率、平均世代历期和种群加倍时间等均存在显著差异. 瓜蚜完成1代所需时间在瓢葫芦上最长, 为5.84 d, 其他4种供试植物上差异不显著(5.24~5.45 d). 成蚜寿命在黄瓜上最长, 为20.04 d, 其他4种供试植物上差异不显著(14.76~16.03 d). 瓜蚜种群存活曲线在所有供试寄主植物上均为I型, 即死亡主要发生在后期, 而且在黄瓜上的存活率高于其他4种供试植物. 根据瓜蚜内禀增长率大小排序, 寄主适合性依次为哈密瓜>瓢葫芦>南瓜>黄瓜>茭瓜.

关键词 瓜蚜 寄主植物 生命表 种群参数

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Effects of host plants on the life table parameters of experimental populations of *Aphis gossypii*. LI Yan-yan, ZHOU Xiao-rong, PANG Bao-ping, CHANG Jing (College of Agriculture, Inner Mongolia Agricultural University, Hohhot 010019, China). -Chin. J. Appl. Ecol., 2013, 24(5): 1435-1438.

Abstract: A comparative study was conducted on the life table parameters of *Aphis gossypii* reared on five host plant species at (25±1)℃ in laboratory. There existed significant differences in the durations of various developmental stages, adult longevity, mean offspring number per day, net reproductive rate, intrinsic rate of increase, finite rate of increase, mean generation time, and population doubling time for the *A. gossypii* populations reared on the host plants. For the aphids on *Lagenaria siceraria* var. *turbinate*, they needed the longest time (5.84 days) to complete one generation, but for those on the other four plants, no significant differences were observed, with the time needed ranged from 5.24 to 5.45 days. The adult longevity was the longest (20.04 days) on *Cucumis sativus*, but had no significant differences on the other four host plants, being from 14.76 to 16.03 days. The populations' survival curves on all test host plants were of Deevey I, i. e., the death mainly occurred during late period. The survival rate on *C. sativus* was higher than those on the other four host plants. Based on the intrinsic rates of increase of *A. gossypii*, its host suitability was in the order of *Cucumis melo* var. *saccharinus* > *Lagenaria siceraria* var. *turbinate* > *Cucurbita moschata* var. *melonaeformis* > *Cucumis sativus* > *Cucurbita pepo* var. *medullosa*.

Key words: *Aphis gossypii*; host plant; life table; population parameter.

瓜蚜(*Aphis gossypii*)又称棉蚜,是一种世界性、多食性害虫,广泛分布于热带、亚热带和温带地区,在温带地区是温室蔬菜的主要害虫. 瓜蚜不仅产生蜜露,诱发霉菌,而且在植物间传播超过50种病毒^[1]. 瓜蚜寄主植物多达74科285种,我国已记载113种,其中以瓜类和棉花受害最严重^[2]. 有研究表明,棉蚜存在寄主分化现象,分为棉花型和黄瓜型

(瓜蚜),两者在寄主适应性方面存在很大差异^[3]. 关于黄瓜型棉蚜(瓜蚜)的研究主要包括寄主抗性^[4-8]、种群动态^[9-10]、实验种群生命表^[11-12]、温度^[13-18]及栽培条件^[19]对瓜蚜生长发育的影响等. 至今有关不同寄主植物与瓜蚜相互作用关系的研究非常少,周琼等^[20]比较了苦瓜(*Momordica charantia*)、丝瓜(*Luffa cylindrical*)及豇豆(*Vigna unguiculata*)3种寄主植物对瓜蚜的生长发育、繁殖及种群增长的影响. 本文比较了5种寄主植物对瓜蚜实验种群生命表参数的影响,以期揭示瓜蚜与寄主植

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物相互作用机理提供必要的基础.

1 材料与方法

1.1 供试寄主植物

供试寄主植物为:黄瓜(*Cucumis sativus*, 山东密刺)、南瓜(*Cucurbita moschata* var. *melonaeformis*, 日本南瓜)、茭瓜(*Cucurbita pepo* var. *medullosa*, 拍砸1号)、哈密瓜(*Cucumis melo* var. *saccharinus*, 新密杂19号)、瓢葫芦(*Lagenaria siceraria* var. *turbinate*, 细腰葫芦).

精选各供试种类无病、饱满的种子,浸种催芽后直播于直径20 cm塑料花盆中,每种15盆,每盆播种3~4穴,每穴2粒,置于温度28℃/20℃(昼/夜)、光周期14L:10D、相对湿度(60±10)%的人工气候箱中,待植株长出1片真叶时每穴选留1株,待长到4~5片真叶时,去掉顶端以防其徒长,备用.

1.2 供试虫源

从内蒙古农业大学教学农场温室中采集无翅成蚜,分别饲养于培养箱内供试寄主植物上,连续繁殖3代以上作为供试虫源.

1.3 试验方法

分别将不同寄主植物上的供试虫源(无翅胎生雌成蚜)接种于相应的盆栽寄主植物上,待成蚜产仔后,用直径5 mm的养虫笼将若蚜罩住,每笼1头,将成蚜和多余的若蚜剔除,然后将盆栽寄主放于(25±1)℃、光周期14L:10D、相对湿度(60±10)%的人工气候箱中.每12 h观察蜕皮、死亡、产仔等情况,记载各发育阶段的发育历期、存活率、产仔量、成蚜寿命等,组建不同寄主植物上瓜蚜的生命生殖力表.每种寄主植物观察40头.

1.4 数据处理

瓜蚜内禀增长力(r_m)采用Wyatt和White^[21]提出的公式: $r_m = 0.738 \ln M_d / d$,其中: d 为出生到开始产仔之前的历期; M_d 为每头成虫在 d 时间内产仔数

量;0.738为校正因子.计算出每头蚜虫的 r_m 值后,再计算出相应的净增值率(R_0)、世代平均历期(T)、种群加倍时间(t)和周限增长率(λ)等种群生命表参数^[22].

存活曲线应用Weibull分布进行拟合^[23],公式为:存活率 $Sp(t) = \exp[-(t/b)^c]$, $t, b, c > 0$,其中: b 为尺度参数; c 为形状参数.当 $c > 1$ 时,存活曲线为Ⅰ型;当 $c = 1$ 时,存活曲线为Ⅱ型;当 $c < 1$ 时,存活曲线为Ⅲ型.如果 c 值相同, b 值越大,存活率越高.

采用SPSS 13.0统计分析软件对数据进行拟合、方差分析和多重比较(LSD法).

2 结果与分析

2.1 不同寄主植物对瓜蚜生长发育的影响

从表1可知,寄主植物对瓜蚜各龄若蚜发育历期和成蚜寿命有显著影响($P < 0.05$).在瓢葫芦上瓜蚜完成一个世代需5.84 d,显著高于其他寄主植物($P < 0.05$);1龄若虫在瓢葫芦上的发育历期最长,为1.79 d,在南瓜上最短,为1.18 d;2龄若虫同样在瓢葫芦上发育历期最长,为1.48 d,在哈密瓜上最短,为1.21 d;3龄和4龄若虫均在南瓜上发育历期最长,在哈密瓜上发育历期最短.成蚜寿命在黄瓜上最长,为20.09 d,显著高于其他4种寄主植物.

2.2 不同寄主植物上瓜蚜的存活曲线参数

应用Weibull分布模型很好地拟合了瓜蚜在5种供试寄主植物上的存活曲线参数(表2).从表2可知,瓜蚜在所有供试寄主植物上的形状参数 c 值均大于1,说明其存活曲线均属于Ⅰ型,即死亡主要发生在瓜蚜生长发育的后期.瓜蚜在黄瓜上的 b 值最大,其他4种寄主植物上的 b 值差异不大,说明瓜蚜在黄瓜上的存活率高于其他4种供试寄主植物.

2.3 不同寄主植物上瓜蚜的实验种群生命表参数

从表3可知,除总产仔量在不同寄主植物间差

表1 (25±1)℃下不同寄主植物上瓜蚜的发育历期
Table 1 Developmental time of *Aphis gossypii* reared on five different host plants at (25±1)℃ (mean±SE, d)

发育阶段 Stage	茭瓜 <i>Cucurbita pepo</i> var. <i>medullosa</i>	哈密瓜 <i>Cucumis melo</i> var. <i>saccharinus</i>	南瓜 <i>Cucurbita moschata</i> var. <i>melonaeformis</i>	黄瓜 <i>Cucumis sativus</i>	瓢葫芦 <i>Lagenaria siceraria</i> var. <i>turbinata</i>
1龄若虫 First instar	1.30±0.08bc	1.68±0.09ab	1.18±0.07d	1.47±0.08bc	1.79±0.07a
2龄若虫 Second instar	1.28±0.08ab	1.21±0.07b	1.25±0.07b	1.35±0.07ab	1.48±0.06a
3龄若虫 Third instar	1.48±0.08a	1.21±0.07b	1.44±0.08a	1.36±0.06ab	1.28±0.05ab
4龄若虫 Fourth instar	1.33±0.07ab	1.15±0.05b	1.38±0.06a	1.26±0.06ab	1.30±0.06ab
若蚜 Nymph	5.38±0.09b	5.25±0.12b	5.24±0.10b	5.45±0.13b	5.84±0.09a
成蚜 Adult	15.71±1.27b	16.03±0.99b	14.80±1.28b	20.09±1.38a	14.76±0.98b

同行不同字母表示差异显著($P < 0.05$) Different letters in the same row indicated significant difference at 0.05 level. 下同 The same below.

表 2 不同寄主植物上瓜蚜存活曲线模型的参数估计
Table 2 Parameter estimation of survival curve models for *Aphis gossypii* reared on different host plants (mean±SE)

参数 Parameter	茭瓜 <i>Cucurbita pepo</i> var. <i>medullosa</i>	哈密瓜 <i>Cucumis melo</i> var. <i>saccharinus</i>	南瓜 <i>Cucurbita moschata</i> var. <i>melonaeformis</i>	黄瓜 <i>Cucumis sativus</i>	瓢葫芦 <i>Lagenaria siceraria</i> var. <i>turbinata</i>
<i>b</i>	24. 19±0. 48	23. 71±0. 28	22. 04±0. 15	28. 49±0. 16	22. 75±0. 14
<i>c</i>	2. 59±0. 20	3. 90±0. 24	2. 64±0. 06	3. 38±0. 09	3. 62±0. 11
<i>R</i> ²	0. 9543 * *	0. 9789 * *	0. 9959 * *	0. 9941 * *	0. 9946 * *

* * *P*<0. 01.

表 3 (25±1) °C 下不同寄主植物上瓜蚜种群生命表参数
Table 3 Life table parameters of *Aphis gossypii* population reared on five different host plants at (25±1) °C

参数 Parameter	茭瓜 <i>Cucurbita pepo</i> var. <i>medullosa</i>	哈密瓜 <i>Cucumis melo</i> var. <i>saccharinus</i>	南瓜 <i>Cucurbita moschata</i> var. <i>melonaeformis</i>	黄瓜 <i>Cucumis sativus</i>	瓢葫芦 <i>Lagenaria siceraria</i> var. <i>turbinata</i>
净增值率 <i>R</i> ₀	45. 10±3. 90b	59. 25±3. 55a	51. 43±4. 41ab	48. 95±3. 86ab	60. 82±4. 05a
内禀增长率 <i>R</i> _m	0. 35±0. 01d	0. 42±0. 11a	0. 39±0. 11bc	0. 37±0. 01cd	0. 41±0. 01ab
周限增长率 λ	1. 42±0. 02b	1. 53±0. 02a	1. 47±0. 02b	1. 45±0. 01b	1. 52±0. 02a
世代平均历期 <i>T</i> (d)	12. 54±0. 47ab	12. 01±0. 36ab	12. 20±0. 42ab	13. 18±0. 38a	11. 73±0. 29b
种群加倍时间 <i>t</i> (d)	2. 12±0. 10a	1. 69±0. 06b	1. 90±0. 11ab	1. 91±0. 06ab	1. 79±0. 12b
总产仔量 Total offspring per female	46. 78±3. 97a	59. 93±3. 59a	55. 83±5. 20a	61. 10±6. 06a	61. 05±4. 01a
日均产仔量 Daily mean offspring per female	2. 98±0. 12c	4. 19±0. 16ab	3. 88±0. 16b	2. 90±0. 15c	4. 45±0. 19a

异不显著 ($F=1.70, df=4195, P=0.151>0.05$) 外, 其他 6 种种群参数在总体上均存在显著差异 ($P<0.05$). 瓜蚜内禀增长率(r_m)在不同寄主植物间差异极显著 ($F=7.78, df=4193, P<0.001$), 按内禀增长率大小排序为哈密瓜、瓢葫芦、南瓜、黄瓜和茭瓜. 说明在供试的 5 种寄主植物中, 对瓜蚜种群增长的适合性大小依次为哈密瓜、瓢葫芦、南瓜、黄瓜和茭瓜.

3 讨 论

了解生命表参数对害虫综合治理有着非常重要的意义,生命表参数提供了害虫本世代和下一个世代种群增长的特征^[24]. 不同寄主植物影响昆虫的种群增长参数,抗性不同的植物使昆虫具有不同的繁殖力和死亡率^[25]. 本研究表明,不同种类寄主植物对瓜蚜生长发育、存活及繁殖有显著影响. 这与周琼等^[20]获得的结果有相似之处. 同一种植物的不同品种也可能对瓜(棉)产生不同影响. van Steenis 和 El-Khawass^[15]研究表明,瓜蚜在 2 个不同黄瓜品种上的生长发育存在差异;棉蚜在不同棉花品种间的生长发育和种群参数也存在显著差异^[26-27]. 本研究表明,瓜蚜总产仔量在供试的 5 种寄主植物间的差异未达到显著水平,但日均产仔量差异显著. Razmjou 等^[27]在比较 5 个棉花品种对棉蚜种群参数的影响时,也获得了相同结果. 昆虫摄入的营养物质的种类和数量直接影响存活率和生殖力,植食性昆虫的生

长发育和繁殖直接依赖于寄主植物营养物质的含量和质量,而且植物受到害虫危害后,自身的化学物质和次生物质也会发生改变^[24,28-29]. 寄主植物营养物质种类、含量及变化情况与瓜蚜生长发育及繁殖的关系有待进一步研究.

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