果 树 学 报 2021,38(3):394-402
Journal of Fruit Science

DOI:10.13925/j.cnki.gsxb.20200258

橘小实蝇对5个品种火龙果果实的产卵选择

黄慧欣,李 媛,黄爱玲,王小云,郑霞林,陆 温*

(广西农业环境与农产品安全重点实验室•广西大学农学院,南宁 530004)

摘 要:【目的】探究橘小实蝇对火龙果不同品种及不同果实成熟度的偏好性。**【方法】**以‘美龙2号’‘美龙6号’‘白肉桂热心’‘普红’和‘台湾大红’5个火龙果品种及其全熟、半熟和不熟的果实为材料,探究橘小实蝇在火龙果5个品种及3个成熟度果实上的着卵量;测定火龙果5个品种不同成熟度果实的硬度,分析果实硬度与橘小实蝇着卵量的相关性。**【结果】**5个品种火龙果中,橘小实蝇偏好在‘普红’‘白肉桂热心’和‘台湾大红’品种的火龙果上产卵。不同火龙果品种的不同成熟度果实中,橘小实蝇偏好在火龙果‘美龙2号’‘普红’和‘台湾大红’品种半熟的果实上产卵,偏好在‘美龙6号’和‘白肉桂热心’品种全熟和半熟的果实上产卵。随着火龙果各品种果实成熟度的增加,果实硬度均显著减小;火龙果‘美龙6号’‘白肉桂热心’和‘普红’品种果实硬度与橘小实蝇着卵量呈负相关性。**【结论】**明确了橘小实蝇对火龙果不同品种及果实成熟度的偏好性,火龙果各品种橘小实蝇的关键防控期为果实转色期。

关键词:火龙果;橘小实蝇;产卵偏好;果实成熟度;果实硬度

中图分类号:S667.9 **文献标志码:**A **文章编号:**1009-9980(2021)03-0394-09

Oviposition preference of *Bactrocera dorsalis* (Hendel) to five varieties of pitaya

HUANG Huixin, LI Yuan, HUANG Ailing, WANG Xiaoyun, ZHENG Xialin, LU Wen*

(*Guangxi Key Laboratory of Agric-Environment and Agric-Products Safety/College of Agriculture, Guangxi University, Nanning 530004, Guangxi, China*)

Abstract:【Objective】*Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae) can damage a wide range of fruit crops, and almost all pitaya fruits are included while the preferences of *B. dorsalis* to numerous pitaya species are unclear. To guide the selection of pitaya species and/or varieties and determine the critical window of population management for *B. dorsalis* in the pitaya producing areas, the oviposition preferences of *B. dorsalis* to five varieties (i.e. ‘Meilong 2’, ‘Meilong 6’, ‘White Cinnamon Zeal’, ‘Puhong’, and ‘Taiwanese Dahong’) and to their different maturity fruits (i.e., fully-ripe, half-ripe, and unripe fruits) were investigated in a laboratory.【Methods】The fruits of *Psidium guajava* L. damaged by *B. dorsalis* were collected from Xi’an village, Yuzhou district, Yulin city, Guangxi Zhuang Autonomous Region, and were put in the cage (length × width × height = 90 cm× 90 cm× 90 cm) until adults emerged. The adults were fed on the artificial diet (yeast extract: sugar = 1: 5) in the cage, and fully-ripe fruits of *P. guajava* and *Musa nana* Lour. were provided for egg laying. These damaged fruits were put in the plastic basin (radius = 8 and 13 cm for bottom and top, height = 11 cm) until the *B. dorsalis* offspring developed to pupae. The pupae were randomly selected and placed in the plastic cup (radius = 4 and 6 cm for bottom and top, height = 15 cm) until adults emerged. Sexual maturity adults (15-20 days old) were paired in one cage, and mated females were chosen as experimental insects. Five varieties of pitaya and their different maturity fruits were used as experimental materials, which were collected from Xining village, Nachen Town, and Nanning Zhenqi Agriculture Technology Development Co.

收稿日期:2020-07-30 接受日期:2020-12-21

基金项目:广西创新驱动发展专项(桂科AA17202017);国家现代农业产业技术体系广西柑橘创新团队建设项目(nycytxgxcxtd-05-03)

作者简介:黄慧欣,女,在读硕士研究生,研究方向为昆虫行为生态学。Tel:180778154259,E-mail:hhxgxunxy@163.com

*通信作者 Author for correspondence. Tel:13607710489,E-mail:luwenlwen@163.com

Ltd., Pumiao town, Nanning city, Guangxi Zhuang Autonomous Region. Thirty mated females of *B. dorsalis* were introduced into one cage, in which the arrangement of different pitaya varieties or different maturity fruits was equidistant diagonally. Each treatment was replicated for 10 times. These fruits were dissected and the number of eggs laid by *B. dorsalis* in these fruits was carefully counted after an exposure of 24 hours. The fruit hardness of different maturity fruits from the five pitaya varieties was measured using a fruit hardness tester. Each treatment was replicated for 5 times. The correlations between the fruit hardness and number of eggs laid by *B. dorsalis* in different pitaya varieties were analyzed using Pearson correlation coefficient with SPSS 22.0 software (IBM SPSS, USA).【Results】In the fully-ripe fruits, the number of eggs laid by *B. dorsalis* in 'Puhong' was the most (25.70±6.15), which was significantly more than all other treatments; in the half-ripe fruits, the number of eggs laid by *B. dorsalis* in 'Puhong' (18.45±5.13) and 'White Cinnamon Zeal' (20.80±7.03) was significantly more than other three treatments; in the unripe fruits, the number of eggs laid by *B. dorsalis* in 'Puhong' (10.13±1.25) and 'White Cinnamon Zeal' (12.45±4.80) was significantly more than all other treatments. As for the different maturity fruits from the five pitaya varieties, the number of eggs laid by *B. dorsalis* in the half-ripe fruits of 'Meilong 2' (83.67±3.61), 'Puhong' (119.67±10.52), and 'Taiwanese Dahong' (63.00±8.67) varieties was significantly more than that in other treatments; *B. dorsalis* laid more eggs in the fully-ripe and half-ripe fruits of 'Meilong' (51.67±6.42 and 58.40±5.40 for fully-ripe and half-ripe fruits, respectively) and 'White Cinnamon Zeal' (134.00±5.62 and 113.00±4.11 for fully-ripe and half-ripe fruits, respectively) varieties than in other treatments. Fruit hardness of 'Meilong 2', 'Meilong 6', 'White Cinnamon Zeal', 'Puhong', and 'Taiwanese Dahong' decreased significantly from (47.61±4.89), (49.20±1.78), (41.36±4.61), (47.34±3.80) and (47.61±2.75) $kg \cdot cm^{-2}$ to (20.30±3.28), (20.23±4.65), (26.42±1.75), (20.23±1.95) and (20.94±2.00) $kg \cdot cm^{-2}$, respectively, from unripe to fully-ripe. The fruit hardness of 'Meilong 6', 'White Cinnamon Zeal', and 'Puhong' varieties was negatively correlated with the number of eggs laid by *B. dorsalis*, respectively, while no correlation was found for the 'Meilong 2' and 'Taiwanese Dahong' varieties.【Conclusion】*B. dorsalis* preferred 'White Cinnamon Zeal', 'Puhong', and 'Taiwanese Dahong' to oviposite among all tested varieties and maturity fruits. Fruit hardness of the five pitaya varieties significantly decreased with the increase of fruit maturity, and the fruit hardness of 'Meilong 6', 'White Cinnamon Zeal', and 'Puhong' varieties was negatively correlated with the number of eggs laid by *B. dorsalis*, respectively. The results suggested that, in the cultivated area of 'White Cinnamon Zeal', 'Puhong', and 'Taiwanese Dahong', those varieties should be reduced (especially under the context where the acceptance level of these varieties was average among consumers), and the critical window of population management for *B. dorsalis* was the color-changed period of these tested pitaya varieties, during which green prevention and control for *B. dorsalis* should be considered to avoid possible pesticide residue.

Key words: Pitaya; *Bactrocera dorsalis*; Oviposition preference; Fruit maturity; Fruit hardness

橘小实蝇 *Bactrocera dorsalis*（Hendel）寄主广泛，包括火龙果（*Hylocereus undulatus* Britt）、番石榴（*Psidium guajava* L.）、李（*Prunus salicina* Lindl.）、番茄（*Lycopersicon esculentum* Miller）等250多种果蔬[1-3]，主要通过雌虫产卵至寄主果实内，幼虫孵化后取食危害[4]，造成落果和坏果，影响果实的质量和产量。

虽然其寄主广泛，但对不同寄主仍有一定的产卵选择。例如，在福建厦门地区的番石榴、杨桃（*Averrhoa carambola* L.）、杧果、番荔枝（*Annona squamosa* L.）、番橄榄（*Spondias dulcis* Parkinson）、黄皮果（*Clausena lansium*（Lour.）Skeels）、枇杷[*Eriobotrya japonica*（Thunb.）Lindl.]、人心果[*Manilkara zapota*（L.）van Royen]、洋蒲桃（*Syzygium samaran-*

gense Merr. & Perry)、鳄梨、橙和柑橘共12种水果中，橘小实蝇嗜好在番石榴上产卵[5-8]；在台湾地区的珍珠番石榴、毛叶枣(*Zizyphus mauritiana* Linn.)、洋蒲桃、柚和杧果共7种水果中，橘小实蝇在柚上的单雌产卵量最高(1 300.3粒)，在杧果上的最低(252.3粒)[9]。其次，橘小实蝇对同一寄主不同品种果实也有选择性。例如，在印度的‘Bangalora’‘Malik’‘Dashehari’和‘Amrapali’4个杧果品种以及‘Lucknow 49’和‘Allahabad’2个番石榴品种中，橘小实蝇偏好在‘Bangalora’和‘Lucknow 49’上产卵[10]。橘小实蝇对同一寄主不同成熟度果实也有选择性，尤其喜好近成熟且颜色艳丽的果实[11]。例如橘小实蝇对‘三华李’(*P. salicina* ‘Sanhuali’)的产卵选择性表现为黄果>红果>青果[12]；对洋蒲桃产卵选择性中，偏好在颜色鲜艳的成熟果实上产卵[13]。橘小实蝇对成熟果实的偏好性，与其挥发物及果表硬度有关[14]。例如，当番石榴果实硬度>11 kg·cm^{-2}时，橘小实蝇不会在其上面产卵[15]。最后，橘小实蝇对同一寄主果实不同部位也有选择性。例如，在‘三华李’、枇杷和石榴的黄熟果上，橘小实蝇主要集中在果蒂/梗处产卵[12,16]。

火龙果是一种集食用、观赏和加工于一体的新兴热带亚热带水果，近几年在我国华南地区广泛种植。据统计，2017—2018年仅广西火龙果种植面积就从1.98万hm^{2}增加至25万hm^2，总产量从0.1万t上升至25万t[17-18]。广西南宁市是广西火龙果主栽区，目前主要栽培的品种包括‘美龙2号’‘美龙6号’‘白肉桂热心’‘普红’和‘台湾大红’。然而，火龙果是最有利于橘小实蝇生长发育和繁殖的寄主之一[7]。目前，橘小实蝇对火龙果危害的研究主要集中在检验检疫、危害程度和发生规律等方面[3,19-21]。尚不清楚橘小实蝇对火龙果不同品种/成熟度果实的产卵选择，研究该问题有助于指导火龙果品种的选种和确定火龙果种植区橘小实蝇的最佳防控期，为火龙果橘小实蝇的可持续治理提供参考依据。

1 材料和方法

1.1 材料

1.1.1 *供试虫源* 橘小实蝇成虫采自广西玉林市玉州区西岸村(22°69'N，110°11'E)的番石榴园。将成虫置于养虫笼(长×宽×高 = 55 cm×55 cm×55 cm)内，在室内温度(26±1)℃、光周期L14:D10和相对湿度(70%±10%)条件下，用人工饲料($V_{酵母膏}$∶$V_{白糖}$=1∶5)饲养，100~200头•笼$^{-1}$。同时提供香蕉和番石榴供雌虫产卵，将着卵果置于另一网笼内铺有5 cm厚沙土的塑料盆(底部直径×顶部直径×高=16 cm×26 cm×11 cm)内，待其孵化和化蛹。挑出蛹单独置于塑料杯(底部直径×顶部直径×高 = 8 cm×12 cm×15 cm)内，将羽化后进入性成熟期(15~20 d龄)的雌雄成虫配对置于同一养虫笼内让其自然交配，取交配后的雌虫待用。

1.1.2 *供试寄主* 供试火龙果品种包括‘美龙2号’‘美龙6号’‘白肉桂热心’‘普红’和‘台湾大红’。其中，‘普红’‘台湾大红’和‘白肉桂热心’品种的火龙果采自广西南宁市那陈镇西宁村农户果园内(108°13′E，22°22′ N)；‘美龙2号’和‘美龙6号’品种火龙果采自广西南宁市那楼蒲庙镇南宁振企农业科技有限公司(108°33′ E，22°39′ N)。在2019年7月火龙果进入第二批果实采摘期，各成熟度火龙果均盛产时开始采果作为橘小实蝇供试寄主。每火龙果品种分别采不熟、半熟和全熟的果实若干(图1)，不熟单果质量为250~350 g，半熟和全熟果的单果质量为350~450 g。

1.2 方法

1.2.1 *橘小实蝇对5个火龙果品种相同成熟度果实的产卵选择* 随机选择质量基本一致、表皮无破损、成熟度为不熟的‘美龙2号’‘美龙6号’‘白肉桂热心’‘普红’和‘台湾大红’火龙果各1个，按对角线随机等距排列在养虫笼内(长×宽×高=90 cm×90 cm×90 cm)(图2)。养虫笼内移入30头已交配的橘小实蝇雌成虫，并放置少量成虫饲料和清水浸湿的脱脂棉，饲养条件同1.1.1。处理24 h后，将火龙果取出，并剖果检查和记录单果的着卵量，重复10次，每次重复时不同品种果实随机排列。橘小实蝇对不同火龙果品种成熟度为半熟和全熟果实的产卵选择研究方法同上。

1.2.2 *橘小实蝇对5个火龙果品种不同成熟度果实的产卵选择* 随机选择质量基本一致且表皮无破损的‘美龙2号’火龙果全熟、半熟和不熟3种成熟度果实各一个，按对角线随机等距排列在养虫笼内(长×宽×高=55 cm×55 cm×55 cm)，养虫笼内移入30头已交配的橘小实蝇雌成虫，并放置少量成虫饲料和清水浸湿的脱脂棉，饲养条件同1.1.1。处理24 h后，将火龙果取出，用果实硬度计GY-4(北京易事达公

A. 美龙 2 号；B. 美龙 6 号；C. 白肉桂热心；D. 普红；E. 台湾大红。图中从左至右依次为全熟、半熟和不熟的火龙果果实。

A. Meilong 2; B. Meilong 6; C. White cinnamon zeal; D. Puhong; E. Taiwanese Dahong. Fruits from left to right represents fully-ripe，half-ripe and unripe，respectively.

图 1　5 个品种火龙果及其不同成熟度果实的分级

Fig. 1　Fruit grading at different maturity of five varieties of pitaya

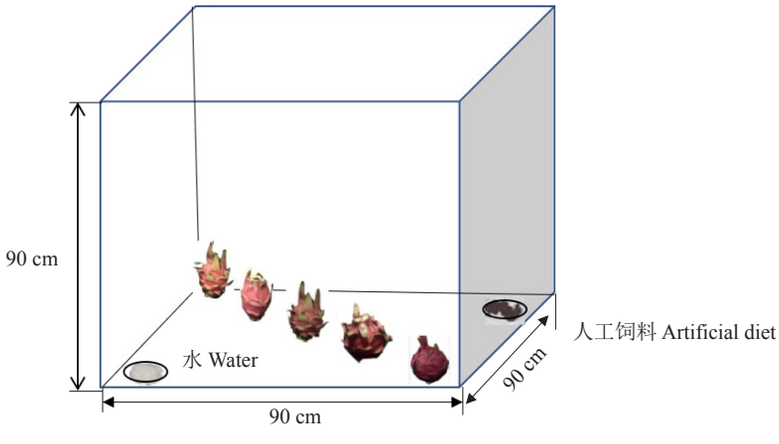


图 2　橘小实蝇对火龙果不同品种相同成熟度果实产卵选择示意图

Fig. 2　Diagram of the oviposition preference in females *Bactrocera dorsalis* to the same maturity fruits among five varieties of pitaya

司，中国）测定不同成熟度果实的硬度，并剖果检查和记录单果的着卵量，重复 10 次。测定不同成熟度果实硬度时，选择火龙果无苞片处光滑部位的中部，取刚戳破果皮的硬度为测量值（$kg \cdot cm^{-2}$），5 次重复；橘小实蝇对‘美龙 6 号’‘白肉桂热心’‘普红’和‘台湾大红’不同成熟度果实的产卵选择研究方法同上。

1.2.3　*数据分析*　采用 SPSS 22.0 软件进行数据统计分析。橘小实蝇对不同火龙果品种相同/不同成熟度果实的产卵选择和不同品种及成熟度火龙果果实硬度采用单因素方差分析（ANOVA），以平均数进行 Tukey 多重比较（$p < 0.05$）。采用 Pearson 相关性

检验分析着卵量与果实硬度的相关性($p < 0.05$)。采用GraphPad Prism 5.0软件制图。

2 结果与分析

2.1 橘小实蝇对5个品种火龙果相同成熟度果实的产卵选择

如图3所示,当火龙果果实均为全熟时,橘小实蝇在‘普红’品种上的着卵量最高(25.70±6.15),显著高于其他品种(F=48.540,df=4,49,$p < 0.05$),表现出的产卵偏好性为‘普红’>‘台湾大红’和‘白肉桂热心’>‘美龙2号’和‘美龙6号’。

当火龙果果实均为半熟时,橘小实蝇在‘普红’‘白肉桂热心’品种上的着卵量最高,分别为18.45、20.80粒•果$^{-1}$,显著高于其他品种(F= 36.415,df=4,49,$p < 0.05$),表现出的产卵偏好性为‘普红’和‘白肉桂热心’>‘台湾大红’和‘美龙2号’>‘美龙6号’。

当果实均为不熟时,橘小实蝇在‘普红’(10.13±1.25粒•果$^{-1}$)和‘白肉桂热心’(12.45±4.80粒•果$^{-1}$)品种上的着卵量最高,显著高于其他品种(F=38.496,df= 4,49,$p < 0.05$),表现出的产卵偏好性为‘普红’和‘白肉桂热心’>‘台湾大红’>‘美龙2号’和‘美龙6号’。

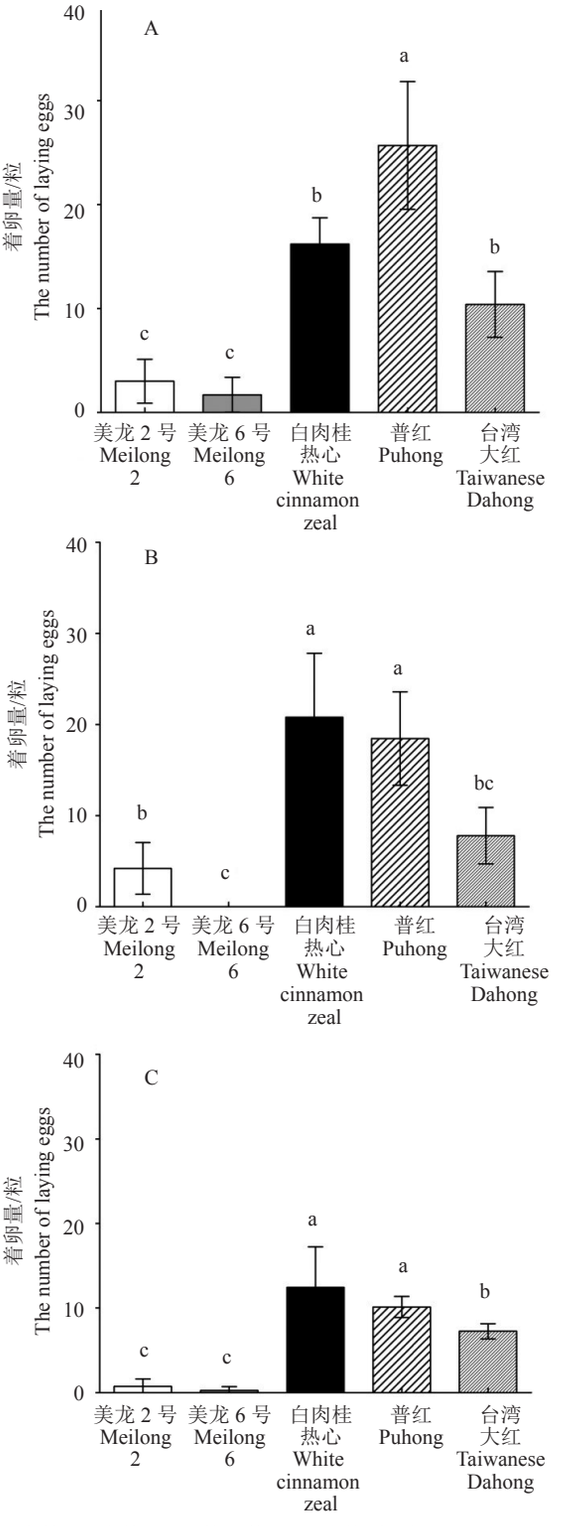
2.2 橘小实蝇对5个品种火龙果不同成熟度果实的产卵选择

如图4所示,橘小实蝇偏好在‘美龙2号’(F=221.117,df=2,29,$p < 0.05$)、‘普红’(F=66.623,df=2,29,$p < 0.05$)和‘台湾大红’(F= 97.860,df= 2,29,$p < 0.05$)半熟果上产卵,而偏好在‘美龙6号’(F=72.583,df = 2,29,$p < 0.05$)和‘白肉桂热心’(F=116.748,df=2,29,$p < 0.05$)的全熟和半熟果上产卵。

2.3 火龙果果实硬度对橘小实蝇产卵选择的影响

‘美龙2号’‘美龙6号’‘白肉桂热心’‘普红’和‘台湾大红’5个品种的果实硬度均随着成熟度的增加而显著降低(表1)。

‘美龙6号’(F=27.92,df=1,17,$p < 0.01$)、‘白肉桂热心’(F=50.74,df=1,17,$p < 0.01$)和‘普红’(F=24.23,df=1,18,p <0.01)3个品种的果实硬度与橘小实蝇的着卵量呈负相关,而‘美龙2号’(F=0.013 95,df=1,12,p =0.907 9)和‘台湾大红’(F=1.595,df=1,19,p =0.221 9)2个品种果实硬度与橘小实蝇着卵量无相关性(图5)。

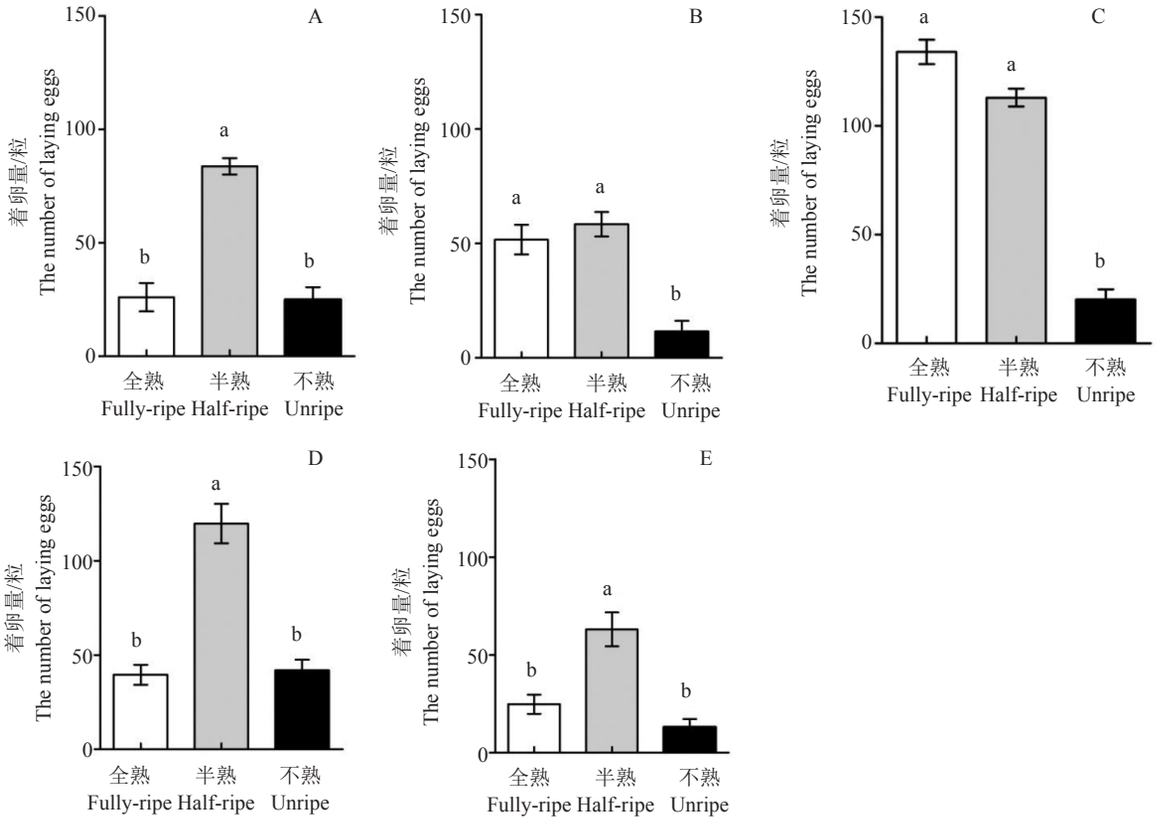


A. 全熟;B. 半熟;C. 不熟。数据(平均值±标准误)后不同小写字母表示差异显著($p < 0.05$)。

A. Fully-ripe; B. Half-ripe; C. Unripe. Values (Mean±SE) followed by different small letters mean significant differences ($p < 0.05$).

图3 橘小实蝇对5个品种相同成熟度火龙果的产卵选择

Fig. 3 Oviposition preference of females *Bactrocera dorsalis* to the same maturity fruits among five varieties of pitaya



A. 美龙 2 号；B. 美龙 6 号；C. 白肉桂热心；D. 普红；E. 台湾大红。数据（平均值±标准误）后不同小写字母表示差异显著（$p < 0.05$）。

A. Meilong 2; B. Meilong 6; C. White cinnamon zeal; D. Puhong; E. Taiwanese Dahong. Values (Mean±SE) followed by different small letters mean significant differences ($p < 0.05$).

图 4　橘小实蝇对 5 个品种火龙果不同成熟度果实的产卵选择

Fig. 4　Oviposition preference of females *Bactrocera dorsalis* to different maturity fruits among five varieties of pitaya

表 1　5 个品种火龙果不同成熟度果实的硬度

Table 1　The hardness of different maturity fruits among five varieties of pitaya

（kg·cm^{-2}）

成熟度 Maturity	美龙2号 Meilong 2	美龙6号 Meilong 6	白肉桂热心 White cinnamon zeal	普红 Puhong	台湾大红 Taiwanese Dahong
全熟果 Fully-ripe	20.30±3.28 c	20.23±4.65 c	26.42±1.75 c	20.23±1.95 c	20.94±2.00 c
半熟果 Half-ripe	32.50±5.69 b	32.40±3.02 b	35.03±1.48 b	36.05±5.31 b	34.81±1.36 b
不熟果 Unripe	47.61±4.89 a	49.20±1.78 a	41.36±4.61 a	47.34±3.80 a	47.61±2.75 a

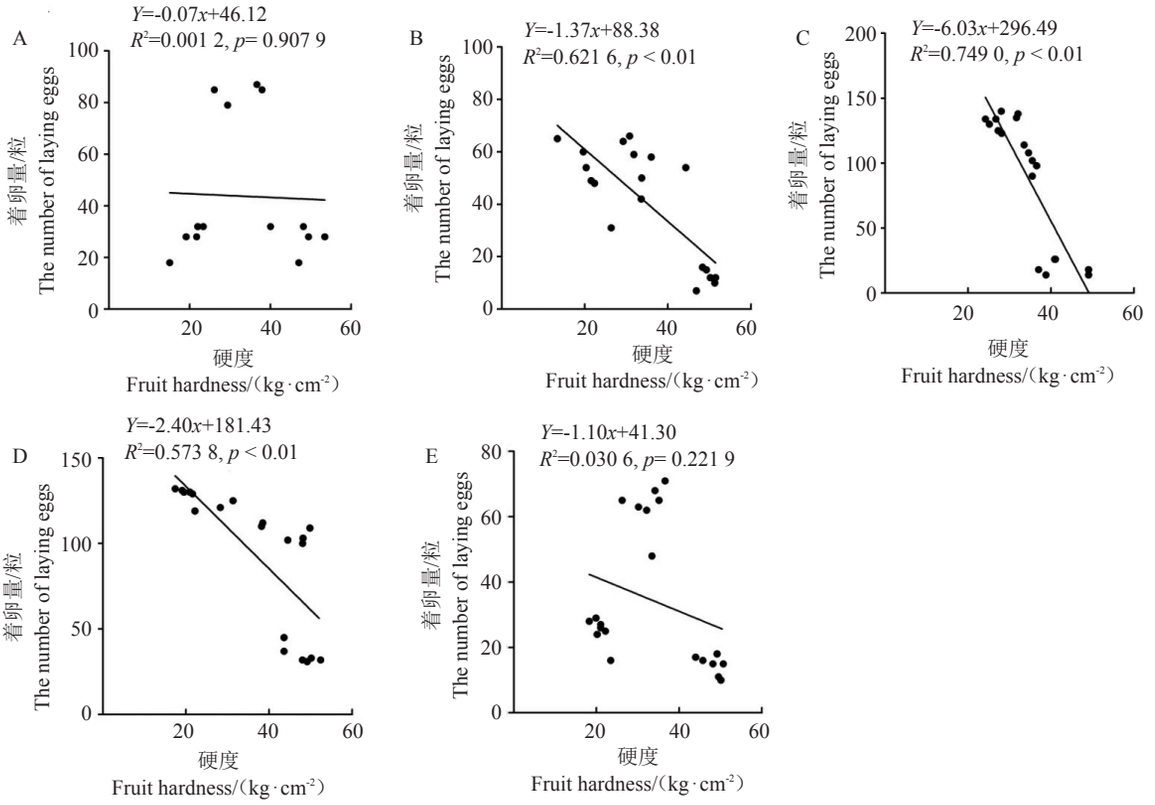
注：同列数据（平均值±标准误）后不同小写字母表示差异显著（$p < 0.05$）。

Note: Values (Mean±SE) followed by different small letters in the same column mean significant differences ($p < 0.05$).

3　讨　论

产卵选择是昆虫对寄主定位的重要行为之一。在产卵过程中，昆虫必须利用来自外部环境的线索选择合适产卵的寄主植物[22]，包括寄主植物种类/品种、成熟度、部位、颜色和气味等[23-25]。

本研究结果表明，橘小实蝇对火龙果不同品种果实的产卵选择存在差异，尤其偏好在‘普红’‘白肉桂热心’和‘台湾大红’3 个品种的果实上产卵。橘小实蝇在杧果不同品种果实上的产卵也存在类似现象[26-27]。例如，橘小实蝇对杧果品种‘Oakrong’的产卵选择高于‘Namdorkmai’[26]；相较于杧果‘台农 1 号’‘金凤凰芒’和‘胭脂芒’品种，橘小实蝇更偏好在‘三年芒’和‘红象牙芒’品种上产卵[27]。橘小实蝇对相同水果不同品种果实产卵选择的差异可能与其自身挥发性物质有关，因为橘小实蝇在搜寻寄主的过程中，寄主植物化学挥发物在定位中起主要作用[28]。例如，胭脂番石榴果的挥发物石竹烯对橘小实蝇雌虫有明显引诱作用[29]；‘巴掌’品种的洋蒲桃对橘小实蝇引诱力最弱，分析发现该品种含有橘小



A. 美龙 2 号；B. 美龙 6 号；C. 白肉桂热心；D. 普红；E. 台湾大红。

A. Meilong 2; B. Meilong 6; C. White cinnamon zeal; D. Puhong; E. Taiwanese Dahong.

图 5 火龙果果实硬度与橘小实蝇着卵量的相关性

Fig. 5 Correlation between fruit hardness and number of eggs laid by females *Bactrocera dorsalis* in different pitaya varieties

实蝇趋避的醇类物质的含量较高[30]。橘小实蝇对火龙果不同品种果实产卵选择的差异是否与其挥发性物质有关需进一步研究。本文研究结果提示，在生产上应尽量减少‘白肉桂热心’‘普红’和‘台湾大红’3个火龙果品种的栽培面积，既可避免橘小实蝇嗜好寄主受灾，还可降低橘小实蝇在嗜好寄主上种群积累的风险，有利于火龙果产业的健康发展。

此外，橘小实蝇偏好在火龙果全熟或半熟的果实上产卵，但不同品种间存在一定差异。这与前人研究橘小实蝇对‘砂糖橘’（*C. reticulata* Blancdo ‘Shatangju’）和‘四季蜜柑’（*M. indica* L. ‘Sijimimang’）[31]、‘Namdorkmai’杧果[26]和‘三华李’[12]的产卵选择结果相一致。例如，橘小实蝇对‘砂糖橘’和‘四季蜜柑’不同成熟度果实的产卵偏好为全熟＞半熟＞不熟[31]；而对‘Namdorkmai’杧果的产卵偏好为全熟、半熟>不熟[26]。橘小实蝇对同种水果不同成熟度果实产卵偏好的差异与果实硬度有关，因为果实越接近成熟期，其硬度越低，有利于橘小实蝇雌虫刺破果皮产卵和幼虫孵化[14]。本研究结果表明，随着这火龙果成熟度的增加，果实硬度显著降低；其中，火龙果‘美龙6号’‘白肉桂热心’和‘普红’3个品种的果实硬度与橘小实蝇的平均着卵量呈负相关，说明橘小实蝇偏好在该3个火龙果品种的成熟果上产卵，结果支持上述观点。当然，果实硬度并不是影响橘小实蝇产卵偏好的唯一因素，其他因素如何与果实硬度协调发挥吸引橘小实蝇产卵的作用尚需进一步研究。此外，本研究结果还提示在生产上火龙果转色期为防治该虫的关键期。

4 结 论

近年来火龙果在我国华南地区广泛种植，南宁市的火龙果已发展为闻名全国的火龙果产业。南宁种植较为广泛的5个品种火龙果中，橘小实蝇偏好在‘普红’‘白肉桂热心’和‘台湾大红’果实上产卵。从橘小实蝇防控及保产的角度出发，生产上可酌情减少火龙果‘白肉桂热心’‘普红’和‘台湾大红’3个品种的种植面积。此外，橘小实蝇偏好在火龙果‘美龙2号’‘普红’和‘台湾大红’品种半熟的果实上产

卵，因此，火龙果果实转色期为防治橘小实蝇的关键期。

参考文献 References：

[1] LEBLANC L. Invasive species compendium，*Bactrocera dorsalis* (oriental fruit fly) [EB/OL]. CABI，2015. https://www.cabi.org/isc/datasheet/17685#tohostPlants.

[2] GEIB S M，CALLA B，HALL B，HOU S B，MANOUKIS N C. Characterizing the developmental transcriptome of the oriental fruit fly，*Bactrocera dorsalis* (Diptera: Tephritidae) through comparative genomic analysis with *Drosophila melanogaster* utilizing modENCODE datasets[J]. BMC Genomics，2014，15: 942.

[3] 马艳粉，田先娇，胥勇，肖春 . 几种物质对火龙果园内桔小实蝇的诱集效果[J]. 中国南方果树，2017，46(2)：116-118.
MA Yanfen，TIAN Xianjiao，XU Yong，XIAO Chun. The trapping effect of several substances on *Bactrocera dorsalis* in pitaya orchard[J]. South China Fruits，2017，46(2):116-118.

[4] 张小凤 . 橘小实蝇气味结合蛋白在雌虫产卵寄主选择中的作用研究及其基因鉴定[D]. 武汉：华中农业大学，2014.
ZHANG Xiaofeng. The study of odorant blinding proteins function in oviposition host selection in females and the study of their identification[D]. Wuhan: Huazhong Agricultural University，2014.

[5] 刘慧，侯柏华，张灿，何日荣，梁帆，郭明昉，武目涛，赵菊鹏，马骏 . 桔小实蝇和番石榴实蝇对 6 种寄主果实的产卵选择适应性[J]. 生态学报 2014，34(9)：2274-2281.
LIU Hui，HOU Bohua，ZHANG Can，HE Rirong，LIANG Fan，GUO Mingfang，WU Mutao，ZHAO Jupeng，MA Jun. Oviposition preference and offspring performance of the oriental fruit fly *Bactrocera dorsalis* and guava fruit fly *B. correcta* (Diptera: Tephritidae) on six host fruits[J]. Acta Ecologica Sinica，2014，34(9): 2274-2281.

[6] 袁盛勇，肖春，孔琼，陈斌，李正跃，高永红 . 桔小实蝇的产卵选择性[J]. 江西农业大学学报，2005，27(1)：81-84.
YUAN Shengyong，XIAO Chun，KONG Qiong，CHEN Bin，LI Zhengyue，GAO Yonghong. Oviposition preference of *Bactrocera dorsalis* Hendel[J]. Acta Agriculturae Universitatis Jiangxiensis，2005，27(1): 81-84.

[7] 张清源，林振基，刘金耀，陈华忠，高泉准，孙国坤，洪赞侨，孙德华，陈加福 . 桔小实蝇生物学特性[J]. 华东昆虫学报，1998，7(2)：65-68.
ZHANG Qingyuan，LIN Zhenji，LIU Jinyao，CHEN Huazhong，GAO Quanzhun，SUN Guokun，HONG Zanqiao，SUN Dehua，CHEN Jiafu. Study on the biology of oriental fruit fly[J]. Entomological Journal of East China，1998，7(2): 65-68.

[8] NANGA N S，HANNA R，GNANVOSSOU D，KUATE A F，FIABOE K K M，DJIETO-LORDON C. Fruit preference，parasitism，and offspring fitness of *Fopius arisanus* (Hymenoptera: Braconidae) exposed to *Bactrocera dorsalis'* (Diptera: Tephritidae) infested fruit species[J]. Environmental Entomology，2019，6: 1286-1296.

[9] HUANG Y B K，CHI H. Fitness of *Bactrocera dorsalis* (Hendel) on seven host plants and an artificial diet[J]. Turkiye Entomoloji Dergisi- Turkish Journal of Entomology，2014，38(4): 401-414.

[10] KALIA V. Bionomics of fruit fly *Dacus dorsalis* on some cultivars of mango and guava[J]. Bulletin of Entomology (New Delhi)，1992，33: 79-87.

[11] 许益镌，曾玲，陆永跃，林进添 . 桔小实蝇对不同水果产卵的选择性[J]. 华中农业大学学报，2005，24(1)：25-26.
XU Yijuan，ZENG Ling，LU Yongyue，LIN Jintian. Oviposition selection of the *Bactrocera dorsalis* (Hendel) to the different fruits[J]. Journal of Huazhong Agricultural University，2005，24 (1): 25-26.

[12] 李媛，黄爱玲，黄慧欣，王小云，郑霞林，陆温 . 橘小实蝇对三华李果实的产卵选择[J]. 南方农业学报，2020，51(2)：319-326.
LI Yuan，HUANG Ailing，HUANG Huixin，WANG Xiaoyun，ZHENG Xialin，LU Wen. Oviposition selectivity of *Bactrocera dorsalis* (Hendel) to *Prunus salicina*[J]. Journal of Southern Agriculture，2020，51(2): 319-326.

[13] 周双云，刘增亮，龙兴，唐文忠，方仁，邓彪，安振宇，尧金燕 . 桔小实蝇在莲雾上的发生规律及产卵选择性研究[J]. 中国南方果树，2020，49(1)：65-69.
ZHOU Shuangyun，LIU Zengliang，LONG Xing，TANG Wenzhong，FANG Ren，DENG Biao，AN Zhenyu，YAO Jinyan. Study on the occurrence regularity and oviposition selectivity of *Bactrocera dorsalis* on lotus mist[J]. South China Fruits，2020，49(1): 65-69.

[14] 蔡子坚，胡菡青，韦晓霞，陈瑾，林雄杰，范国成，吴如健 . 杨桃果实性状与橘小实蝇危害严重度的关系[J]. 福建农业学报，2012，27(12)：1298-1302.
CAI Zijian，HU Hanqing，WEI Xiaoxia，CHEN Jin，LIN Xiongjie，FAN Guocheng，WU Rujian. Traits and damage of carambola fruit by *Bactrocera dorsalis*[J]. Fujian Journal of Agricultural Sciences，2012，27(12): 1298-1302.

[15] 郑玉忠，张振霞，成小莲，刘博聪，陈锦武，黄培钿 . 橘小实蝇对不同硬度番石榴果实的产卵选择[J]. 昆虫知识，2009，46(2)：301-303.
ZHENG Yuzhong，ZHANG Zhenxia，CHENG Xiaolian，LIU Bocong，CHEN Jinwu，HUANG Peidian. Ovipositional preference of the *Bactrocera dorsalis* to *Psidium guajava* fruits with different hardness[J]. Chinese Bulletin of Entomology，2009，46(2): 301-303.

[16] 方薛交，闫振华，张金龙，朱文禄，张文华，岳蕊，蒋小龙，吴浩，陈国华，陶玫 . 桔小实蝇成虫对不同水果的产卵为害特点及种群动态[J]. 云南农业大学学报（自然科学版），2017，32(2)：212-217.
FANG Xuejiao，YAN Zhenhua，ZHANG Jinlong，ZHU Wenlu，ZHANG Wenhua，YUE Rui，JIANG Xiaolong，WU Hao，CHEN

Guohua，TAO Mei. The characteristics of oviposition and population dynamics of *Bactrocera dorsalis* in different fruit orchards in Mengzi[J]. Journal of Yunnan Agricultural University (Natural Science)，2017，32(2): 212-217.

[17] 覃新强 . 中国火龙果看广西 广西火龙果看南宁 第四届中国火龙果产销对接峰会在南宁开幕[J]. 食品安全导刊，2019(20)：18-19.
QIN Xinqiang. The 4th China pitaya production and marketing summit has opened in Nanning[J]. Food Safety China，2019(20): 18-19.

[18] 刘光琳，张仲高 . 南宁火龙果，全国龙头崛起之谜[J]. 农家之友，2019(7)：4-8.
LIU Guanglin，ZHANG Zhonggao. Pitaya in Nanning，the mystery of rise of the national leader[J]. Nong Jia Zhi You，2019(7): 4-8.

[19] 苏仕凤 . 桔小实蝇对广西火龙果的为害及防治[J]. 中国热带农业，2013(5)：52-53.
SU Shifeng. Damage and control of *Bactrocera dorsalis* on pitaya in Guangxi[J]. China Tropical Agriculture，2013(5): 52-53.

[20] 黄慧欣，何昌玮，李媛，黄爱玲，王小云，郑霞林，陆温 . 南宁市火龙果产区桔小实蝇成虫消长规律研究[J]. 中国南方果树，2020，49(2)：65-70.
HUANG Huixin，HE Changwei，LI Yuan，HUANG Ailing，WANG Xiaoyun，ZHENG Xialin，LU Wen. Study on the population dynamics of *Bactrocera dorsalis* (Hendel) adults in pitaya-producing areas in Nanning[J]. South China Fruits，2020，49(2): 65-70.

[21] 娄定凤 . 深圳口岸输入台湾水果的疫情特征[C]//中国植物保护学会：2007 年学术年会论文集，2007，9：61-69.
LOU Dingfeng. Epidemic characteristics of fruits imported from Taiwan at Shenzhen Port[C]// China Society of Plant Protection: Conference Proceedings of Academic Annual Conference in 2007，2007，9: 61-69.

[22] KRODER S，MESSING R H. A new parasitoid from Kenya，*Fopius ceratitivorus*，complements the extant parasitoid guild attacking Mediterranean fruit fly in Hawaii[J]. Biological Control，2010，53(2): 223-229.

[23] PIETERSE W，MANRAKHAN A，TERBLANCHE J S，ADDISON P. Comparative demography of *Bactrocera dorsalis* (Hendel) and *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae) on deciduous fruit[J]. Bulletin of Entomological Research，2020，110(2): 185-194.

[24] EKESI S，MOHAMED S，DE MEYER M. Fruit fly research and development in Africa-Towards a sustainable management strategy to improve horticulture[M]. Switzerland: Springer International Publishing，2016.

[25] EKESI S，DE MEYER M，MOHAMED S A，VIRGILIO M，BORGEMEISTER C. Taxonomy，ecology，and management of native and exotic fruit fly species in Africa[J]. Annual Review of Entomology，2016，61: 219-238.

[26] RATTANAPUN W，AMORNSAK W，CLARKE A R. *Bactrocera dorsalis* preference for and performance on two mango varieties at three stages of ripeness[J]. Entomologia Experimentalis et Applicata，2009，131(3): 243-253.

[27] 叶文丰，李林，谢长伟，董文霞，肖春 . 橘小实蝇对五个芒果品种的产卵偏好及清理落果防治效果研究[J]. 应用昆虫学报，2013，50(4)：1126-1132.
YE Wenfeng，LI Lin，XIE Changwei，DONG Wenxia，XIAO Chun. The effectiveness of removing fallen fruit on control of the oriental fruit fly *Bactrocera dorsalis* and evaluation of the infestation rate of this pest in five mango varieties[J]. Chinese Journal of Applied Entomology，2013，50(4): 1126-1132.

[28] PROKOPY R J，GREEN T A，VAGRAS R I. *Dacus dorsalis* flies can learn to find and accept host fruit[J]. Journal of Insect Behavior，1990，3(5): 663-672.

[29] 吴健，宋学森，胡碗晴，蔡普默，陈家骅 . 8 种寄主植物挥发物对橘小实蝇的引诱作用[J]. 福建农林大学学报(自然科学版)，2018，47(6)：655-660.
WU Jian，SONG Xuesen，HU Wanqing，CAI Pumo，CHEN Jiahua. The attractiveness of eight host volatile compounds to *Bactrocera dorsalis* Hendel[J]. Journal of Fujian Agriculture and Forestry University (Natural Science Edition)，2018，47(6): 655-660.

[30] 金菊，阮赞誉，黄珍富，赖贵炎，黄颂颂，范骁凌 . 莲雾果实挥发物对橘小实蝇的引诱作用[J]. 华南农业大学学报，2015，36(3)：71-77.
JIN Ju，RUAN Zanyu，HUANG Zhenfu，LAI Guiyan，HUANG Songsong，FAN Xiaoling. Attractions of volatiles from wax-apple fruit to the oriental fruit fly[J]. Journal of South China Agricultural University，2015，36(3): 71-77.

[31] 段云博 . 柑橘和芒果主产区橘小实蝇的发生及转移为害规律研究[D] 南宁：广西大学，2018.
DUAN Yunbo. Study on the occurrence regulation of *Bactrocera dorsalis* (Hendel) in the citrus and mango-producing areas [D]Nanning: Guangxi University，2018.