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研究论文

三种麦蚜在温度梯度中活动行为的临界高温

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摘要 利用自制的温度梯度产生装置，研究了禾谷缢管蚜*Rhopalosiphum padi*、麦长管蚜*Sitobion avenae*和麦二叉蚜*Schizaphis graminum*在寄主植物叶片温度梯度上栖息、爬行和取食时的躲避临界高温。温度梯度内，麦蚜在小于等于温度T的温度区域内的累积栖息分布量占温度梯度场内蚜虫栖息总量的百分比Pa=90%时，则把T记为栖息躲避临界高温。将蚜虫在温度梯度内从低温端向高温端爬行的过程中，受到热刺激后调转运动方向时的温度定义为蚜虫爬行时的躲避临界高温。将蚜虫在温度逐渐升高的叶片上取食时拔出口针开始挣扎逃跑时的温度定义为蚜虫取食时的躲避临界高温。为研究麦蚜栖息和爬行时的躲避临界高温，在盛有水的搪瓷托盘一端下方置一盏白炽灯加热水温，在漂浮于水面的小麦叶片上产生了叶片温度梯度，用照相机记录蚜虫在温度梯度内栖息时的分布状态。为研究麦蚜取食时的躲避临界高温，在盛有水的塑料培养皿的下方设置一盏白炽灯用于加热水温，在漂浮于水面的小麦叶片上产生逐渐升高的温度。两个装置的温度设置均可通过调节白炽灯泡顶端与托盘或培养皿底部的距离来控制，用红外测温仪测量叶片上的温度。试验明确了3种麦蚜的栖息躲避临界高温，在26~43℃的叶片温度梯度内，禾谷缢管蚜、麦长管蚜和麦二叉蚜成蚜累积栖息分布达90％的临界高温分别为30.2、28.8℃和27 3℃，用Sigmoidal函数模型描述了麦蚜在温度梯度内的累积分布百分率与温度之间的关系。测定了3种麦蚜爬行和取食时的躲避临界高温，禾谷缢管蚜、麦长管蚜和麦二叉蚜爬行时的躲避临界高温分别为42.0、39.1℃和38.5℃；取食时的躲避临界高温分别为39.3、40.2℃和39.0℃。试验表明，3种蚜虫中禾谷缢管蚜较耐高温。讨论了温度梯度本身的设置、湿度控制、供试蚜虫种群的不同对麦蚜在温度梯度内行为可能造成的影响，并指出在温度梯度中，研究麦蚜若蚜蜕皮、成蚜生殖及有翅蚜和无翅蚜对适宜温度的选择将是今后继续开展的工作内容。本研究的结果为提高麦蚜田间调查取样及预测预报的准确度提供了依据，同时也为今后开展其它昆虫对环境高温的行为对策研究提供方法上的参考。

关键词 麦蚜；温度梯度；活动；临界高温

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Upper critical temperatures for behaviors of three species of cereal aphids in leaf temperature gradients

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Abstract We carried out three experimental studies to investigate the upper critical temperatures of cereal aphids, *Rhopalosiphum padi*, *Sitobion avenae* and *Schizaphis graminum*, for inhabiting, crawling and feeding with self-made temperature gradient apparatus. The temperature gradient for testing inhabiting and crawling of aphids was generated across a wheat leaf which floated on the water in an enamelware tray by heating one side of the tray with an incandescent light under the tray. The gradually increasing temperature for testing feeding behavior of aphids was generated on a wheat leaf which floated on the water in a plastic petri dish by setting an incandescent light under the petri dish for heating. Temperatures of the two kinds of temperature gradients were controlled by lengthening or shortening the spatial distance between the top of the adjustable incandescent light and the bottom of enamelware tray or plastic petri dish. Infrared thermometer was used to measure the temperatures on wheat leaves in each study. Digital camera was used to record the distribution of tested aphids in leaf temperature gradient when studying the upper critical temperatures of cereal aphids for inhabiting. Upper critical temperature for inhabiting is defined as the temperature below which the accumulative percentage (P_a) of tested aphids distributed in certain temperature gradient had reached to 90%. Our results indicate that, in the leaf temperature gradien

t (26-43℃), the upper critical temperatures of R. padi, S. avenae and S. graminum for inhabitin g were 30.2, 28.8℃ and 27.3℃ respectively, when the Pareached to 90%. P_a were influence d by the temperatures along the temperature gradient and can be described with a “Sigmoidal” m odel. Upper critical temperature for crawling is defined as the temperature at which the tested aph ids began to turn back when they were moving along the temperature gradient from the cool side t o the hot side. Meanwhile, upper critical temperature for feeding is defined as the temperature a t which the tested aphids began to pull out the stylet from the host leaf and escape, when they wer e feeding on the increasingly heated plant leaves. Our results show that the upper critical temperat ures of R. padi, S. avenae and S. graminum were 42.0, 39.1℃ and 38.5℃ respectively, for cra wling; and 39.3, 40.2℃ and 39.0℃ for feeding. Our results show that R. padi has higher toleran ce to high temperature than S. avenae and S. graminum. We discussed the potential effects of tem perature extent, relative humidity and source of the tested aphid populations on the behavioral res ponse of cereal aphids to temperature gradient. More detailed investigation should be carried ou t in the future on favourable temperatures for ecdysis of nymphs and reproduction of adults, and t he differences between apterous and alatae for temperature preference. Our results may be helpfu l to improve the sampling method of the cereal aphids in the fields, and enhance the accuracy of fo recasting the infestation of cereal aphids. Our experimental apparatus and methods supply an exa mple in studies on temperature preference of other species of insects.

Key words cereal aphids _ temperature gradient _ behavior _ critical temperature

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