斜纹夜蛾和烟青虫在烟草上的生态位

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摘要:斜纹夜蛾和烟青虫同是烟草上食叶类的重要害虫 ,对烟叶产量和品质均可构成严重的影响。研究两者在烟草上的生态位和种间关系 ,结果表明斜纹夜蛾的空间生态位宽度和空间生态位重叠指数均略大于烟青虫 ,两者空间生态位的比例相似性为 0. 0973 ,说明两种害虫在空间资源上几乎不存在竞争。斜纹夜蛾和烟青虫的时间生态位及时间生态位重叠指数很接近 ,时间生态位的比例相似性高达 0. 9485。斜纹夜蛾和烟青虫在烟草植株上、中、下部叶片共存的比例分别为 6. 11 %、3. 23 %和 0. 51 %。由于对空间垂直资源的不同选择 ,使它们可以同时在同株烟草上为害而互不干扰。

关键词:烟草 ,斜纹夜蛾 ;烟青虫 ;生态位

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Niches of Spodoptera litura (Fabricius) and Helicoverpa assulta (Guenée) in tobacco plants

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Abstract: Tobacco caterpillar (*Spodoptera litura* (Fabricius)) and oriental tobacco budworm (*Helicoverpa assulta* (Guenée)) are important insect pests on tobacco which causing serious damage by defoliation. The niches and relationships of the two species were studied in this paper. The results indicated that the spatial niche breadth value and spatial niche overlap value of *S. litura* were higher than that of *H. assulta* , the spatial niche similarity between them was 0. 0973. The temporal niche breadth values and temporal niche overlap values of *S. litura* and of *H. assulta* were very similar , and the temporal niche similarity between them was 0. 9485. The coexistence ratios of *S. litura* and *H. assulta* on upper leaves , mid-leaves and underneath leaves of tobacco plants were only 6. 11 % , 3. 23 % and 0. 51 % , respectively. The results may suggest that the competition between *S. litura* and *H. assulta* is extremely improbable. The two species can occur and damage on the same tobacco plant at the same time because they incline to choose different spatial vertical resources.

Key words: Tobacco ; *Spodoptera litura* ; *Helicoverpa assulta* ; niche

Segregation by habitat is a common means by which ecologically similar species partition resources[1]. Competition occurs when these species occupy the same resources. Competition is usually classified as either exploitative or interference[2]. Interspecific competition can influence habitat utilization and a superior species may exclude an inferior one from parts of its fundamental niche or , in extreme cases , make it go extinct[3,4]. Hutchinson provided the valuable distinction between the fundamental niche , which is the range of theoretical possibilities , and the realized niche that part

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which is actually occupied, given interactions with other species such as competition[5]. In ecological system, the different species have different feeding behaviours, environmental requirements and choice and utilization of resources, these differences play an important role in niche segregation[4, 6-12].

Tobacco caterpillar (*Spodoptera litura* (Fabricius)) and oriental tobacco budworm (*Helicoverpa assulta* (Guenée)) are important insect pests on tobacco. The biology and ecology of the two species had been extensively researched[13-16]. However, in these studies, entomologists used to only take one of them as the object of study, and they didn't probe into the ecological relationships of them, such as the spatial vertical distribution pattern of them and if they will compete against each other for occupying spatial vertical resources and so on, which, so far, were not regarded by entomologists. Therefore, we combined *S. litura* with *H. assulta* and regarded them as an entity in our study, moreover, we carried out this study to understand the ecological relationships of *S. litura* and *H. assulta* on tobacco plants and the results of our research will provide scientific basis for the monitoring and controlling of the two species.

1 Material and methods

1.1 Study Sites

This study was conducted in the tobacco field at the experimental farm of Nanxiong Research Institute of Tobacco, Nanxiong, Guangdong Province.

1.2 Tobacco Variety

Nicotiana sp. 9601 variety was planted on 16 February in 2005 and the density was about 1100 plants per 667 m^2.

1.3 Investigation

Investigation was conducted from 14 April to 3 June in 2005 at Nanxiong. 180 plants of tobacco were sampled every time in tobacco field by "checkerboard model" and investigated 1 time every 4 days. Spatial vertical resources in tobacco plants were divided into three grades containing upper leaves, mid-leaves and underneath leaves. Temporal resources were divided by sampling and investigation times. The number of *S. litura* and *H. assulta* larvae in various positions were recorded every time.

1.4 Statistical Analyses

In order to master the population dynamics of *S. litura* and of *H. assulta*, the number of *S. litura* and of *H. assulta* per 180 tobacco plants were analyzed from 14 April to 3 June in 2005, respectively. To search for the ecological relationship of *S. litura* and *H. assulta*, the niche of the two species were compared.

Niche breadth was calculated by $B = 1/\left(\sum_{i}^{s} p_i^2\right)$ [19]. In this formula, B is niche breadth of species, S is the number of resource grades and P_i is the ratio of "i" grade resource used by species in total resources. Niche overlap was measured by $L_{ij} = \sum_{h}^{s} p_{ih} p_{jh} (B_i)$, where L_{ij} is the niche overlap index value which "j" species is overlapped by "i" species, P_{ih} and P_{jh} are the ratios of "h" grade resource used by "i" species and by "j" species in total resources, respectively and B_i is the niche breadth of "i" species[17]. The similarity of niche was calculated by $C_{ij} = 1 - 1/2 \sum_{h}^{s} | P_{ih} - P_{jh} |$, where C_{ij} is the similarity of niche of "i" species and "j" species and P_{ih} and P_{jh} are the same as above[18]. Temporal and spatial two-dimensional niches were measured by May provided "multidimensional niche models"[19].

2 Results

2.1 Population Dynamics of *S. litura* and *H. assulta*

The results showed that the densities of *S. litura* were always lower before 29 April, but higher from 29 April to 24 May, while lower again from 24 May to 3 June compared to that of *H. assulta*. Except for from 24 April to 29 April and

from 19 May to 29 May in 2005, the tendency of population dynamics of the two species was homogenous (Fig. 1).

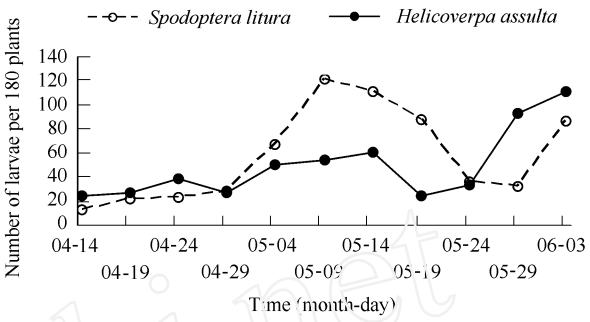

Fig. 1　Population dynamics of *S. litura* and *H. assulta* on tobacco

2.2　Niches of *S. litura* and *H. assulta*

The spatial niche breadth value and spatial niche overlap value of *S. litura* were higher than that of *H. assulta*, and the spatial niche similarity between the two species was 0.0973. The results reveal that the active scope of *S. litura* was larger than that of *H. assulta*, and the vertical distribution of the two species on spatial resources was significantly different. The temporal niche breadth value and temporal niche overlap value of *S. litura* was very similar to that of *H. assulta*, and the temporal niche similarity between them was 0.9485. The results suggest that *S. litura* and *H. assulta* may occur and damage in tobacco fields at the same time.

Temporal and spatial two-dimensional niche breadth of *S. litura* has a relatively higher value than that of *H. assulta*, and the two species have comparatively low values in the two-dimensional niche overlap and the two-dimensional niche similarity (Table 1). These results demonstrated that there was an extremely little probability of the two species occurring and damaging on the same position of tobacco plants at the same time.

Table 1　Niches of S. litura **and** H. assulta **on tobacco**

Items	Niche breadth		Niche overlap		Niche similarity	
	S. litura	*H. assulta*	*S. litura*	*H. assulta*	*S. litura*	*H. assulta*
Spatial niche						
S. litura	0.4636	—	1	0.0228	1	0.0973
H. assulta	—	0.3613	0.0292	1	0.0973	1
Temporal niche						
S. litura	0.7016	—	1	0.0785	1	0.9485
H. assulta	—	0.7622	0.0722	1	0.9485	1
Two-dimensional niche						
S. litura	0.3253	—	1	0.0785	1	0.0923
H. assulta	—	0.2754	0.0021	1	0.0923	1

2.3　The damage of *S. litura* and *H. assulta* on tobacco plants

The most number of *S. litura* larvae occurred on underneath leaves, whereas *H. assulta* larvae prefer to damage upper leaves of tobacco plants and the coexistence ratios of the two species on upper leaves, mid-leaves and underneath leaves of tobacco plants were only 6.11 %, 3.23 % and 0.51 %, respectively (Fig. 2).

3　Discussion

The results of our investigation in tobacco fields reveal that *S. litura* prefer to damage tobacco underneath leaves, while *H. assulta* prefer to concentrate on upper leaves. In early growth period, from 14 April to 29 April, the number of *H. assulta* was found to be superior to that of *S. litura*, but the number of *S. litura* was higher than that of *H. assulta* in middle growth period, from 29 April to May 24. However, in later growth period, from 29 May to 3 June, *S. litura* revealed lower densities compared to *H. assulta* again. The tobacco underneath leaves began to be reaped on 16 May, then underneath leaves were reaped on 24 May, 29 May and 1 Junne, respectively. Consequently, we may suggest that *H. assulta* may adapt for a lower temperature environment than *S. litura* in early spring, but the reproduction of the

population of *S. litura* was faster than that of *H. assulta*. The underneath leaves of tobacco plants were reaped which could affect on *S. litura*, so the population of *S. litura* decreased as underneath leaves of tobacco plants were reaped, but *H. assulta* wasn't affected by the reaping of tobacco underneath leaves because they live in upper leaves of tobacco plants.

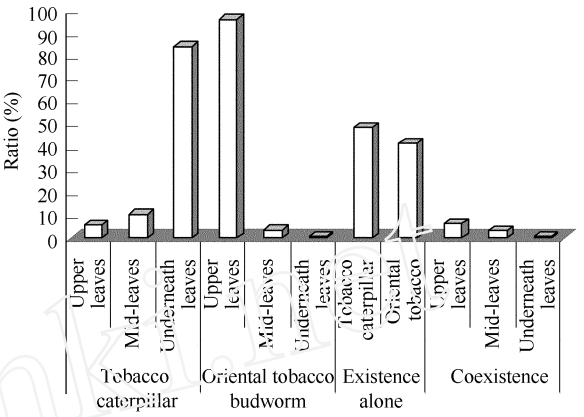

Fig. 2 The damage of *S. litura* and *H. assulta* on tobacco plants

The "niche" is recognized as the status and function of a species in a definite *n*-dimensional space within a definite community. Although biologists have questioned such an approach, describing patterns of coexistence of species traditionally assumes that each species is adapted to exploit a unique niche-shady or sunny, wet or dry, etc., thus allowing coexistence. Niche differentiation occurs along several dimensions to facilitate coexistence. Under the premise of *n*-dimensional hyper-volume, niche differentiation (and resource-use overlap) is generally complementary; when species are similar on 1 dimension, they differ on another. However, in fact, those species which live in the same ecological spatial resource often conflict for occupying more food resource, especially in short of food resource. For insect pests on crops, the damage of crops may reduce when competitions exist between two species of insect pests, because one of them may exclude the other one. For example, Luo *et al*[4]. provided *H. assulta* and *H. armigera* couldn't live in the same tobacco plants at the same time because they locate similar spatial niches, and the intense competition occurred between them for occupying spatial vertical resources, thus the same tobacco plant may not be damaged by the two species at the same time, which will decrease the damage degree of tobacco. In order to define the relationships of *S. litura* and *H. assulta* and attest to whether competitions occurred between the two species, niche relationships and the damage of them on tobacco plants were further researched. The results showed that the spatial niche similarity between *S. litura* and *H. assulta* was far lower than the temporal niche similarity between them, and the coexistence ratios of them on the same position of tobacco plants revealed an extremely little value. These results suggest that the competition between *S. litura* and *H. assulta* is improbable, and they can occur and damage on the same tobacco plant at the same time because they incline to choose different spatial vertical resources. From these conclusions, we may suggest that the damage of tobacco may be more serious when the two species occur together on tobacco. Consequently, the population dynamics of the two species should be monitored and they should be regarded as the targets of controlling in tobacco fields, synchronously.

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