Influence of Seasonal and Daily Changes of Spatial Niche of Spiders in Paddy Field and Two Insecticides to Spatial Niche and Predatory Function

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Abstract: The experiment was conducted in the experimental farm of Yangzhou Agricultural School. Rice was transplanted on 21 June 1999. A plot (0.1333hm²) was selected for spatial niche observation, and another four plots, 0.01667hm² for each plot, were used for comparing the effect of spraying of two insecticides, bisulfate and methamidophos, at common dosage at different time on niche breadths of spiders and planthopper and predation function of spiders. Rice plants were distinguished into three resource grades, upper leaf layer, stem and base. Number of spiders and planthoppers was recorded on schedule. Number of various species in leaf, stem and base was observed in morning (6:00), at noon (12:00) and in afternoon (18:00) at three selected stages of rice, 21 July, 22 August and 10 September (representatives of early-, middle- and late-stage of rice, respectively). The niche breadth (Bn) was measured using the equation index, $Bn = \frac{1}{\sum_{i=1}^{s} p_i^2}$, where $Bn$ is the niche breadth of observed species, $p_i$ is the proportion occupied by the species in total resource series, and $s$ is total resource series number. Measurements of similarity were calculated using Schoener index of proportional similarity of niche, $C_{ij} = \frac{\sum_{i=1}^{s} p_i^2}{\sum_{i=1}^{s} p_i^2}$.
1 - \frac{1}{2} \sum_{k=1}^{s} |P_{ih} - P_{jh}|$, where $C_{ij}$ is the measurements of similarity of niche, $P_{ih}$ is the proportion occupied by species $i$ in resource series $h$, $P_{jh}$ is the proportion occupied by species $j$ in some resource series $h$. Function decrease rate was also used to evaluate the effect of spraying two insecticides on predation function of spiders. $FD_i = D_i + (1 - D_i) (F_{i} - F_{i})/F_{i}$, where $FD_i$ is the function decrease rate of natural enemies at time $t$, $D_i$ is the mortality rate of natural enemies at time $t$, $F_i$ is the predation function of surviving natural enemies at time $t$ after insecticide application, $F_{i}$ is the one of control (CK), meanwhile, the spiders were considered as a predator guild, thus the function decrease rate of the guild after insecticide application ($FD$) can be obtained by the following equation, $FD = \sum_{i=1}^{s} a_i \times FD_i$, where $a_i$ is the predation share of species $i$ in the whole predation number of the guild, calculating by the following equation, $a_i = \frac{N_{a_i} \times B_i}{\sum_{i=1}^{s} N_{a_i}}$, where $N_{a_i}$ is the mean predation number of the spider $i$ in the field, which was the predation number in disc equation of function response when $N$ is 10, $B_i$ is the relative abundance of the species $i$ in the guild. The results were as follows:

The spatial niche breadth of spiders and planthopper varied with season, but different species had different regularity. The trend of the spatial niche breadth of Micryphantidae and planthopper was consistent before 22 August, but opposite after that, That of Lycosidae increases gradually as rice development, but that of Tetragnathidae was just opposite; that of Tetragnathidae decreased continually before 22 August, but there was a peak on September 1, and declined quickly. That of Theridiidae reached the maximum during late August to early September.

Change of spatial niche in a day varied with species. The spatial niches of planthopper and Theridiidae were broadest in morning, narrowest in afternoon; that of Saltidae was narrowest in morning, but broadest in afternoon; Tetragnathidae was similar with Saltidae during July to August, but inversely during September. However, that of wolf spiders was narrowest in morning and broadest at noon during July to August, but narrowest at noon during September; that of Micryphantidae and Araneidae was changeable, without obvious regularity.

Proportional similarity index ($C_{ij}$) was an important index reflecting the species similarity for resource utilization. The bigger the value is, the bigger the similarity extent of the distribution in resource series between species was. The index of wolf spiders was smaller than other species, but other species had bigger ones with one another. Among spiders, Micryphantidae had biggest similarity index with planthopper, other species also had higher ones with planthopper. This indicated that spiders have very high encountering chance with planthopper, which was related to the habitats of themselves. Wolf spiders mainly distributed on the base of rice plant, and Tetragnathidae mainly on leaf and stem, so $C_{ij}$ between the former and the later was the smallest, being only 0.2576; Apart from planthopper and Micryphantidae, other species mainly distributed on stem, so they have smaller ones with wolf spiders.

Application of bisulfate and methamidophos in morning and in afternoon showed different effects on spatial niche of spiders and planthopper. For bisulfate application in morning, the niche of Micryphantidae and planthopper was broader than CK, while that of Tetragnathidae and Lycosidae was just opposite; for methamidophos application in afternoon, the niche of Micryphantidae, Tetragnathidae and Theridiidae was broader than CK in morning, but inversely for wolf spiders and planthopper. Generally, the impacts of methamidophos on spatial niche of spiders were bigger than that of Bisulfate, but inversely for planthopper.
Spraying of two insecticides in morning and in the afternoon also had different impacts on predation function. The effects of spraying of bisultap in morning on predation functions of Micryphantidae, Lycosidae and Theridiidae were bigger than that in afternoon, and there are the same results for predator guild, but reverse for Tetragnathidae; methamidophos application had the opposite results with bisultap.

To minimize the effects of insecticides on spiders, it was better to spray in afternoon than in morning, but reverse for methamidophos.

**Key words:** spiders; spatial niche; insecticide; rice field
为物种在资源等级中所占的比例。

蜘蛛捕食功能减退率评价法采用功能法评价两种杀虫剂对各蜘蛛类群捕食功能的影响。

其中是0时刻天敌种群的功能减退率，为0时刻天敌的死亡率，为正常天敌的捕食功能。

为药剂处理区存活天敌0时刻的捕食功能。

同时将田间各蜘蛛类群作为捕食性集团来考虑，则一次施用杀虫剂引起该集团的捕食功能减退率为

结果与分析

2.1 主要蛛虫空间生态位的季节动态

各蛛虫的空间生态位宽度值随季节而变，但不同的类群变化规律不同。

2.2 各蛛虫生态位宽度值的季节动态

表2

<table>
<thead>
<tr>
<th>Taxa</th>
<th>07.13</th>
<th>07.21</th>
<th>08.10</th>
<th>08.22</th>
<th>09.01</th>
<th>09.10</th>
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<td>Plutiotruncatum</td>
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<td>0.781</td>
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<td>0.700</td>
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<td>Tetragnathidae</td>
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<td>0.591</td>
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<td>0.333</td>
<td>0.452</td>
<td>0.480</td>
<td>0.460</td>
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<tr>
<td>Theridiidae</td>
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<td>0.788</td>
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<td>Clubionodae</td>
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</tr>
</tbody>
</table>

表1 Seasonal niche breadth of spiders and planthopper (Yangzhou, 1999)

2.3 各蛛虫空间生态位的比例相似性指数

比例相似性指数是反映种间利用资源相似性程度的一个重要指标。比例相似性指数越大，种间在资源序列上分布的相似性也就越大。

狼蛛和其它蜘蛛类群的比例相似性指数较小，其它各类群间的比例相似性指数皆较高。

微蛛和飞虱具有最大的比例相似性指数，其它蜘蛛和飞虱的相似性指数也较高。

表2表明蜘蛛对飞虱具有非常好的空间相遇机率，这与各类群的栖息部位有关。

狼蛛主要分布在基部，肖蛸主要分布在叶片和茎部，因此二者的生态位比例相似性指数最小，仅为0.2576。

除飞虱和微蛛外，其它类群主要

2.4 各蛛虫空间生态位的日变化

空间生态位在一日中的变化因物种类群而异。图3图4飞虱和球腹蛛具有相似的日变化，早晨最，下午最窄。跳蛛早晨最窄，下午最宽。

肖蛸和跳蛛在+月份较为类似，后期F月3日则相反。

跳蛛在+月份早晨最窄，中午最宽。

狼蛛的生态位+月份早晨最窄，中午最宽。

跳蛛在+月份早晨最窄，中午最宽。

2.5 各蛛虫日变化的总趋势

肖蛸和跳蛛在+月份较为类似，后期F月3日则相反。

跳蛛在+月份早晨最窄，中午最宽。

狼蛛的生态位+月份早晨最窄，中午最宽。

跳蛛在+月份早晨最窄，中午最宽。

2.6 空间生态位的这种日变化规律与它们各自的生态学习性有关。

对喜凉类群，早晨具有较宽的生态位，飞虱和球腹蛛可能就是这样的类群。

对喜温类群，如狼蛛，肖蛸和跳蛛则中午，下午具有较宽的生态位。

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对喜温类群，如狼蛛，肖蛸和跳蛛则中午，下午具有较宽的生态位。
分布在茎部，因此和狼蛛的生态位比例相似性指数也较小。作为两大优势类群，狼蛛和肖蛸通过空间生态位的分离，相互之间对空间资源的竞争减小，增强了整体的控虫效果。而其它蜘蛛之间占据的生态位具有较大的相似性，竞争激烈，有可能削弱对飞虱的控制作用。

### 2.4 不同时间用药对飞虱和蜘蛛生态位的影响
杀虫双和甲胺磷分别在上午和下午喷药，对各蛛虫的生态位影响不同。杀虫双上午喷施，微蛛和肖蛸的生态位比对照宽，狼蛛则变窄。上午与下午相比，微蛛和肖蛸的生态位宽度值上午大于下午，狼蛛的生态位影响不大。球腹蛛下午变宽。甲胺磷下午喷施，微蛛、肖蛸和球腹蛛生态位宽度值比对照宽，并且比上午喷施宽，而狼蛛和飞虱则变窄。总体而言，甲胺磷对各类蜘蛛的空间生态位的影响要比杀虫双大。而飞虱则相反。这可能是因为甲胺磷对飞虱的杀伤力比杀虫双大，使得栖息在喷施过甲胺磷的稻株上的蜘蛛所能获得的猎物飞虱，要比栖息在喷施过杀虫双的稻株上的蜘蛛所能获得的猎物少得多。因此通过扩大搜索范围来满足猎物需求。

### 表2 不同时间用药对飞虱和蜘蛛生态位的影响

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Planthopper</th>
<th>Miętyphantidae</th>
<th>Tetragnathidae</th>
<th>Lycosidae</th>
<th>Theridiidae</th>
<th>Araneidae</th>
<th>Saltidae</th>
<th>Thomisidae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planthopper</td>
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</tr>
</tbody>
</table>

### 图1
Niche breadth of spiders and planthopper during early stage of rice (21 July)

### 图2
Niche breadth of spiders and planthopper during middle stage of rice (22 August)

### 图3
Niche breadth of spiders and planthopper during late stage of rice (10 September)
响大于下午

甲胺磷下午用药对微蛛和狼蛛的影响大于上午，对肖蛸的影响则上午大于下午。

杀虫双上午用药大于下午。甲胺磷则相反。

对集团功能减退率的影响杀虫双上午用药大于下午。甲胺磷则相反。

年结果与相似，个别类型蜘蛛略有差异，但两种农药对集团功能减退率的影响完全与相似。

农药对各类蜘蛛捕食功能减退率的影响与各类蜘蛛空间生态位的日变化规律有关。从表可以看出肖蛸和狼蛛的生态位在下午变宽，即表明下午分布在植株上部的肖蛸变少，狼蛛变多，从而使各自的农药接触量变化而产生上述结果。

杀虫双由于对蜘蛛的作用时间较长，在药后没有表现出这种现象。不过在药后则产生和甲胺磷相同的结果。由此可见，为使对天敌影响最小化，杀虫双以下午用药较好，甲胺磷则以上午为好。

表不同时间用药对飞虱和蜘蛛生态位的影响。

表不同时间用药对优势蜘蛛类群存活率及捕食功能的影响。
午用药要好于上午。但依据生态位的变化调整用药时间，重点应考虑保护天敌，从蜘蛛集团功能减退率来看，可能与这两种农药具有不同的作用机制有关。胃毒和一定的熏蒸作用在防效相差不大时，从蜘蛛集团功能减退率来看，可能与这两种农药具有不同的作用机制有关。从蜘蛛集团功能减退率来看，可能与这两种农药具有不同的作用机制有关。


