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不同密度条件下芨芨草空间格局对环境胁迫的响应

Spatial pattern responses of *Achnatherum splendens* to environmental stress in different density levels

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中文摘要:

基于小尺度上植物间相互作用与空间格局的高度相关性,选用可避免环境异质性影响的*K*2点格局函数,研究了沙枣-芨芨草群落中63个芨芨草样方(3密度条件×3生境条件×7重复)中芨芨草种群在小尺度下(0-0.5 m)的空间格局,探讨了在3种密度条件(高、中、低)及3种生境条件下(冠盖区、过渡区、空旷区),芨芨草种群空间格局对土壤理化性质胁迫(盐分、有机质及容重)程度的响应。研究结果表明,就土壤盐分,养分含量及土壤容重而言,土壤理化性质胁迫程度沿冠盖区、过渡区和空旷区增加的趋势。相应地,芨芨草种群呈聚集分布的样方比例在沿冠盖区(6/21)较低,而在过渡区(11/21)和空旷区(11/21)较高。然而,在不同密度条件下,芨芨草种群空间格局对土壤性质胁迫的响应不同。在低密度条件下,芨芨草种群在冠盖区多数为聚集分布(4/7),在过渡区和空旷区全部为聚集分布;中密度条件下,芨芨草聚集分布样方比例沿冠盖区-过渡区-空旷区梯度增加(分别为2/7,3/7,4/7),但低于同等胁迫条件下低密度样方中聚集分布数量;高密度条件下,在各胁迫条件下,除了一个过渡区高密度样方,其余芨芨草种群均为随机分布。总体上,随着环境胁迫增强,在中低密度下,芨芨草种群趋向于聚集分布;但在高密度下,芨芨草种群均以随机分布为主。此外,芨芨草种群空间格局随密度变化趋势比随土壤理化性质胁迫梯度变化趋势更加明显,可能表明相对于土壤理化性质胁迫程度,芨芨草种群密度对其空间格局影响更大。因此,在考虑芨芨草种群空间格局对环境胁迫的响应时,应当考虑种群密度因素。

English Summary:

A strong correlation exists between small-scale spatial patterns and intraspecific plant interactions for *Achnatherum splendens* (Trin.) Nevski. *K*2 point pattern function, a spatial analysis method designed to avoid the effects of environmental heterogeneity, was applied to analyze the spatial patterns and intraspecific interactions of *Achnatherum splendens* on a small scale (within 0.5 m). Sixty-three *A. splendens* quadrats were established and studied in an arid community dominated by *Elaeagnus angustifolia* L. and *A. splendens* in the northwest China. The quadrats were established at three density levels in three microenvironmental types and with seven replicates of each. The different responses of *A. splendens* were compared based on the three spatial density patterns, low, medium, and high, and three microenvironmental types, subcanopy, transitional, and open areas. The soil physicochemical properties of electricity conductance, soil organic matter, and soil bulk density, were measured in the three microenvironments to quantify the environmental stresses. The results show soil physicochemical stress increased along the subcanopy to transitional area to open area gradient. The subcanopy area had relatively low environmental stress as evidenced by low soil electrical conductivity, high soil organic matter, and low soil bulk density. *A. splendens* was clumped in only six of the 21 subcanopy quadrats, while in the transitional and open areas where environmental stress was high *A. splendens* was clumped in a small majority of the quadrats (11/21). The high environmental stress areas were defined as areas having high soil electrical conductivity, low soil organic matter, and high soil bulk density. *A. splendens* tended to be clumped in areas with increasing environmental stress along the subcanopy to transitional area to open area gradient. However, the spatial responses of *A. splendens* to environmental stress differed at the three density levels. At the low-density level, *A. splendens* had a clumped distribution in most quadrats at all three environmental stress levels. The clumped distribution proportions of *A. splendens* quadrats were 4/7, 7/7, and 7/7 in subcanopy area, transitional area, and open area, respectively. In the medium density level, the frequency of *A. splendens* quadrats with clumped distribution increased with the environmental stress. In these medium density level areas the proportion of clumped distribution of *A. splendens* populations were 2/7, 3/7, and 4/7 in subcanopy area, transitional area, and open area, respectively. In the high-density level, *A. splendens* was distributed randomly in most quadrats (except one in a transitional area) in all three environmental stress levels. Since the spatial pattern of *A. splendens* showed a clear tendency to be clumped along the density gradient rather than along the soil physicochemical stress gradient, this might suggest the spatial pattern of *A. splendens* was more influenced by density than by the stresses caused by severe soil conditions. We concluded the spatial pattern of *A. splendens* on a small scale responded to the environmental stresses differently based on population density. As the result, population density should be considered when analyzing the variations of spatial patterns and the occurrence of positive interactions along the stress gradient.

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