Strategies of seed germination on sand dune and seedling desiccation tolerance of *Psammochloa villosa* (Poaceae)


Abstract: *Psammochloa villosa* is a sand dune perennial grass mainly distributed in the moving sand dunes of Ordos Plateau, China. This species is one of the pioneer plants of sandland vegetation succession, and is usually found in sand dune habitats. It occurs in large sand covered areas where desertification is becoming quite serious.

A general survey indicated that seed germination is quite low and slow, and only a few new seedlings each growing season can be found in their natural habitats. Hardly any research has been done on the strategies and adaptation of *L. racemosa* seed germination and seedling emergence in sand, which are important for the survival of this plant under extreme sandy desert conditions with unpredictable, small amounts and distribution of rain. To this end, we studied seed germination and seedling emergence from different depths of sand and seedling desiccation tolerance after a period of drought.

Sand depth influences both seed germination and seedling emergence. The deeper the seed in the sand, the lower was the germination and seedling emergence. Higher percentages of seedling emergence were obtained from the shallowly buried seeds, ranging from 0.5 ~ 2.0 cm, because it increases soil contact and relative humidity around the seeds, thus enhancing the probability of germination. Seedlings of some germinated seeds cannot emerge to the sand surface. This may be because the seeds do not have enough energy to grow to the surface. Later they decompose in the soil.

The deeper the seeds were buried, the more remained ungerminated and in the condition of enforced dormancy. Many factors may cause enforced dormancy. Poor aeration at the greater sand depth has been shown to be one of the causal factors of enforced dormancy of *P. villosa* seeds. However, the seeds were able to overcome the enforced dormancy when the upper sand...
layer was removed and the buried seeds were at the suitable sand depth for germination, or meliorate the sand aeration content at greater depths. This enforced dormancy may have ecological advantages for \( P. \text{ villosa} \) by maintaining a long-term seed bank in the sandy soil, in that seedlings can be produced when erosion reduces the depth of sand and the seeds become exposed to a suitable depth for germination.

In natural habitats, the germinated seedlings may be wholly exposed to the air by sand erosion and undergo drought stress. However, the young seedlings have the ability to resist drought and start to recover after rehydration. The root length at dehydration and drying periods from 7 to 60 days influenced seedling revival ability. The later the stage of seedling development, the longer is the root and the smaller is the endosperm that remains. Further field observations need to be done in order to study the importance of the present findings on the ecological adaptations of this species to its natural habitats.

**Key words**: \( \text{Psammochloa villosa} \); depths of sand burial; seed germination and seedling emergence, enforced dormancy; sand erosion; point of no return of seedling desiccation tolerance

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8  28cm×17.5cm×12cm  P. V. C.  28cm×17.5cm×12cm  13%~16%.

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8  0.5, 1.2, 4cm  8cm  25°C  100μE/(m²•s).
著的长短分成的幼苗为子被埋不同时间干燥后的幼苗并出土

留发率就越低恢复率就越低发却无显著提高

讨论选择大小相对相同的种子进行萌发实验结果以百分率数据分析

包括出土的和未出土的幼苗通气对被埋种子萌发的影响从沙层下方通气能够显著地提高

上层沙土移走对种子萌发和幼苗出土的影响培养

因此本实验的目的是探讨在实验室的条件下

萌发但未出土的沙层覆盖在种子上方

原来位于的光敏感种子来说

包括移去沙层前的幼苗和

相似种子被传播以后的命运会如何

幼苗的出土率随着种子被埋的不同深度而表现出显著性的差异

当根的长度达到

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研究表明，沙层的深度影响着沙鞭种子的萌发。从种子被埋越深，萌发率就越低。从到，根据野外观察，通常情况下，沙丘的表层由于阳光照射造成的高温而使沙层表面迅速变干，很难出现大量种子在沙表面大量出现的现象。沙层表面种子的高萌发率出现在偶尔发生的连续阴雨的天气中，尽管具有很高的萌发率，但是在沙层表面萌发的种子其幼根却很难扎入沙层。这表明种子需要浅层的沙埋，这样有助于增加种子与周围土壤的接触以及提高相对的湿度，对提高种子萌发提供可能性。幼苗的出土与沙层对种子的沙埋深度呈负相关。从种子被埋越深，则出苗率就越低。在的深度没有幼苗萌发出土。研究还发现，一些萌发的幼苗不能长出沙层表面，例如在沙层下处的种子有. 的种子萌发，但是只有 . 的幼苗能够长出沙层表面。这可能是由于部分种子没有足够的能量长出地表；它们随后可能在地表下死亡并且腐烂。有时种子的品质和大小可能影响幼苗在沙层的不同深度出土。

图。被埋于不同沙层深度的沙鞭种子的萌发率，出苗率，处于强迫休眠状态的具有活力种子的百分率。根据检验，每一组中由不同小写字母标记的值之间的差异是显著的。

图。沙鞭种子位于沙层表面以下和处以及将上层的沙层移走，只保留厚的沙层覆盖种子后的出苗率。根据检验同图。每一图相同深度由不同小写字母标记的值之间的差异是显著的。

图。通气处理对位于沙层下和的沙鞭种子萌发率和出苗率的影响。根据检验，每一组中由不同小写字母标记的值之间的差异是显著的。在不同的深度，种植的沙层移走只保留厚的沙层覆盖种子后的出苗率。根据检验同图。每一图相同深度由不同小写字母标记的值之间的差异是显著的。
Table 1 Two-way ANOVA analysis of effects of lengths of roots at dehydration, drying periods, and their interaction on the percentages of revived seedlings of *Psammochloa villosa*

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root length</td>
<td>4</td>
<td>1.942</td>
<td>0.261</td>
<td>139.347</td>
<td>0.001</td>
</tr>
<tr>
<td>Period of desiccation</td>
<td>3</td>
<td>1.093</td>
<td>0.364</td>
<td>194.882</td>
<td>0.001</td>
</tr>
<tr>
<td>Root length × period of desiccation</td>
<td>12</td>
<td>0.680</td>
<td>0.055</td>
<td>29.420</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Fig. 4 Effect of root length at initial dehydration and period of desiccation on final revival percentage of *Psammochloa villosa* seedlings.

**References**


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