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Effect of vapor pressure deficit on gas exchange in wild-type and abscisic acid-insensitive plants

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摘要	Stomata control the gas exchange of terrestrial plant leaves, and are therefore essential to plant growth and survival. We investigated gas exchange responses to vapor pressure deficit (VPD) in two grey poplar (<i>Populus × canescens</i>) lines: wild type (WT), and abscisic acid-insensitive (<i>abi1</i>) with functionally impaired stomata. Transpiration rate in <i>abi1</i> increased linearly with VPD, up to about 2 kPa. Above this, sharply declining transpiration was followed by leaf death. In contrast, WT showed a steady or slightly declining transpiration rate up to VPD of nearly 7 kPa, and fully recovered photosynthetic function afterward. There were marked differences in discrimination against ¹³ CO ₂ ($\Delta^{13}C$) and C ¹⁸ O ($\Delta^{18}O$) between <i>abi1</i> and WT plants. The $\Delta^{13}C$ indicated that intercellular CO ₂ concentrations decreased with VPD in WT plants, but not in <i>abi1</i> plants. The $\Delta^{18}O$ reflected progressive stomatal closure in WT in response to increasing VPD; however, in <i>abi1</i> , stomata remained open and oxygen atoms of CO ₂ continued to exchange with ¹⁸ O enriched leaf water. Coupled measurements of $\Delta^{18}O$ and gas exchange were used to estimate intercellular vapor pressure, <i>e_i</i> . In WT leaves, there was no evidence of unsaturation of <i>e_i</i> , even at VPD above 6 kPa. In <i>abi1</i> leaves, <i>e_i</i> approached 0.6 times saturation vapor pressure before the precipitous decline in transpiration rate. For WT, a sensitive stomatal response to increasing VPD was pivotal in preventing unsaturation of <i>e_i</i> . In <i>abi1</i> , after taking unsaturation into account, stomatal conductance increased with increasing VPD, consistent with a disabled active response of guard cell osmotic pressure.
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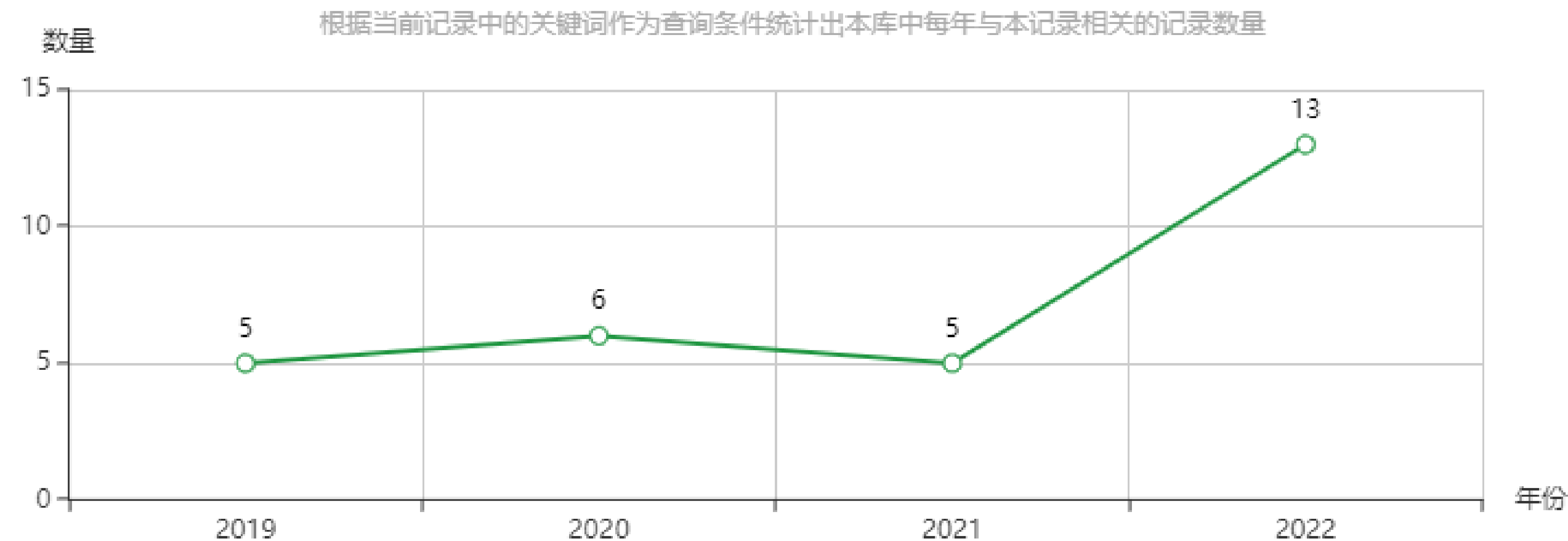
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