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非对称性增温对水稻品种南粳44米质及关键酶活性的影响

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Effects of Asymmetric Warming on Grain Quality and Related Key Enzymes Activities for *Japonica* Rice (Nanjing 44) under FATI Facility

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摘要 气候变暖存在明显的昼夜不同步性，日最低气温升幅大于日最高气温升幅。到目前为止，基于稻田实际增温试验研究非对称性增温对稻米品质形成的影响尚少。笔者利用稻田开放式增温系统在江苏南京开展了昼夜不同增温对稻米品质及其关键酶活性的影响研究。结果表明，3种增温处理均明显提前了水稻的灌浆结实期，并改变了灌浆期高于35℃高温的出现日期和天数，引起了稻米整精米率、垩白率、垩白度、RVA特征谱、淀粉组分、淀粉合成关键酶活性、蛋白质含量以及蛋白质合成关键酶活性的明显变化。稻米的整精米率显著下降，垩白率和垩白度显著增加，总淀粉含量差异不显著，但籽粒中直链淀粉含量显著下降，籽粒中支/直淀粉比例显著提高。其中夜间增温的直链淀粉含量下降最多，全天增温的支/直比提高最多，比常规对照下降4.5%和提高4.6%。灌浆前期3种增温处理均降低了籽粒ADPG-PPase活性，而灌浆中后期表现不一致。增温处理对籽粒SBE活性的影响不明显。增温处理下稻米的峰值黏度、热浆黏度、崩解值和糊化温度呈上升趋势，最终黏度、消解值和回复值呈下降趋势。其中，以全天增温的峰值黏度和崩解值增幅最大，白天增温的最终黏度和回复值降幅最大。增温处理均降低了籽粒中蛋白质含量，全天和夜间增温差异显著，分别较常规对照降低5.6%和4.0%。灌浆前期3种增温处理均降低了籽粒GS、GOGAT活性，灌浆中后期有所差异。上述结果表明，预期的气候变暖将使稻米的加工、外观品质变劣。稻米直链淀粉含量可能受灌浆前期ADPG-PPase活性的影响较大，而支链淀粉含量受SBE活性的影响较大。蛋白质的合成与灌浆前期GS和GOGAT活性关系密切。因此，增温对稻米品质及关键酶的影响较为复杂。

关键词： 气候变暖 开放式增温 稻米品质 淀粉 蛋白质 关键酶

Abstract： Climate warming presents significantly asymmetric trends with greatly diurnal differences, greater temperature elevations existing for the daily mean minimum temperature than for the daily mean maximum temperature. So far, the evidence is lacking for the effects of asymmetric warming on grain quality of single cropping rice based on field experiments. We performed field warming experiment under Free Air Temperature Increased (FATI) facility to investigate the impacts of asymmetric warming on grain quality and activities of key enzymes of single cropping rice in 2008 in Nanjing city, Jiangsu province, China. The results showed that the all-day warming (AW), daytime warming (DW) and nighttime warming (NW) treatments obviously advanced the grain filling and seed setting stage and changed the beginning date and the duration of high temperature above 35° C in the stage of grain filling, consequently resulting in obvious changes of head rice rate, chalky grain rate, chalkiness, RVA characteristics, starch content and its components, protein content and the activities of key enzymes for starch and protein syntheses. All the treatments decreased significantly head rice rate, increased significantly chalky grain rate and chalkiness of rice grain, and had no significant impact on the starch content of rice grain but tended to reduce the amylose content and increase the ratio of amylopectin to amylose. And the highest values of the amylose content and the ratio of amylopectin to amylose existed in the NW and AW plots which were 4.5% lower and 4.6% higher than those in the control plots in 2008, respectively. The activity of ADPG-PPase in grain decreased under the warmed plots during the early phase of rice grain filling,while had certain differences during the middle and late phases of rice grain filling. Warming treatments had no significant effect on the activity of SBE in grain. There were increasing trends of peak viscosity, hot viscosity, break down and pasting temperature, and decreasing trends of final viscosity, setback and consistency in rice grain under the warmed plots. The highest increase of peak viscosity and break down existed in the AW plots, and the highest decrease of final viscosity and consistency existed in the DW plots compared with those in control plots. The content of grain protein was decreased by warming treatments. Grain protein contents were significantly decreased by 5.6% and 4.0%, respectively in the AW and NW treatments. The activities of GS and GOGAT in grain were decreased under the warmed plots during the early phase of rice grain filling, while there were differences for them during the middle and late phase of rice grain filling. All these results suggest that milling and appearance qualities of rice

would get worse under warming plots. The impact of ADPG-PPase activity was greater on amylose content and that of SBE on amylopectin content in rice during the early phase of grain filling. The protein synthesis was closely related to the activities of GS and GOGAT during the early phase of rice filling. Therefore, the effects of asymmetric climate warming on grain quality and activities of key enzymes for single cropping rice are complicated.

Keywords: Climate warming Free air temperature increased (FATI) Rice quality Starch Protein Key enzyme

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