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Impacts of climate warming, cultivator shifts and phenological date changes on rice growth period length in China

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Phenology is an important indicator of the vegetation response to climate change. The impact of climate warming on crop phenology has drawn great attention. The existing literature generally analyzes the statistical relationship between growth period length (GPL) and growth period temperature to determine the direction and extent of the effects. However, since the change in growth period is seasonal in nature, growth-period temperature change includes not only the climatic trend but also seasonal variations. Failing to consider the seasonal effects, it may lead to the estimated deviation of the warming trend and the corresponding influence of the warming on the phenology.

We focused on the question of rice phenology change in China, using based on 892 phenological record series from 157 stations, using multivariate time-series regression analysis incorporating climatic factors and time trends while controlling for phenological dates (PDs).

Results show that the true climate warming effects for early rice and single rice have been underestimated by 0.16—0.22, and 0.08—0.11 K/decade, respectively, should the seasonal effect due to advanced PDs have not been removed. The true climate warming effect for late rice has been overestimated by 0.16—0.22 K/decade. Correspondingly, the net climate warming impacts on GPL after removing seasonal confounding effects were -1.9 d/k for early rice, -5.1 d/k for late rice, and -3.0 d/k for single rice, which was weaker for early rice and single rice, but late rice is stronger than the results suggested in the literature. GPL changes was found to have the strongest linkage to PD changes, while the linkage to climate warming was weaker. In addition, our results suggest the adoption of cultivator shifts to prolonged vegetation growth period for all rice varieties, and prolonged reproductive growth period for single rice. As PD changes are subjected to strong human influence in planting decisions, along with the inferred cultivator changes, our results provided further evidence of active adaptation in rice cultivation to climate warming in China.

Keywords: rice phenology; climate warming; seasonal temperature pattern; cultivator shift; planting decision

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