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The occurrence of drought amplified yield loss risk for maize production in China

Shengli Liu and Wenbin Wu
Key Laboratory of Agricultural Remote Sensing (AGRIRS), Ministry of Agriculture and Rural Affairs/Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, China (liushengli@caas.cn)

Increasing drought event is one of the major threats to yield stability and crop production. However, the precise quantification of crop response to such extreme weather is still in lack. Unlike the deterministic researches of drought effects, we propose an insightful probabilistic perspective to quantify drought impacts on maize yield across China. The county-specific combination of annual maize yield anomaly and standardized precipitation evapotranspiration index (SPEI) across its growing season during 1981-2010 was utilized to build a copula-based probabilistic diagram, for the purpose to predict yield loss risk under different drought types. The results reveal that, when compared with the expected long-term yield, the reduction of maize yield and its uncertainty was in line with the drought severity across the growth season, with yield reduced by -5.14%, -8.05% and -3.94% under moderately dry, severely dry, and extremely dry, respectively. Despite the spatial pattern of SPEI existed varying timescales in determining yield anomaly across different counties, the number of counties where maize experienced drought with a response time starts from June and July accounted for 55.28% of counties across China, and that drought with one month duration occupied 50.29%. A considerable gap in the likelihood of maize yield reduction was detected under drought and under non-drought conditions, which further confirmed the negative impacts of drought on maize yield. Moreover, the conditional estimation revealed that the semi-arid region was more susceptible to the drought-induced yield loss risk of maize in comparison to other regions. The probability of yield loss for maize amplified according to the drought severity along with the significant differences ($P < 0.05$) among the extreme, severely and moderately drought conditions across all of these sub-regions. Our results highlight the improving knowledge of drought on crop yield anomaly and consequent adaptation was essential for the decision making in coping with extreme weather in agricultural production.