J. Crop Sci. Biotech. 2015 (December) 18 (4) : 205 ~ 207
DOI No. 10.1007/s 12892-015-0137-2

EDITORIAL LETTER

Focus on the Application of Crop Science and Biotechnology to Climate Change Impact Assessment and Adaptation

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Received: December 9, 2015 / Accepted: December 13, 2015

Abstract

Climate change is an apparent phenomenon affecting life in many aspects including crop production, so the assessment of its impact on crop production is urgently required to establish strategies and technologies to mitigate and adapt to climate change. Numerous efforts have been made to investigate the effects of climate change with emphases on elevated temperature and CO_2 on crops, to assess climate change impact on crop production, and to develop application technologies for coping with climate change in a sustainable manner. This special issue of JCSB contains a collection of peer-reviewed research articles covering the impact of microclimate conditions on crop production (4 papers), modeling approaches for impact assessment (3 papers), and applications of crop science and biotechnology for climate change adaptation (3 papers). It is believed that this special issue will help crop scientists broaden their knowledge and understanding on climate change issues in crop production and facilitate research in crop science and biotechnology in battling against climate change to sustain current crop production and increase future crop production to feed ever continuously increasing human population.

Key words : adaptation, climate change, crop production, crop science, impact assessment

Introduction

Climate change due to the increase of atmospheric CO_2 and consequential elevated air temperature has initiated many efforts to mitigate climate change in many human activities including crop production. Crop science is now facing challenges to tackle the threats of climate change but also to feed an increasing human population projected to be 90 billion by 2050. There is no doubt that climate change is a main issue in future crop production to meet the increasing food demand and one of the most interesting topics in crop science. Therefore, the editorial board of Journal of Crop Science and Biotechnology (JCSB), The Korean Society of Crop Science, has decided to publish a special issue focusing on "Climate Change and Crop Science & Biotechnology". We are pleased to introduce the first special issue of JCSB that focuses on the topics of significant interest to our readership. All published manuscripts were subject to the normal peer review process for publication in JCSB. This special issue addresses the topic of climate change impact assessment and adaptation using different approaches based on crop science and biotechnology. This aspect of climate change impact assessment and adaptation intersects with considerable efforts to improve crop production in the future.

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Impact of microclimate on crop production

The first four articles highlight the impact of microclimate conditions during flowering and grain-filling periods on crop production. Jung et al. (2015a) explore the response of spikelet fertility to microclimate conditions near the spikelet of rice and found that the spikelet fertility was closely associated with not only temperatures of spikelet and panicle but also vapor pressure deficit. They also showed that air temperature was a better predictor for spikelet fertility than temperatures of the spikelet or panicle. Their results would facilitate a more reliable prediction of spikelet fertility using microclimate conditions and would help in the development of adaptation strategies for rice production including adjustment of planting date.

Shin et al. (2015a) investigated the impact of extended drought period on growth and yield of maize. They found that extended drought conditions during tassel initiation resulted in less dry mass accumulation and delayed silking. The authors suggested that water deficit during periods for initiation of tassel and internode elongation could reduce grain yield by 50%.

Lee et al. (2015) determined grain-filling duration and maximum grain weight under elevated temperature conditions, which would occur frequently in future climate conditions. They revealed that grain-filling duration had little difference between elevated temperature conditions whereas maximum grain weight decreased with increasing air temperature. These authors (Lee at al. 2015) speculated that decrease of grain weight under high temperature would result from reduced supply of assimilates into grains. Their findings could be used to guide a rice breeding approach in order to develop cultivars tolerant to high temperature conditions.

In the fourth article on the relationship between maize yield and a period of drought stress, Shin et al. (2015b) demonstrated that drought stress during tassel emergence of maize would cause serious yield reduction. They showed that a yield reduction of about 50% could result from exposure to drought for less than 7 days. Their findings indicated that response of maize production to duration of drought stress would differ by cultivars, which suggested the need for development of maize cultivars tolerant to extended periods of drought during flowering periods.

Impact assessment

For impact assessment studies, crop growth models have been used to project crop yield under climate conditions. Because those projections are based on climate data in the future, it is important to assess the impact of uncertainty associated with climate data as well as crop growth models. Kim and Yoo (2015) showed that climate scenario data available in Korea had a different spatiotemporal pattern of uncertainty by spatial resolution of these scenario data. They found that the uncertainty of regional climate scenario data was relatively similar between data at high (12.5 km) and very high (1 km) spatial resolution in major rice production areas. Their findings suggest that reliable crop yield projection could be obtained even when climate data at a high resolution would be used as inputs to crop growth models.

Another article by Kim et al. (2015) documented that the impact assessment of climate change on crop production yield would be affected by uncertainty of regional climate scenario data when a crop growth model is used to simulate crop yield. In Korea, regional climate data at a spatial resolution of 12.5 km tended to have large uncertainty in areas near bodies of water and mountainous areas whereas these data had relatively accurate representation of climate conditions in major rice production areas for simulations of crop growth. These results suggested that uncertainty of crop yield projections should be taken into account in assessment of climate change impact on crop production and development of adaptation strategies.

Ban et al. (2015) demonstrated that maize growth models including CERES-Maize and IXIM-Maize models could have a limitation in the projection of crop yield under elevated temperature conditions. Under high temperature conditions, these models tended to underestimate anthesis date and grain-filling ratio in simulation of crop phenology. Both models failed to simulate considerable decreases in kernel number resulted from heat stress during flowering periods. Their results suggested that improvement of modules to predict phenology of crops under elevated temperature conditions would be needed for reliable assessment of climate change impact on crop production.

Climate change adaptation

For climate change adaptation, development of cultivars tolerant to abiotic and biotic stress is essential. Lee and Kwon (2015) suggested that quantitative trait loci (QTL) could be used to screen genes associated with seedling growth under low temperature conditions. They identified *qLTG8* on chromosome 8 as a QTL for germination rate and coleoptile length resistant to cold stress. Their findings would be useful to develop a cultivar that has tolerance to diverse abiotic stress that are increasingly frequent under climate change conditions.

Because the pattern of disease outbreak would be affected by climate change, it is of great importance to develop cultivars resistant to plant diseases that would occur frequently in the future climate conditions. Kang et al. (2015) showed that the incidence of wildfire disease, caused by *Pseudomonas amygdali* pv. *tabaci,* would increase under climate change. They also demonstrated that a soybean cultivar resistant to wildfire could be selected through a systemic soybean breeding program. Their work can be used to enhance selection of soybean cultivars resistant to plant diseases and, as a result, adaptation options for climate change impact on crop production.

A shift in planting date would be the simplest adaptation strategy to improve crop production under climate change. Jung et al. (2015b) demonstrated that the optimal planting date for buckwheat would be mid to late August for cultivars grown in Korea. They also illustrated that planting date could be identified not only for crop yield but also the quality of the crop. Their findings would be useful to guide a prudent climate change adaptation strategy.

Conclusion

This special issue on approaches in crop science and biotechnology for climate change impact assessment and adaptation sheds light on recent efforts and development to improve crop production under climate change and offers a platform for exciting new approaches in this field. We believe that this issue could be a milestone in the efforts of JCSB to encourage, facilitate, and support crop science. JCSB will continuously publish special issues with particular emphases on topics that reflect contemporary issues associated with crop science and biotechnology. We are grateful to all the authors for their contributions and for making this special issue possible.

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