WORKSHOP 07

Assessment of Benefit and Risk on Shifting Planting Date as a Climate Change Adaptation Option

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I. Introduction

Climate change would cause a considerable impact on crop production in high latitude regions as well as mid and low latitude regions. Identification of the potential risk on crop production under climate change would be useful to design adaptation planning in a region of interest. In East Asia, where most of the farmer are smallholders (Hazell *et al.*, 2007; Jeong, 2008; Martini and Kimura, 2009), it would be advantageous to derive practical strategies for climate change adaptation, which requires the minimum capital investments. One of such an adaptation option is the shift of planting date.

It is likely that shifts of planting date would result in changes in heading periods, which could affect crop production. Assessment of climate conditions associated with heading periods followed by a shift of planting date would be useful to project the effectiveness of shifting planting date as an option to climate change adaptation. The objectives of this study were to examine changes in crop yield estimates using a simple empirical approach on the marginal heading periods as a result of shifting planting dates.

II. Materials and Methods

Weather data were collected from 51 weather stations managed by Korea Meteorological Administration (Lee *et al.*, 2014). A web-based weather data portal (https://metsky.kma.go.kr/) was used to prepare daily weather data including temperature and sunshine duration. Weather data were collected from 1971 to 2010. An automated data tool was used to download those weather data (Lee *et al.*, 2015). To compare climate conditions in past and current times, two sets of normal data were generated from 1971-2000 and 1981-2010, respectively.

Instead of performing crop growth simulations with a range of planting dates, climate conditions during grain filling periods were used to assess changes of yield on a given planting date. Yoshio (1975) reported that variation of rice yield was explained highly using a

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climatic yield potential (CYP) defined as follows:

$$CYP = S \times \{4.14 - 0.13(21.4 - t)^2\} \quad (1)$$

where S and t represent sunshine duration and average daily temperature for 40 days after heading. The values of CYP were compared with different heading date, which was determined by thresholds of temperature for grain filling periods including 760, 800, 840, and 880°C. The maximum of CYP was also determined in a season and compared with the value of CYP on a given heading date.

III. Results and Discussion

Our results indicated that the marginal heading date for normal grain filling processes would be delayed for current times (1981-2010) compared with past times (1971-2000) (Fig. 1). For example, the last date of suitable heading periods would occur a week later at Seoul and Gangneung when a threshold temperature of 840°C was used. This suggested that planting dates could be delayed for about a week under current climate conditions compared with past conditions.

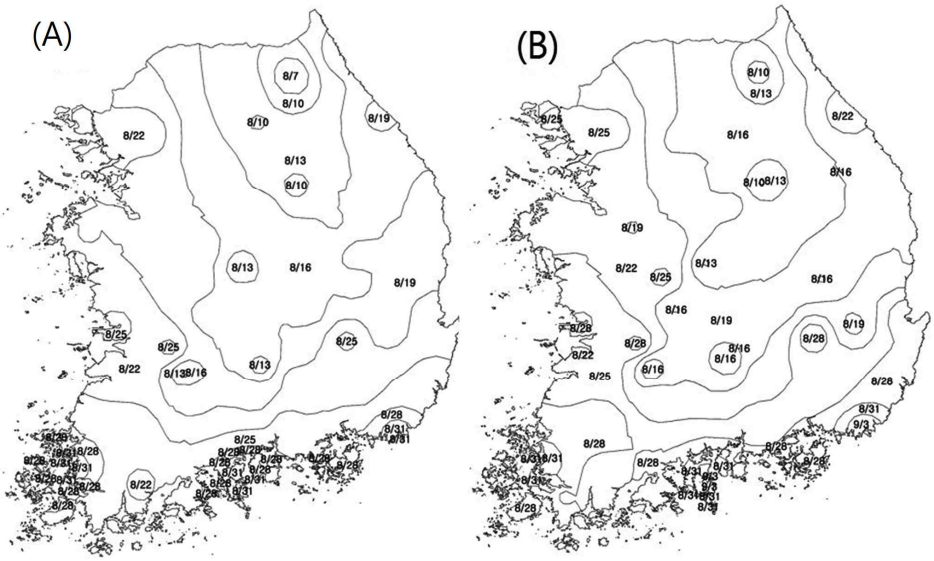

Fig. 1. Late marginal heading date for normal maturation under past (A: 1971-2000) and current (B: 1981-2010) climate normal conditions using 800°C as the threshold temperature during 40 days of grain filling period .

Little change in CYP values was estimated when heading would occur on the marginal heading dates in current times compared with past times (Fig. 2). For example, the values of CYP obtained on the marginal heading date were about 90% of the maximum CYP value in a given season. It would be challenging to obtain the maximum yield without perfect knowledge of climate conditions as well as crop management. Thus, it appeared that reasonable yields could be obtained even on the marginal heading date, which would allow delay of planting dates.

In regions where double cropping is limited due to climate conditions in current times, it is likely that climate change would allow changes in a cropping system. For example, Italian ryegrass, which is a productive forage crop, could be grown before rice at a higher latitude in the future than in current times. Still, drastic changes in climate conditions in the future would limit crop production due to elevated temperature during grain filling period, which would merits further detailed analysis for climatic risks during which yield formation process would occur mostly.

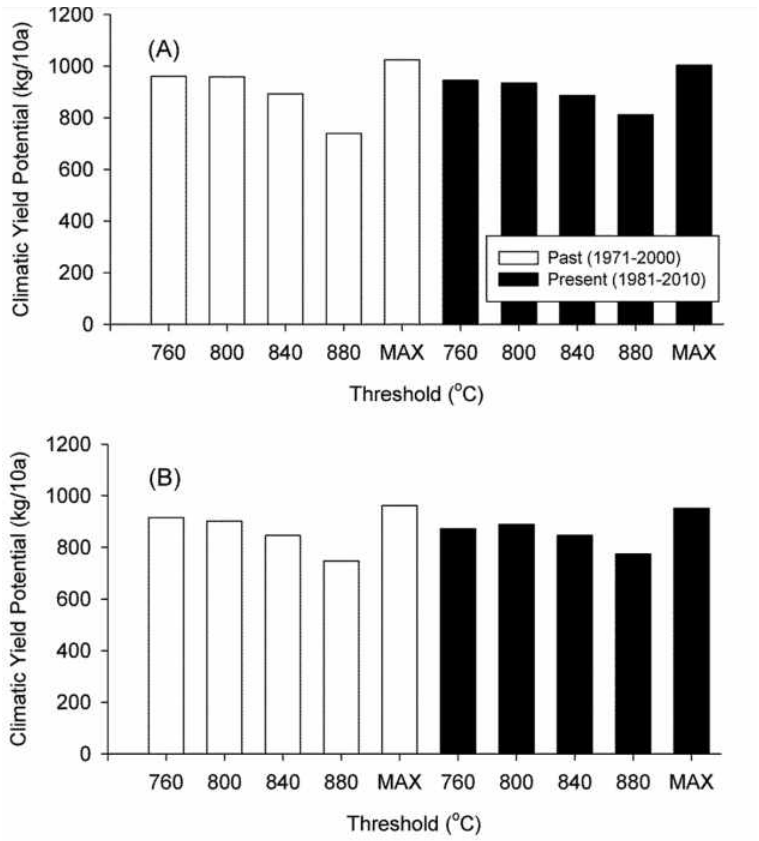

Fig. 2. The climatic yield potential on the late marginal heading date for thresholds (760°C, 800°C, 840°C, and 880°C) and maximum (MAX) climatic yield potential under past (1971-2000) and present (1981-2010) climate normal conditions in Suwon (A) and Daegu (B).

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