POSTER 24

An Agrometeorological Reference Index for Projecting Weather-Related Crop Risk under Climate Change Scenario

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I. Introduction

The agrometeorological reference index means 'the agrometeorological damage possibility' or the possibility of the normal year climate condition to damage the crop cultivation in a certain region. It is a reference used to compare the cultivation risk of a crop by region. The global climate warming is expected to increase the winter temperature. At the same time, the frequency of extreme weather events will also increase. Therefore, people pay attention to the potential of low temperature-induced damages (e.g., frost damage and injury) to fruit trees under the future climate condition. However, simple damage projection based on climate conditions does not help the climate change adaptation in the practical aspect because the climate change affects the phenology of fruit trees as well. This study predicted the phenology of the pear, peach, and apple trees by using the climate change scenarios of major regions. Furthermore, low temperature induced agrometeorological reference indices were calculated based on the effects of temperature on the each plant growth stage to predict the damage possibility.

II. Materials and Methods

Daily maximum and minimum temperature data were collected for the current normal year (1981-2010) and RCP8.5 scenario climate (2010-2099) of six target areas (i.e., Seoul, Incheon, Daegu, Jeonju, Busan, and Mokpo) (NIMR, 2011). The dormancy, bud-burst, and flowering timings of grape, pear, and peach trees were estimated for the current year and climate scenario conditions by employing the widely used phenological model based on the collected temperature data. (Table 1; Cessaraccio *et al.*, 2004; Kim *et al.*, 2009a; 2009b).

We calculated the mean (μ) and standard deviation (σ) of daily minimum temperature for each growing period of current normal year (1981-2010) and future 3 normal years (2011-2040, 2041-2070, 2071-2100).

The agrometeorological reference index was estimated by using the low temperature damage

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critical temperature (Table 2; http://www.nongsaro.go.kr) at each growing period with the following equation.

$$Z = \frac{X - \mu}{\sigma} \qquad (1)$$

Table 1. Parameter values used for the growth stage prediction model for each plant

Crop	Cultivar	Base Temperature	Chill Requirement	Heat Requirement
Apple	Fuji	6.1°C	-100.5	275.1
Pear	Niitaka	5.4	-86.4	231.3
Peach	Changhowon Hwangdo	5.7	-108.0	234.5

Table 2. The critical temperature causing a frost damage for each fruit type and growth stage (http://www.nongsaro.go.kr/)

	Apple (Fuji)	Pear (Niitaka)	Peach (Changhowon Hwangdo)
Resting period	-11.0°C	-25.0	-25.5
Dormancy release - Bud-burst	-2.8	-1.7	-1.7
Bud burst - Flowering date	-2.2	-1.9	-1.1

III. Results

3.1. Future dynamics of phenology

It was predicted that the breaking of dormancy would delay more in the future while the bud-burst date and flowering date will be earlier. Fuji apple and Changhowon peach reached a growth stage slower than Niitaka pear did. In Daegu, Jeonju, and Mokpo, the breaking of dormancy delayed more as time passed. The bud-burst date and flowering date of Seoul and Incheon regions were later than other regions. Seoul and Incheon showed a similar pattern, while Daegu and Jeonju revealed a similar pattern. Busan and Mokpo also showed a similar pattern (Fig. 3).

3.2. Future dynamics of agrometeorological reference index

All regions were safe from the frost damage during the dormancy period. However, plants were vulnerable to frost damage between the dormancy breakage and the bud-burst period. Regions showed different frost damage patterns between the bud-burst period and the flowering period. During the bud-burst and flowering period, the risk level decreased in general, although the risk of some areas tended to increase (Fig. 4).

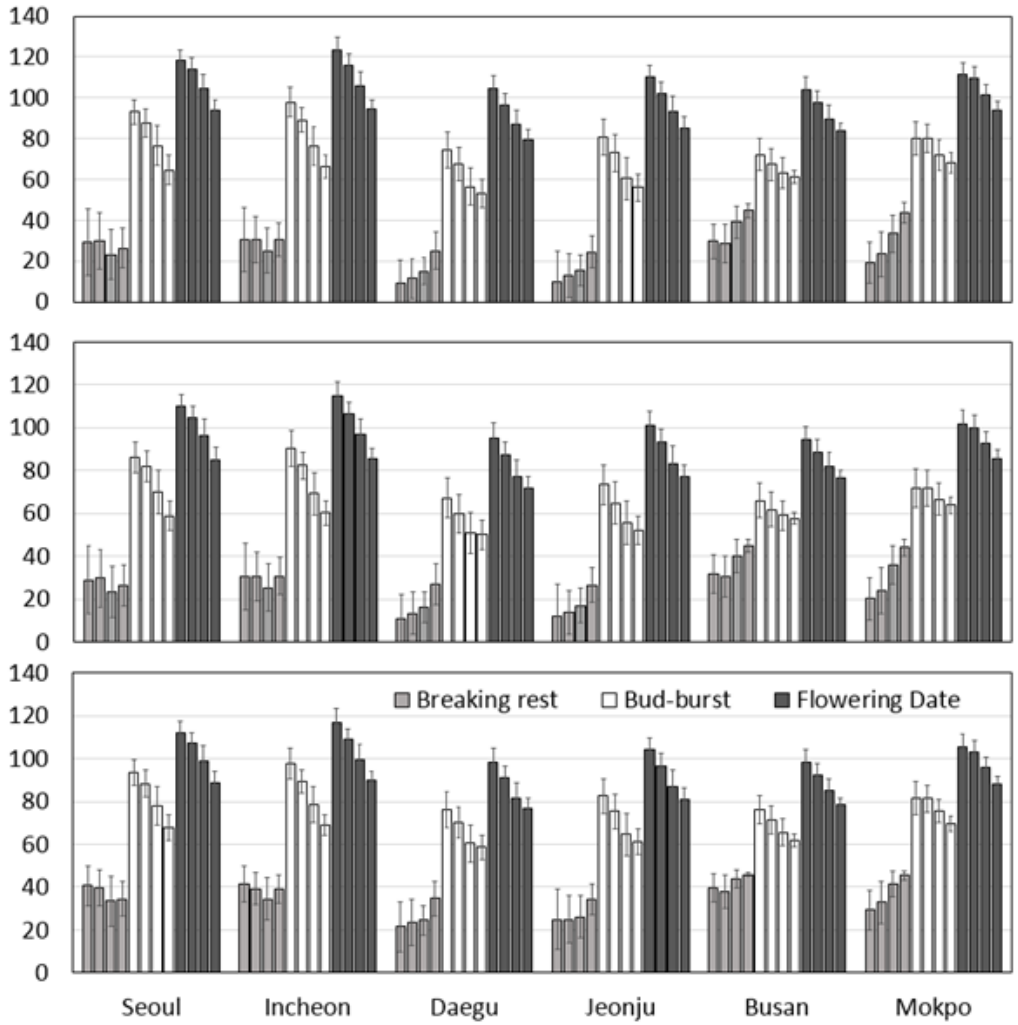

Fig. 3. The trend of time taking to growth stages under the future climate scenario (Fuji apple, Niitaka pear, and Changhowon peach from the top to the bottom).

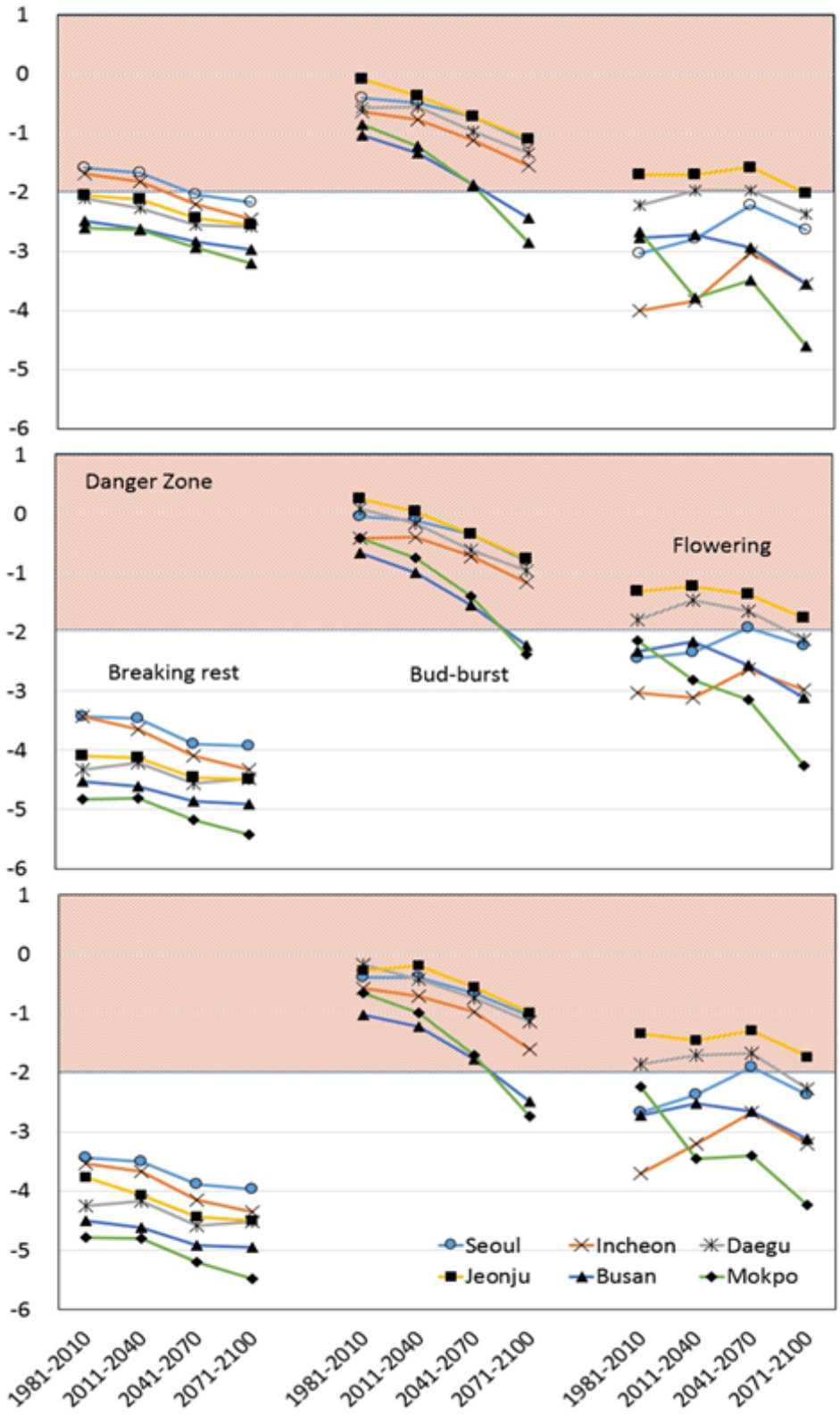

Fig. 4. The trend of agrometeorological reference index dynamics for each crop species. Fuji apple, Niitaka pear, and Changhowon peach from the top to the bottom.

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