POSTER 14

Outlook on the Marginal Date for Economic Harvest as Affected by Planting Date Migration in Kimchi Cabbage

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I. Introduction

The Kimchi cabbage grows better under a higher temperature before forming a head but it grows worse under a higher temperature after a head is formed. Recently, it has been worried that the quantity and quality of the Kimchi cabbage will be decreased due to the climate warming. Changing a planting date can be a promising cultivation solution. To apply this solution we must know the marginal date for economic harvest, which can be free of head defect or other damages in Kimchi cabbage, in advance. The temperature is the main climate factor influencing the growth of the cabbage. Therefore, a thermal time–based phenology model of the Kimchi cabbage to estimate the growth stage by using the temperature was proposed based on previous studies (Kim and Yun, 2015).

This study aimed to find the future harvesting period under a changed planting date and identify a possible cultivation area for economic harvest by using the thermal time–based phenology model at 1km high resolution over South Korea under the RCP8.5 projected climate.

II. Material and Methods

2.1. The thermal time – based phenology model

When the period of seedling stage (after seeding and before planting) which can be artificially adjustable is excluded, the main growth stages of the Kimchi cabbage can be divided into planting, heading, and maturity. The 'growth stage' is after the planting and before forming a head and the ‘heading stage’ is after forming a head and before the harvesting. From the daily temperature, it was confirmed that the minimum heat unit (standard heat unit to start heading) required to reach the head starting after planting was 30 and the harvesting standard heat unit required for the physiological maturity from the planting was 60.5 (Kim and Yun, 2015). The growth response of the Kimchi cabbage by the temperature during the growth and heading stages can be expressed as Fig. 1.

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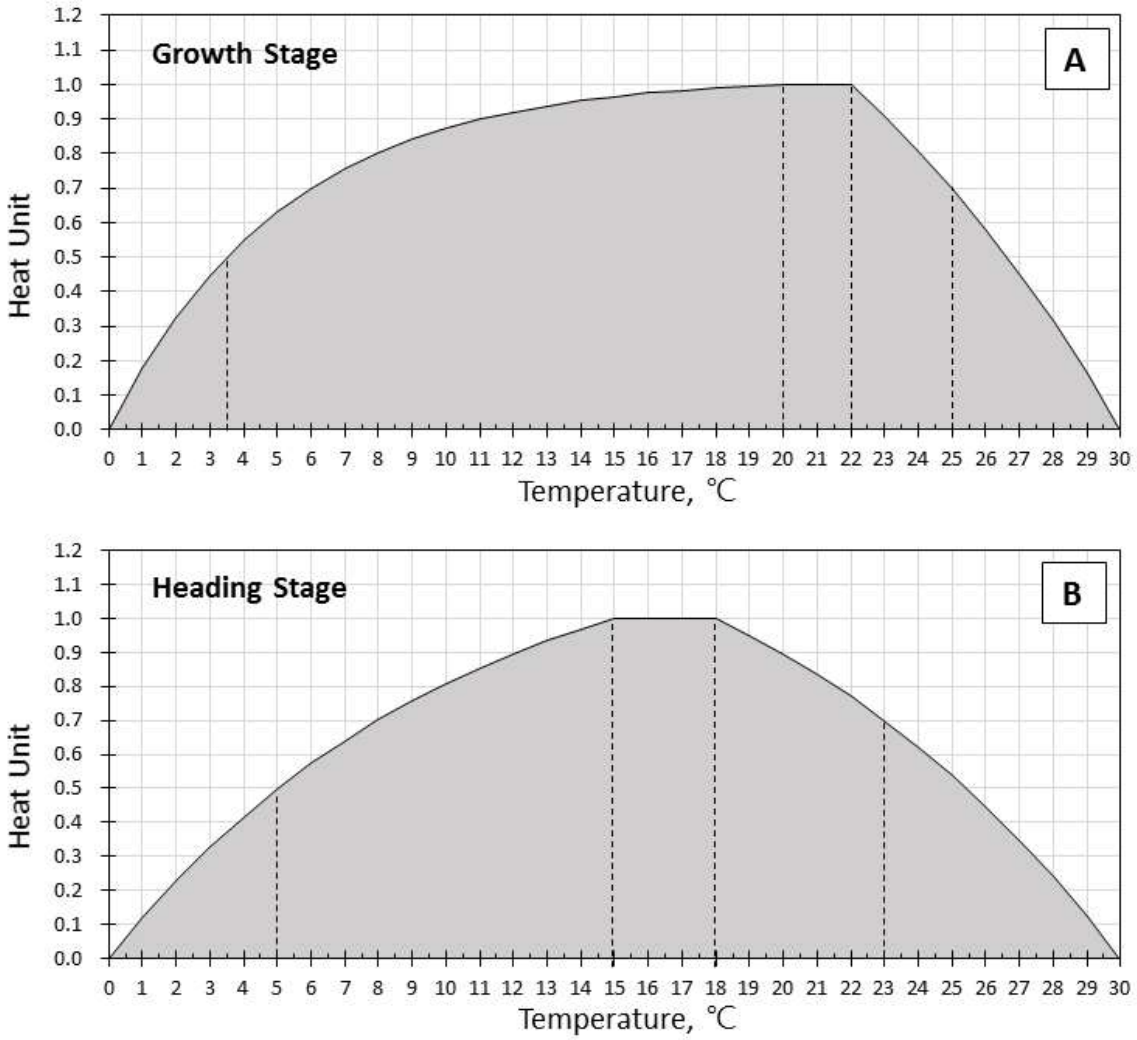

Fig. 1. A non-linear graph of the heat unit based models for estimating growth stages of the Kimchi cabbage.

2.2. Determination of the possible cultivation area by planting date migration

By using the thermal time–based phenology model, expected heading and harvesting dates by planting date were found. The Kimchi cabbage was determined not harvestable, when (1) the average of the daily maximum temperature exceeded 30℃ during a growth and heading stages, (2) the average of the daily minimum temperature was below 5℃, or (3) the average of the daily mean temperature exceeded 23℃. Moreover, when the average of the daily mean temperature is below 13℃ for more than 7 consecutive days in growth stage, the bolting by chilling is expected. Consequently, this condition was considered not harvestable as well. Additionally, it was also considered not harvestable when the heat unit required for the physiological maturity is not fulfilled within 100 days since planting because temperature

inappropriate for the Kimchi cabbage growth frequently appeared.

The daily high resolution scenario data over South Korea based on the RCP8.5 projected climate using HadGEM3-RA, which was provided at the Climate Information Portal (http://climate.go.kr), was used to see the current and future spatial pattern of the expected Kimchi cabbage harvesting date by planting date migration. The spatial distribution of the predicted harvesting date was presented by dividing into 4 climatological periods (2001-2010, 2011-2040, 2041-2070, and 2071-2100) based on the daily temperature data of the scenario. It is possible to see the results by changing the Kimchi cabbage planting date from the Jan. 1 to the Dec. 31. This study calculated results with considering the Jul. 1 and Sep. 1, the most common summer and fall Kimchi cabbage (for economic harvest) planting dates, as the representative dates. The predicted harvesting date and cultivation potential was calculated for the entire South Korea by a grid and the changes in the future spatial distribution was evaluated on the assumption that summer Kimchi cabbage was planted in the South Korea on these two dates.

III. Results and Discussion

When the Kimchi cabbage is planted on Jul 1, prediction indicated that it would most commonly take 67~69 days until it reached the physiological maturity at the current normal. However, in the 2041-2070 period, the 70~72 days would be the most frequent class. It showed that it would take longer to harvest the Kimchi cabbage in the future. It was predicted that the possible cultivation area of the Kimchi cabbage, which was distributed at the highland in Gangwon-do and So baek Mountains, would decrease. In the current normal, the possible cultivation area of the Kimchi cabbage in Gangwon-do is 10,008 km^2. It was predicted that it would decrease to 6,855, 1,862, and 115 km^2 in 2011-2040, 2041-2070, and 2071-2100, respectively. It was determined that it would be impossible to grow the summer Kimchi cabbage in South Korea.

When it was planted on Sep. 1, the predicted harvesting would take 61~65 days in the current and future climate condition. Under the current normal condition, Jeollanam-do had the largest land possible to cultivate the Kimchi cabbage, which was approximately 9,671 km^2. In 2011-2040, the possible cultivation area decreased in Jeollanam-do but that in Gyeongsangnam-do substantially increased to 14,011 km^2. After 2041-2070, the Kimchi cabbage producing area clearly went the north and the Kimchi cabbage was actively grown in Gyeongsangbuk-do, Chungcheongbuk-do, and Gangwon-do regions. It was predicted that the fall Kimchi cabbage will be a major crop in Gangwon-do in the 2071-2100 period. The distribution of possible cultivation area planted on Sep. 1 in the 2071-2100 period was similar with that planted on Jul. 1 in the current normal condition, which is the current major producing land in the highland of Gangwon-do.

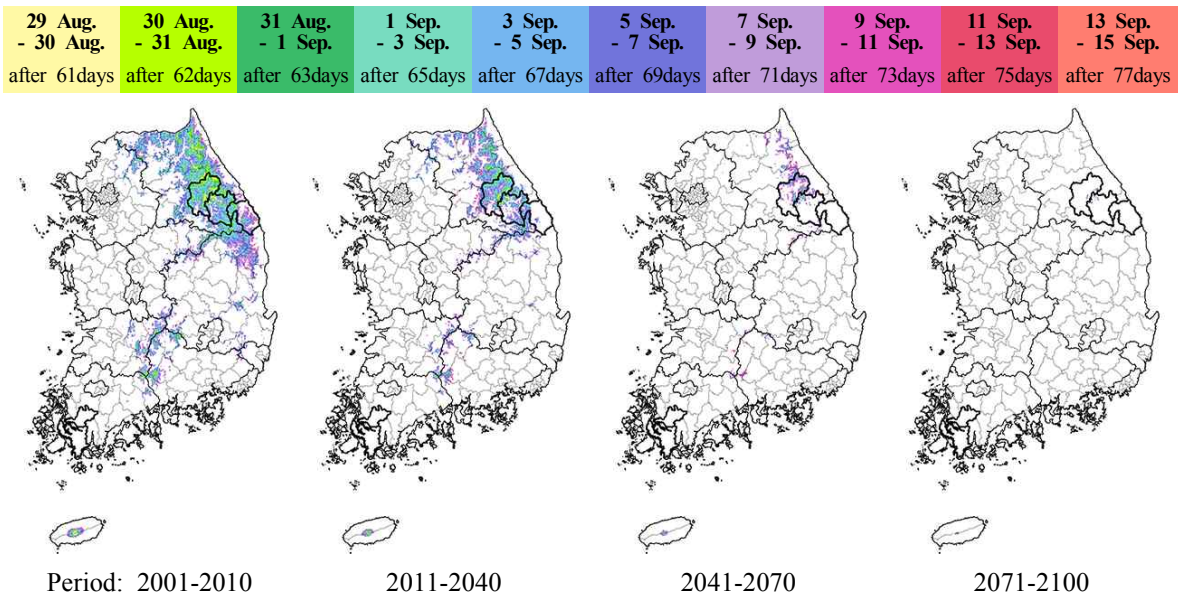

Fig. 2. The distribution of estimated harvesting dates and possible cultivation area planted on Jul. 1.

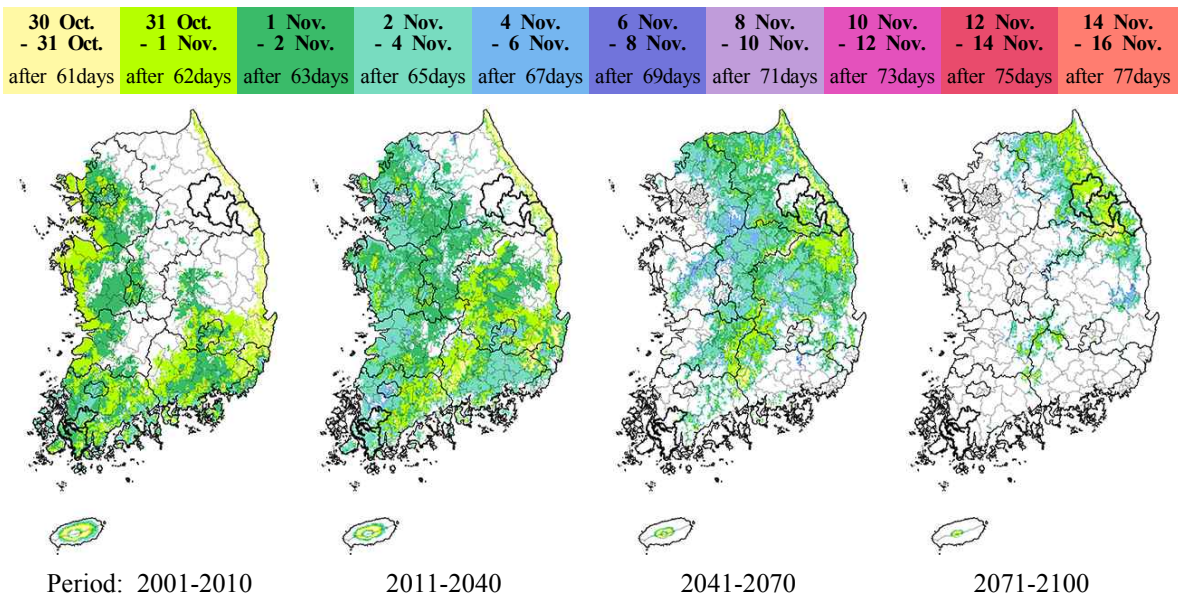

Fig. 3. The distribution of estimated harvesting dates and possible cultivation area planted on Sep. 1.

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