



## Abstract

Garlic, an ingredient of Kimchi, is one of important vegetables in Korea. Changes of germination rate of southern type garlic were investigated using chambers with 5 temperature treatments of 10°C, 15°C, 20°C, 25°C, and 30°C. Two sets of 32-hole tray, planted 64 garlic cloves, were set in each chamber, and investigated germination rate with daily-base. Germination rate of garlic were highest at 15°C treatment, and were decreased by increasing or decreasing temperature from experiment. From 50% germination days at each temperature, which were estimated from curve fitting using experiment data, an exponential equation was developed to estimated germination rate from daily temperature. Based on the equation, germination rate was highest of 0.1007 % per day at 13.4°C. To test germination model, garlic were planted with different planting date in the field. Field experiment data revealed that germination model can predict well the initiation time and the pattern of germination of garlic with well cultivated condition.

## Objectives

- Elucidation of temperature effect on garlic germination on field

## Materials & Methods

### [Chamber Experiment]

- Plant material : garlic (Southern ecotype)
  - garlic cloves planted on two 32-seed-tray filled with artificial soils
- Treatment : environment
  - temperature : 10°C, 15°C, 20°C, 25°C, 30°C
  - light : red and blue LED 12hrs, night 12hrs

### [Model Construction]

- Germination was determined by success of garlic tip appearance above soil surface, and appearance date also recorded.
- The date of 50% germination was determined from curve fitting with relative germination percentage.
- Reciprocal number of 50% germination duration was considered as representative germination rate for the temperature.
- By fitting the relationship of germination rate and temperature, an equation of germination rate for temperature was determined.
- Garlic germination was estimated to sum of germination rates for each mean temperature.

### [Validation]

- Garlic was planted with different days on field and daily mean temperature and sprout appearance was recorded.
- The ratio of sprout appearance were compared to results of model predicted.

Table 2. Models to estimate garlic germination rate from daily temperature and to predict percentage of garlic germination from germination rate.

| models                                                         | description                                                                                             |
|----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Rate = $R_{max} \cdot \exp[-0.5 \cdot ((Temp - T_{max})/c)^2]$ | $R_{max}$ : maximum rate(0.1007)<br>$T_{max}$ : optimum temperature(13.4°C)<br>$c$ : coefficient(10.53) |
| Percentage = $100 \cdot [1 - \exp(-(Rate/a)^b)]$               | $a$ : coefficient (1.073)<br>$B$ : coefficient (5.2056)                                                 |

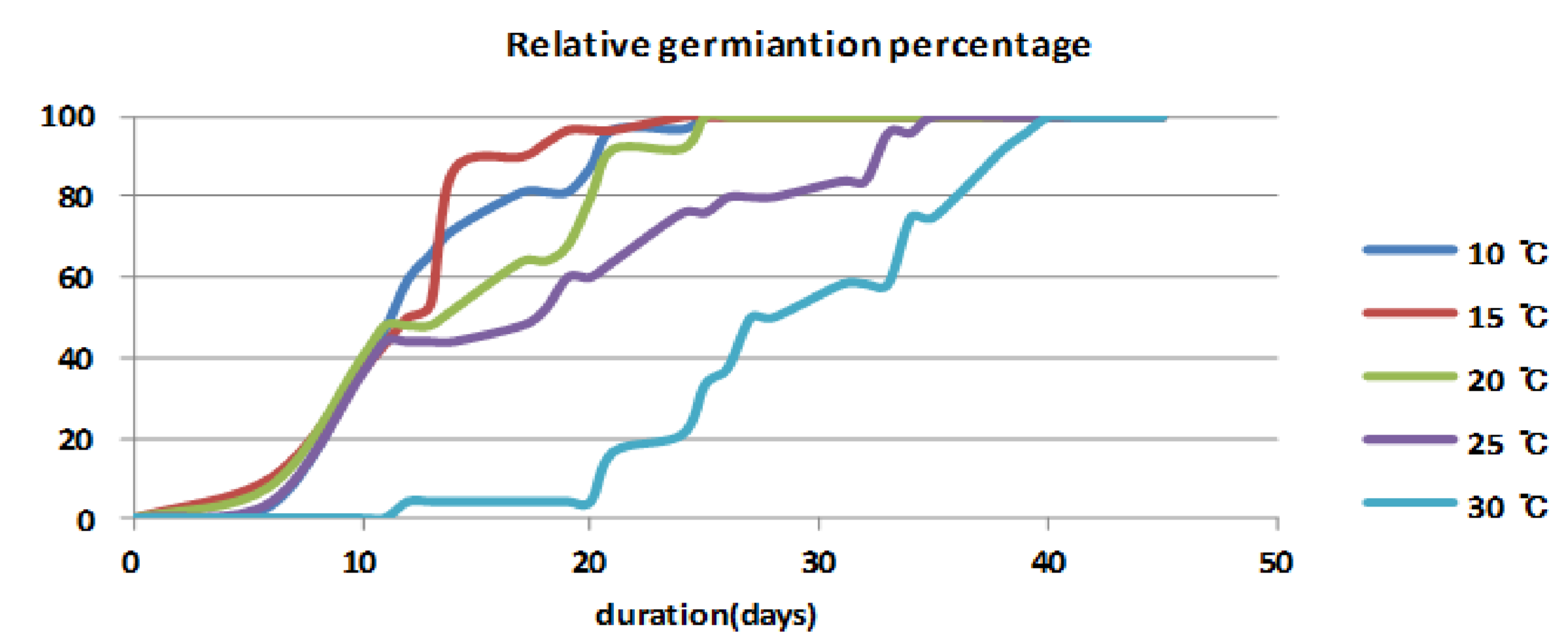


Figure 2. Patterns of relative germination percentages of garlic cloves by various temperature treatments in chamber reveal of retardation of garlic germination at high temperatures.

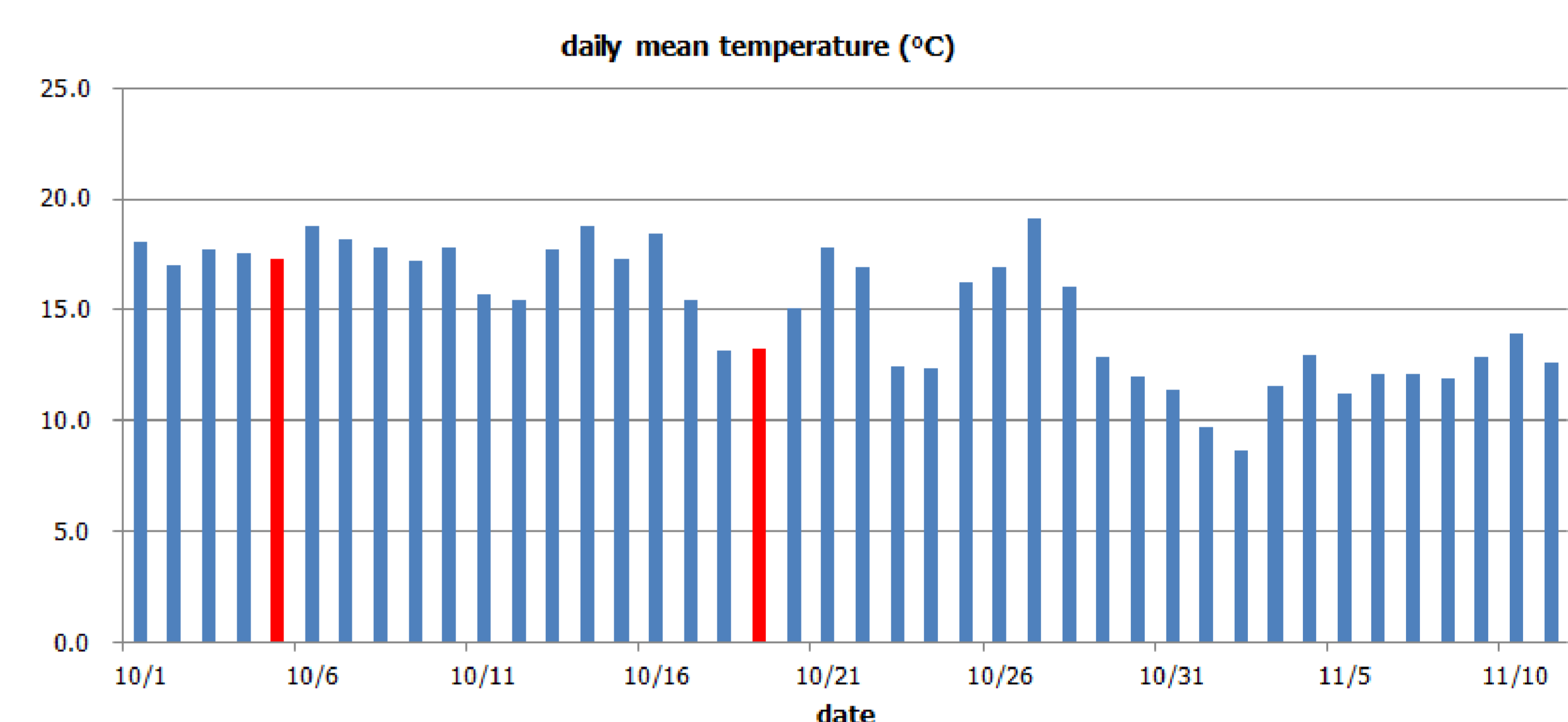


Figure 3. Changes in daily mean temperature on garlic planted field during garlic germination seasons. Red bars mean garlic planting days of 5 Oct. and 19 Oct.

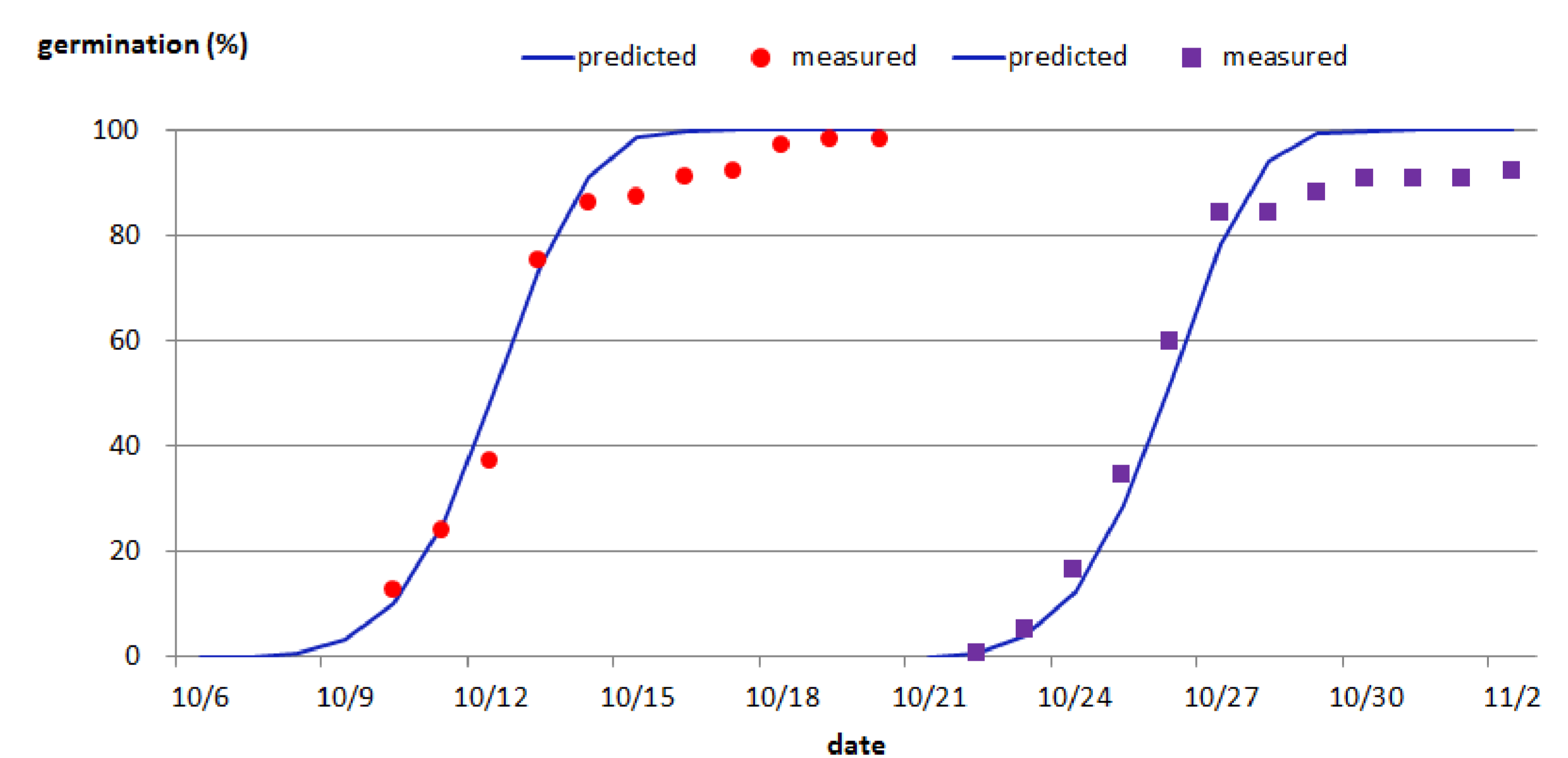


Figure 4. Comparison of model prediction and measured data of garlic germination on field experiment. Garlic were planted 5 Oct. and 19 Oct. on different experiment sites.

## Results & Discussion



Figure 1. Germination experiments conducted in temperature-controlled chambers with different temperature of 10°C(A), 20°C(A) and 30°C(A).

Table 1. The 50% of garlic germination rates were different by temperatures

| Temperature(°C)                      | 10     | 15    | 20     | 25     | 30     |
|--------------------------------------|--------|-------|--------|--------|--------|
| Germination rate(day <sup>-1</sup> ) | 1/11.2 | 1/8.6 | 1/15.0 | 1/17.5 | 1/29.0 |

## Conclusions

1. We made a simple mathematical model to predict germination percentage of southern type garlic using daily mean temperature.
2. Germination rate of garlic in the 2 times of field experiments was successfully elucidated by the temperature model. But more investigation of effects of soil moisture conditions was needed (see reference).

## Reference

Bradford, K.J. 2002. Application of hydrothermal time to quantifying and modeling seed germination and dormancy. *Weed Science*. 50 248-260