POSTER 07

Development System Providing Information for Pest Control and Growth Management of Apple Based on ICT

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I. Introduction

Recently, Korea is pursuing the convergence of ICT with agriculture as a core strategy to resolve the rising production costs incurred by the lack of agriculture labor, aging and energy cost increase, and to revitalize the stagnant agricultural industry. To date, Korean ICT-based research in the field of agriculture has been active in the areas of sensing technology, protected cultivation automation control system and plant factory. Yet, there have not been many cases applying ICT to outdoor field crops.

In this study, an ICT-based web system was developed by converging agriculture and IT technology to provide information to support the precise management of apples. Here, a weather and disaster alert and an apple growth estimation system were created via ICT-based environmental measurement, and a web-mobile user interface was implemented to enable users to access information through the web or a smartphone. In terms of function, the system broadly consists of a pest outbreak system, an apple growth estimation system, and an irrigation control system utilizing environmental measurement information. A brief introduction shall be made in the following text.

II. Materials and Methods

2.1. System outline

The system developed by this research team collects real-time environmental measurements within a group of apple trees, including temperature, relative humidity, rain, and soil moisture, by utilizing the unmanned weather observation equipment installed in each group. The collected data is used in a temperature-based degree day model of *Phyllonorycter ringoniella*, *Grapholita molesta* and *Carposina niponensis*, to predict their growth stages and provide the

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information required for pest control. Also, by predicting and providing information on the growth stages of the apples, the system supports proper crop management in the sprouting and full bloom stages. Finally, by utilizing the environmental measurements observed in the orchard, the system estimates the evapotranspiration in the orchard and provides automated remote control of irrigation according to a base value set by an expert.

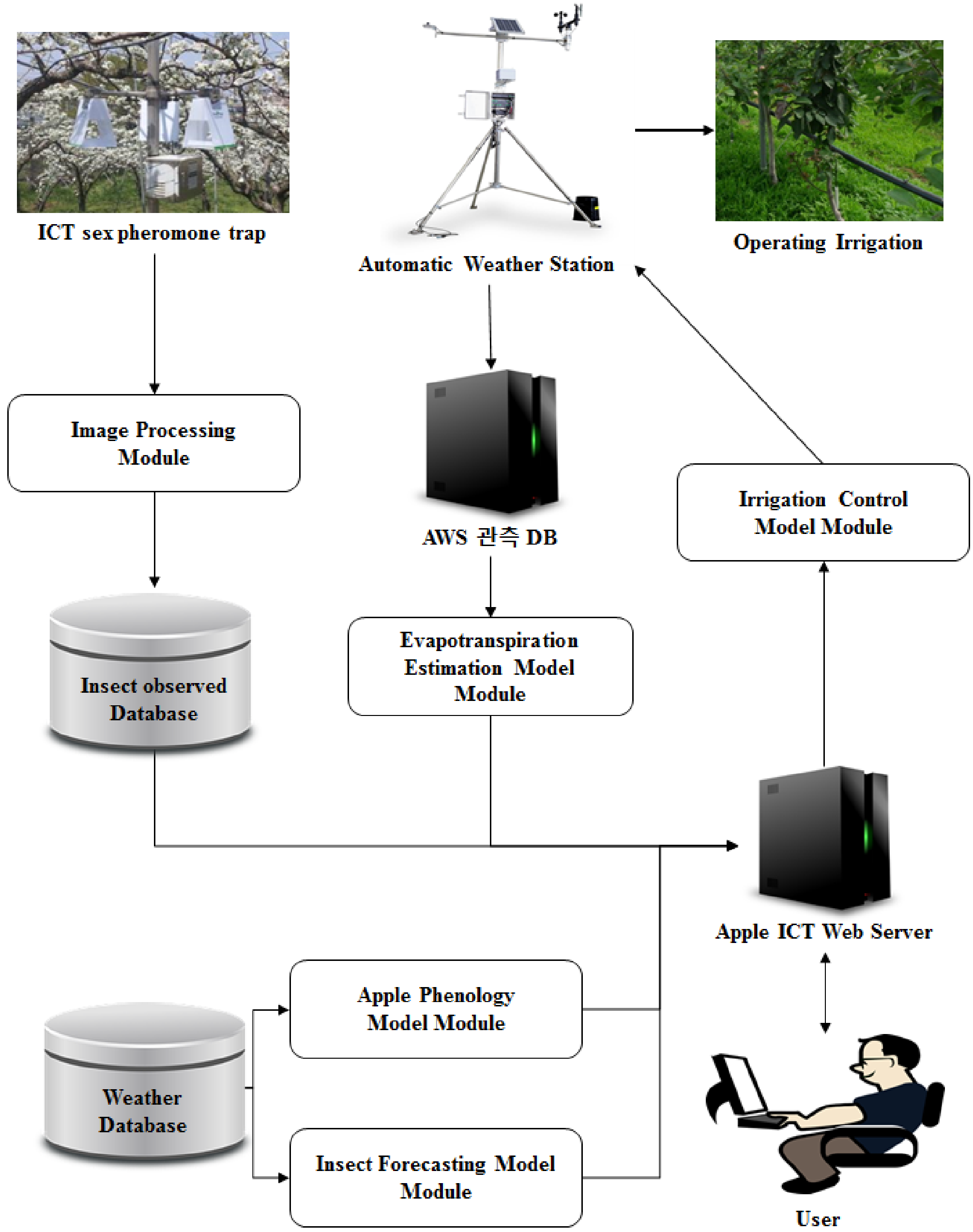

Fig. 1. Overview system providing information for pest control and growth management of apple based on ICT.

2.2. Forecasting pest outbreaks using environmental measurements

Predictions about *Phyllonorycter ringoniella*, *Grapholita molesta* and *Carposina niponensis* were made using the reported model. Models for the target pests were all developed based on the temperature-based degree day model, and these were then modularized into a programming language and uploaded to the system. The model operates on a daily basis, and not only uses real-time weather information but also utilizes the local and medium-range forecasts of the Korea Meteorological Administration (KMA) to provide up to 10 days of pest forecasts.

2.3. Apple growth estimation using environmental measurements

The estimated sprouting date and full bloom date are provided by utilizing the observed data and average annual climate data for the group of trees. The growth estimation model for the sprouting and full bloom of apples was based on the reported base temperature of 6.1°C, the chilling requirement of –100.5 days, and the full bloom heat requirement of 275.1 days (Kim *et al.*, 2009).

2.4. Irrigation Control System using Environmental Measurements

Automatic irrigation is executed according to the automated irrigation system, as shown in Fig. 3. The estimated value of actual evapotranspiration is deduced by applying the crop coefficient by growth stage to the observed data in the orchard and the potential evapotranspiration obtained from the formula in Fig. 2. Irrigation hours per day is deduced by adjusting the actual evapotranspiration based on the expert’s set value (number of drip irrigation units, volume per hour) and observed rainfall values. The auto irrigation system using observed soil moisture is controlled by the hour according to the settings for the period or minimum value.

$$ETO=\frac{(0.408\times asc\times Rn)+r\times\left(\frac{900.0}{T+273.0}\right)\times PV\times\left(Es-\left(\frac{Es\_Ea}{10.0}\right)\right)}{(asc+r\times(1.0+0.34\times PV))}$$

Fig. 2. Formula for calculating potential evapotranspiration.

ETO=soil moisture, r=moisture coefficient, T=average temperature, PV=average wind velocity, Es=saturated water vapor pressure, rad=solar irradiance, Es_Ea=saturation deficit, asc=slope

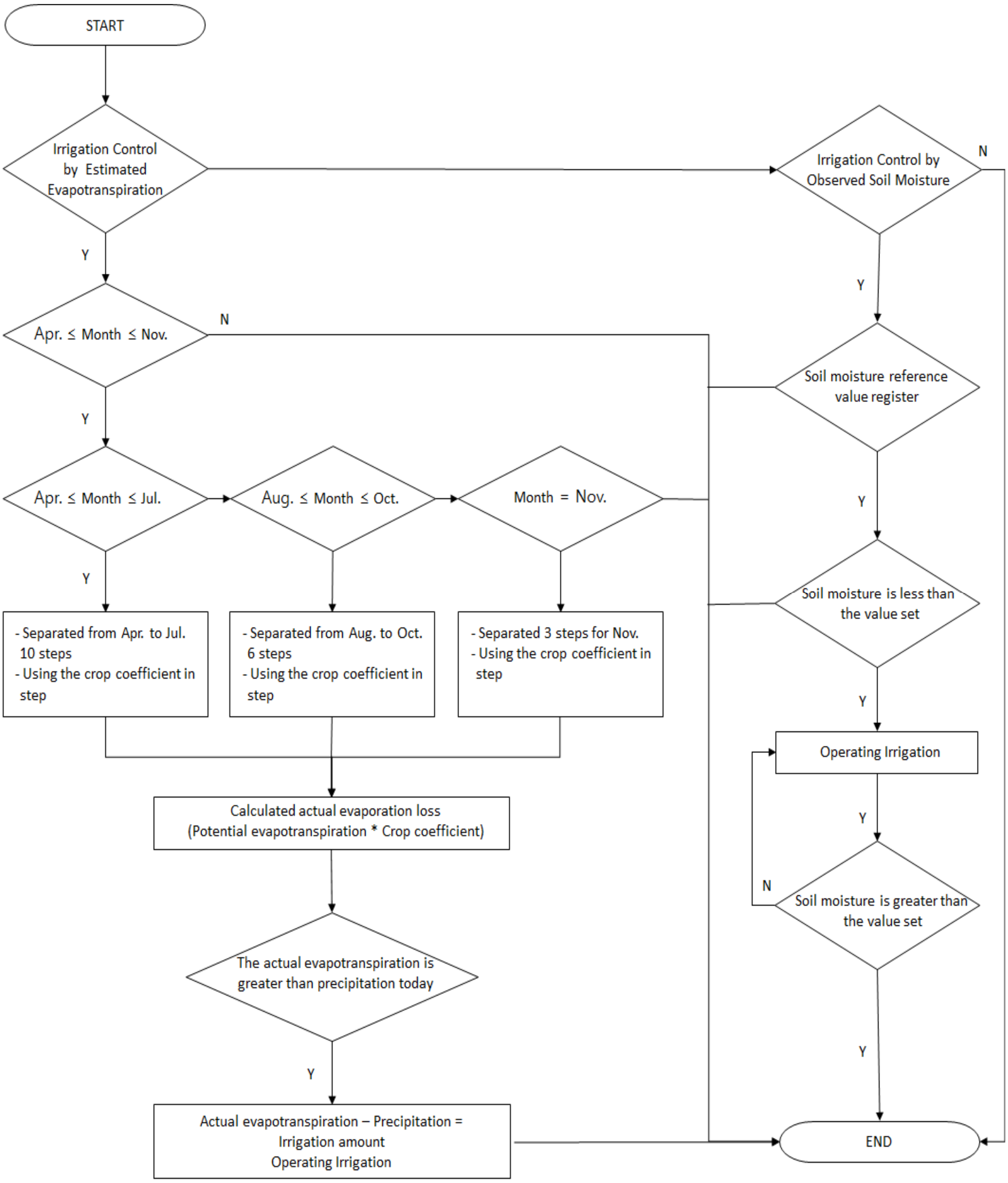

Fig. 3. Flow chart for the automated irrigation control system.

III. Results and Discussion

3.1. Forecasting pest outbreaks using environmental measurements

Fig. 4 is a screenshot of the calendar-based user interface showing predictions for *Phyllonorycter ringoniella*, *Grapholita molesta* and *Carposina niponensis* based on environmental measurements. When the user inserts research findings for a registered time period on his/her account, a blue mark appears in the calendar. This is to provide support for more efficient pest control decision-making based on the pest prediction data and the density of pests observed in the field.

A module estimating pest appearance density through image sensing, which is under research, will be added. Also, if the expert's stage-by-stage algorithm for pest control decision-making is applied, it is expected to serve as the major expert pest control system for apples.

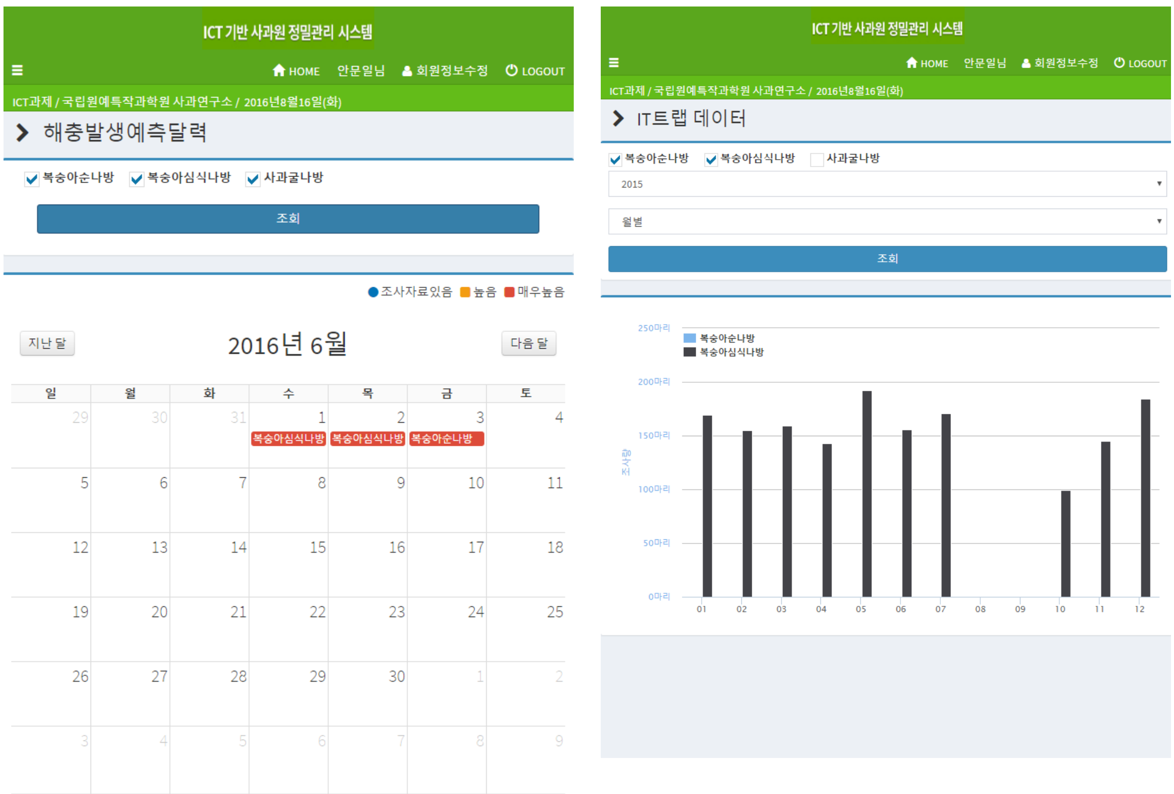

Fig. 4. A screenshot showing ICT-based prediction of pest outbreak and IT trap data.

3.2. Apple growth estimation using environmental measurements

Fig. 5 demonstrates a prediction of growth period and possible damage from low temperature in calendar form, by utilizing environmental measurements and the KMA's forecasts. The growth period (sprouting and full bloom date) is shown after running the March model of each year, and the prediction of low temperature damage is shown up to 10 days from the present date. Such information is expected to assist the user establish scheduled plans for preparation and implementation of soil amendment, artificial pollination, and low temperature damage mitigation technology.

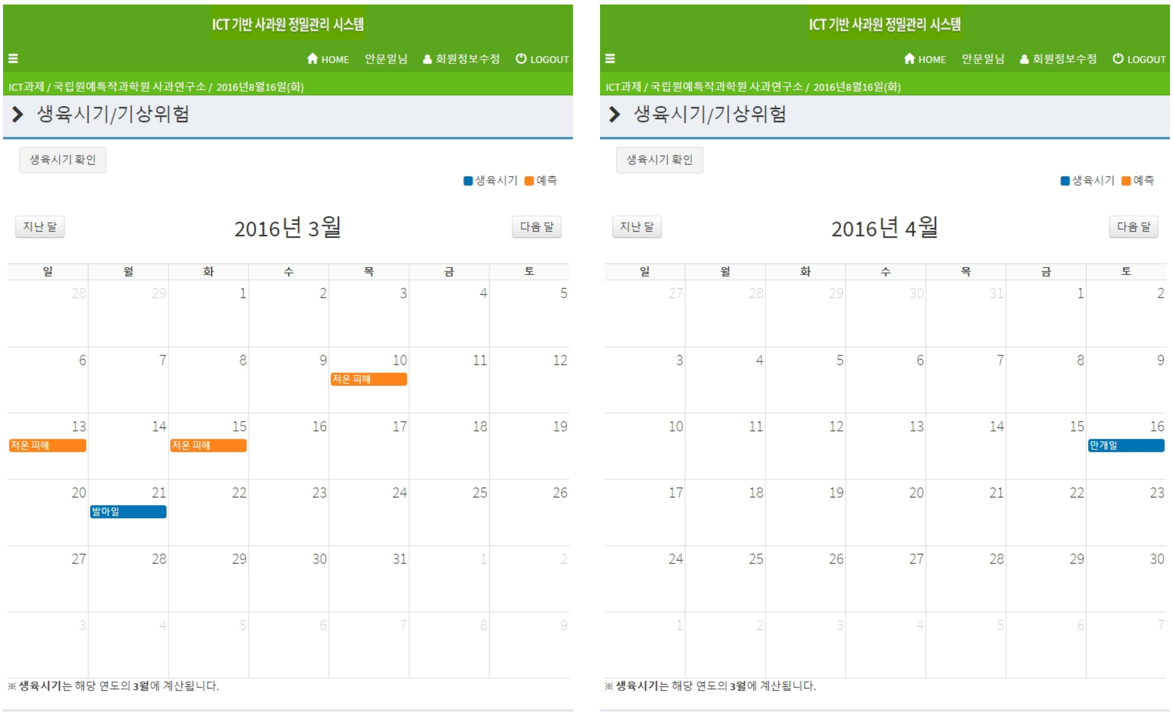

Fig. 5. Screenshots of ICT-based apple growth prediction and meteorological risks.

3.3. Irrigation control system using environmental measurements

Fig. 6 is a screenshot of the table-based user interface showing environmental measurements and the potential and actual evapotranspiration deduced from these measurements. The user can access the information for any given time period, and can also download an Excel file containing this information. When the user turns on auto irrigation, a table-based user interface provides the operation history, including evapotranspiration and soil moisture, in the "automation history" section. By viewing the operation history and irrigation timing, the user can check the irrigation volume in the past. It is expected that the user will be able utilize such information when making agricultural decisions.

Fig. 6. Screenshots of evapotranspiration predictions using ICT-based environmental measurements, and the irrigation control system that utilizes these predictions.

Acknowledgements

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References

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