Estimation of daily primary inoculum of rice blast disease based on weather data

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Background

Rice blast is an endemic disease in Korea. Its outbreak depends on the favorableness of the weather conditions for the disease. Recent epidemics had occurred in 1976, 1977, 1980 and 1993. Due to the climate changes, favorable weather conditions are more likely to occur in the future. Therefore the weather conditions for rice blast outbreak should be monitored on a yearly basis. Most rice blast monitoring models incorporate daily spore observation to estimate infection warnings (Teng et al., 1991). Daily microscopic observation is, however, a time-consuming process and only applicable in small areas.

To extend the effective area of such models, direct observation process need to be substituted by a numerical model, which estimate daily spores based on weather data. Primary inoculum is a cohort of the very first spores of the growing season, which initiates disease cycle of the year. Because not all of the primary inoculum can cause infection, daily existence and amount of the inoculum are very important in estimating daily probability of disease onset. In this study, weather conditions for spore dispersion as well as spore formation were analyzed to estimate daily existence of primary inoculum.

Materials and Methods

Daily observed number of spores and hourly weather data from Hwaseong, Korea during 1994-1999 were used for model development. Daily spores were captured by a rotor type spore sampler during 01:00 – 02:00 and counted using a microscope. Daily inoculum potential (IP) for spore formation was calculated by hourly accumulating the reciprocal of maturation hours (Hcp; Arai and Yoshino, 1987) for a spore-bearing part or conidiophore, which were initially estimated by hourly temperature and relative humidity (Eq. 1).

$$Hcp = 14.35 – 0.25\ T\ (15C < T < 27C \text{ and } RH > 93\%)$$

$$Hcp = -8.5 + 0.59\ T\ (27C < T < 35C \text{ and } RH > 93\%) \quad \text{(Eq. 1)}$$

$$IP = \sum (1/Hcp)$$

Maximum IP was limited to 50 because the primary inoculum was usually observed at IP 50 or earlier. Daily IP, air temperature, relative humidity, solar radiation, rainfall, and wind speed were lagged by 1 to 7 days as the independent variables in the following analyses. Discriminant analysis was performed to estimate daily existence of spores (Spc = 1 (exist) or -1 (non-exist)). Regression analysis was used to estimate daily number of spores (Lsp). The stepwise procedure of SAS was used to select significant independent variables for both analyses (Fig. 1). The models were validated using a separate dataset from the modeling dataset observed from 10 locations including Hwaseong during 1998-2001 (Table 1). The discriminant model was applied to the hourly weather data of the validation dataset to determine the accuracy for the existence of daily spores. If the spores were determined to exist by the model (Spc = 1), then the regression model was used to estimate daily number of spores (Lsp), if Spc was -1 then Lsp was set as 0. Regression analysis was performed to evaluate the effectiveness of the Lsp model.

Results and Discussion

Daily existence of the spores was correctly estimated by 87% and 70% of the times when spores were observed and not observed, respectively. The daily number of spores was more difficult to estimate: the coefficient of determination for the validation of the regression model was 0.11. The regional differences in cultivar and transplanting date make it difficult to forecast daily number of spores. Another origin of the poor correlation can be the complex nature of spore dispersal. Numerical dispersal models can be utilized to help estimating the daily spores.

The models developed in this study can be incorporated in initial disease forecasting over wide area based on numerical weather forecasts. Daily number of spores, however, needs more investigation on the usefulness of the model.

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References

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Teng, P. S., Klein-Gebbinck, H. W., and Pinnschmidt, H. 1991. An analysis of the blast pathosystem to guide modeling and forecasting. In *Rice blast modeling and forecasting*. P.O. Box 933, Manila, Philippines: International Rice Research Institute.

Table 1. Data used in the model development and validation

Purpose of the Data	Location	Data Years
Model Development	Hwaseong Gyeonggi	1994-1999
Model Validation	Hwaseong Gyeonggi	1994-1999
	Hwaseong Gyeonggi	2000-2001
	Yuseong Chungnam	1998-2001
	Cheongwon Chungbuk	1998-2000
	Nampyeong Jeonnam	1998-2001
	Iksan Jeonbuk	1998-2000
	Jinju Gyeongnam	1998-2000
	Chilgok Gyeongbuk	1998-2000
	Chuncheon Gangwon	1998-2000
	Cheolwon Gangwon	1998-2000
	Geochang Gyeongnam	1998-2000

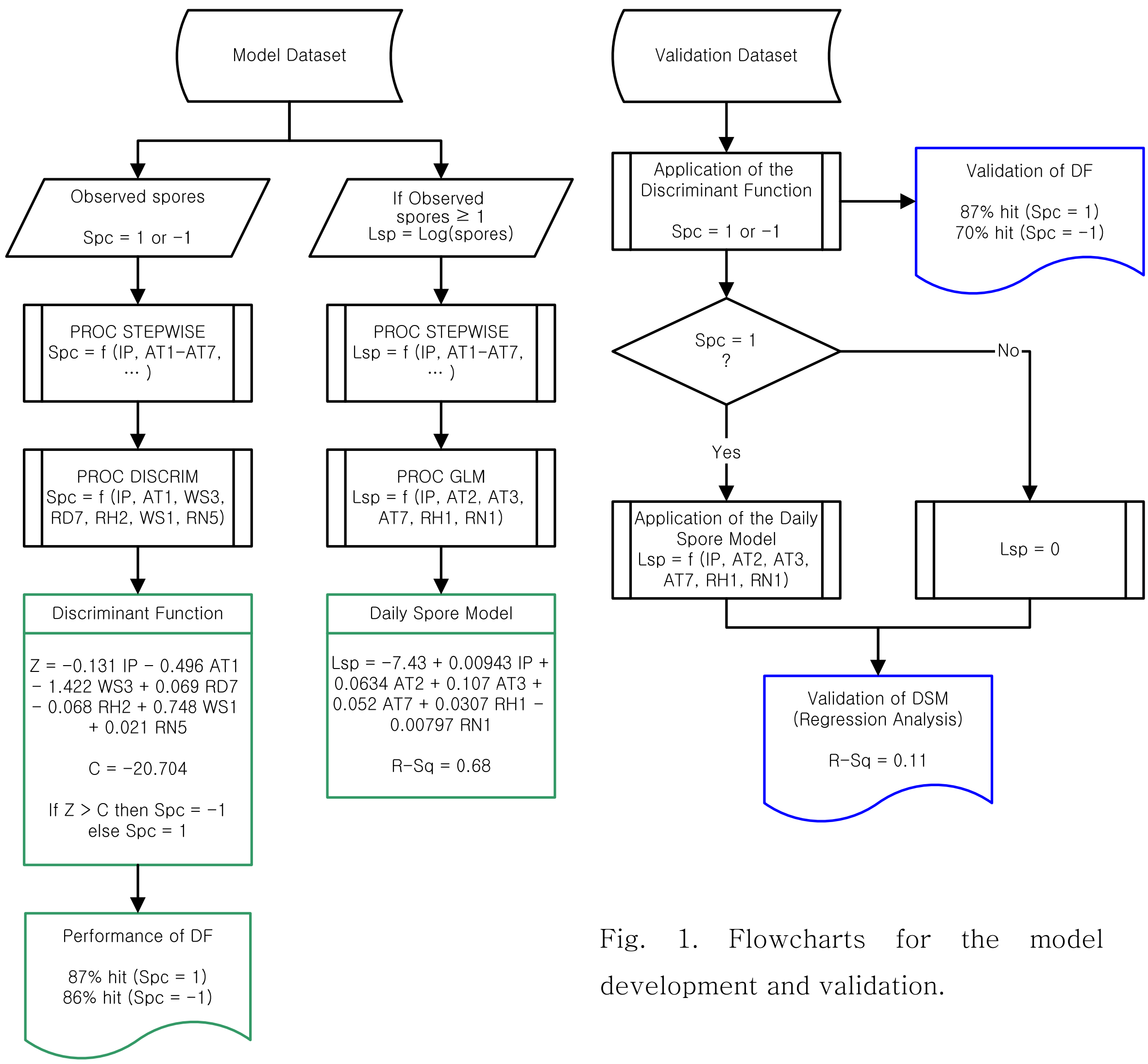

Fig. 1. Flowcharts for the model development and validation.