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Forecasting Late Blight of Potatoes at the Alpine Area in Korea.

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韓國의 高冷地帶에 있어서의 감자疫病 發生豫察에 關하여

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ABSTRACT

Late blight incited by *Phytophthora infestans* (Mont.) de Bary, is an important problem for seed potato prodcution in Korea. At the alpine Daekwanryeong area, unprotected potatoes are often defoliated within 14 days after late blight is first observed in the field. Since regular spraying can control late blight, the forecasting service is needed for timely initiation of the spraying program.

Climatological data and notes on late blight incidence were recorded during 1970-1977 at the Alpine Experiment Station. The moving graph method using 7-day average mean temperature and 7-day total rainfall did not give highly accurate forecasts. Adding data on relative humidity and 7-day average minimum temperature increased the usefulness of the moving graph. Yields of late blight susceptible varietieties in sprayed plots were related to late blight occurrence and to the rainfall distribution pattern.

INTRODUCTION

Late blight incited by *Phytophthora infestans* (Mont.) de Bary is annually a very serious disease in the Daekwanryeong area, the alpine region where most of Korea's seed potatoes are produced. Late blight causes premature vine maturation and tuber rots and results in very low yields in certain years. Since all certified seed potatoes grown for planting, Korea's spring and alpine crops are produced in the Daekwanryeong area, the disease affects seed potato production and its price.

Irish Cobbler(Namjak), the only cultivar recommended for the spring and alpine crops, is susceptible to all races of *P. infestans*.[8] At present late blight resistant cultivars maturity with early and acceptable quality are not available yet. Thus, application of fungicides is the principal means by which yield losses can be reduced. Since late blight epidemics appear to be related to weather conditions in the alpine area, blight forecasting may help growers to initiate spraying before blight actually develops in

Numerous methods of forecasting late blight of potato have been proposed[1,2,4,6,12,13,14,15] and tried in several countries.[3,5,7,11] In some, the potato blight

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warning service has proven very successful.

The purpose of this study is to identify factors affecting occurrence of potato late blight and to determine if late blight forecasting is possible at the alpine Daekwanryaong area in Korea.

METHODS

Climatological data were obtained from the Daekwanryeong Meteorological Office and blight occurrence data were recorded in experimental fields of Alpine Experiment Station, Daekwanryeong, which is located 830 meters above sea level.

The 'moving graph' technigue as dscribed by Hyer [9,10] was used to estimate periods favorable for late blight spread. The moving graph based on 7-day total precipitation and 7-day average mean temperature was developed each year from 1970 to 1977. The average total rainfall for 7 days used to determine if rainfall is favorable for blight was 26.7mm. This value was derived from climatological data on average total rainfall for the period May 31 to August 31, 257mm. The average mean temperature considered favorable for blight devlopment was above 10° C and below 24°C.

Annual estimates of potato yield were obtained from the regional yield trial grown on the Alpine Experiment Station. Although plots were sprayed regularly, the differences of yield with age of the plants between 90 and 120 days may indicate the health of the potato plants. The plants which 90 days after planting were provided on estimate of blight devleopment. Irish Cobbler, a very early variety and Kangneung No. 6, a medium maturity selection, were used to estimate annual affections of late blight.

RESULTS

Climatological data showing period of favoratble temperature and rainfall from 1970 to 1977 are presented in Figure 1. The average mean temperature was above 10°C and below 24°C during the period from May 31 to August 31. The 7-day moving graph for rainfall indicates considerable yearly variation in favorable days. The date of late blight was first observed at the Alpine Experiment Station does not seem to be closely related to rainfall days based on the moving graph (Figure 1). For example, in 1971 and 1976 extended wet periods occurred before blight were observed and in 1977 the blight occurred at the end of long dry period.

Addition of data on days with the avrage humidity above 85 percents and days with minimum temperature below 10°C improved the accuracy of blight forecast (Figure 2). If late blight was observed in June or early July, it commonly was found three or four days after the end of cool period. Exceptions were 1970, 1972, and 1976 when blight appeared during cold period, when June and July were dry and cool, and when conditions were favorable for one month before late blight was detected, respectively. Because temperature and mositure were favorable and the blight occurred late, the 1976 potato yields were the highest ever recorded at the Alpine Experiment Station. (Table 1).

Table 1. Potato yileds and late blight occurrences from 1970 to 1977 at the Daekwanryeong area in Korea.

Year	Date of Planting	Date of blight observed first	Days with first /2 symptom	Yield (MT/ha)1/ Irish Cobbler harvested after 90 days	120 days	percents yield difference	Kangweon 6 harvested after 90 days	120 days	percents yield difference
1970	May 3	June 17	45	21.1	23.0	109.0	19.6	28.3	144 4
1971	May 1	July 5	65	11.6	12.4	106.8	18.3	17.7	96.7
1972	April 26	July 28	93	13.1	19.1	145.8	10.1	26.7	264.4
1973	April 25	June 27	62	24.8	32.9	132.7	19.6	37.9	203.8
1974	April 24	July 4	73	19.0	29.0	152.6	16.3	38.6	236.8
1975	April 28	June 19	52	20.2	19.3	95.5	12.8	19.9	153.9

1976	April	27	July	20	84	26.3	41.0	155.9	26.2	46.9	179.0
1977	May	1	June	30	60	23.4	20.6	88.0	15.8	—	—

1/ Yield data were oftained from the regional trial, 4 replications and 4 row plots 5 to 7 meters long, 75 by 25 cm plant spacing.

2/ Days after planting to first symptom ocurred.

When protective sprays were not applied, nearly complete defoliation of vines occurred within two weeks after late blight was first observed at the Alpine Experiment Station in most years. Even with protective sprays, severe leaf damage was commonly noted by mid to late August. The results from yield trials at Daekwanryeong indicate a close relationship between the days with first symptom occured and the yield change that havested within 90 day and 120 days. (Table 1) The correlation value for both varieties is $r=0.99$ and the correlation for yield change between Irish Cobbler and Kangweon No. 6 is $r=0.98$ The correlations between days to first blight and 120 day yields are highly significant for both Irish Cobbler and Kangweon No. 6, $r=0.94$ and 0.90, respectively.

DISCUSSION

Methods of forecasting late blight of potatoes reported by Beaumont[1,2] Cook[4], Hyre[6,10] and Vallin, et. al[13] were based on the assumption that *P. infestans* requires a certain temperature range and high humidity for its rapid development. Walker[16] indicates that cool, moist nights are required for rapid build-up of inoculum, conidia formation is optimum at 18 to 22°C, and zoospore formation at 12 to 12 to 15°C. Higher temperatures, 21 to 24°C, favor growth after infection. The moving graph based on days of favorable rainfall and temperature and a forecast of continuing favorable weather could not be used to predict the start of the annual late blight epidemic in the Daekwanryeong area. The deifinition of a favorable day, 7-day mean temperature between 10 and 24°C and 7-day rainfall equal or greater than the 7 day average tainfall for Daekwanryeong, needs to be modified to increase accuracy.

Addition of data on minimum temperature, days below 10°C, does improve the blight forecast. Late blight was observed within 3 or 4 days after the minimum right temperature were above 10°C. Data on days with the average humidity above 85 percents suggest that the number of days favorable for blight development is much higher than actually recorded one based on 7-day rainfall date. Also actual yields appear more closely related to blight progress as indicated by humidity than by rainfall. The inability to predict late blight development with a high degree of precision may reflect local environmental conditions. The Alpine Experiment Station is located at 850 meters near the edge of the plateau about 40 kilometers from the east coast. During the spring and summer, coastal fogs and low hanging clouds commonly move inland across the Daekwanryeong area. The coastal fogs may or may not be associated with rainfall. Late blight is commonly found on the Alpine Experiment Station or in surrounding farmers fields before it is observed in fields further from the east coast.

Since weather between the first blight observation and harvest is commonly warm and humid, dry periods do occur but not during all years, regular spraying from late blight appearance unill the end of the growing season is recommended. In practice, this period is often too wet to maintain regular spray program for much longer than 4 weeks. This could explain the very close relationship between days of first blight observation and percent yield increase between 90 and 120 day harvests. If this correlation holds, it may be possible to predict the 120 day yields and the supply of seed potato in the Daekwanryeong area based on the blight observations and 90 day yields.

In other parts of Korea, the value of blight forecasting service is questionable because late blight is normally not a problem. This may be because favorable conditions for the blight development are limited to short periods during the growing seasons. In spring crop and southern alpine area, potatoes can be planted one month earlier than in Daekwanryeong area; foggy and cloudy periods are short during the spr-

ing before the summer rains start; and mean temperature are above 24°C for one or two months during the summer. Thus, temperature is favorable only during late May and June and the number of days having favorable humidity is limited. When late blight is found in other areas of Korea, it rarely defoliates plants completely.

The potato variety grown during the autumn season, Shimabara has a moderate level of horizontal resistance to late blight. Hence, we have not observed serious damage during the autumn season or on Je ju Island where only Shimabara is grown.

SUMMARY

Climatological data showing periods favorable for late blight development for eight years, 1970, 1977 were studied using the moving graph method. The moving graph using 7-day total rainfall proved to be unsuitable for predicting the occurrence of late blight at the Daekwanryeong area in Korea. Addition of minimum temperature and high humidity data increased the value of the moving graph method. More climatic data and refinement of the blight forecasting paramenters may improve the ability to forecast late blight development.

Since the Alpine Experiment Station is located in an area which often has high humidity, coastal fogs and low hanging clouds, late blight develops on or around the station before it does in a large portion of Korea seed growing area. Thus, late blight forecasts based on actual occurrence may be satisfactory for the Deakwanryeong area until better forecasting methods developed. Data on late blight and 90 day yields may be useful in predicting potato yields and seed potato supply in the Daekwanryeong area. In other areas of Korea, late blight is not commonly a serious problem and a forecasting system would be of little value.

摘 要

감자의 重要한 病인 疫病(*Phytopthora infestans*)은 우리나라의 主要씨감자 生産地帶인 中部 高冷地帶에서 每年 甚한 被害를 招來하고 있는데 만일 圃場에 疫病이 처음 觀察된 後 藥劑를 撒布치 않으면 植物體의 地上部는 14日 以內에 完全枯死하게 된다. 規則的인 藥劑撒布로 疫病防除가 可能하지만 더욱이 疫病發生豫報에 따라 適期에 藥劑撒布하므로써 防除効果는 물론 生産費를 節減할 수 있게 된다.

本試驗은 1970~1977年 8年間에 걸쳐 大關嶺의 氣象狀態와 疫病發生 狀況을 調査한바 7日 平均氣溫과 7日 積算降水量을 使用한 Hyre氏의 移動그라프(Moving graph)法에 依한 豫報는 正確性이 높지 않았으나 여기에 相對濕度와 7日 平均最低氣溫을 첨가하므로서 比較的 "Moving graph"法에 依한 豫報의 正確性을 높일 수가 있었다. 그러나 아직도 보다 正確한 疫病豫察을 爲하여 계속적인 調査試驗이 必要하다고 생각된다.

또한 藥劑를 撒布하는 곳에서의 疫病에 感受性인 品種의 收量은 疫病發生程度와 降雨量과 밀접한 關係가 있었으며 特히 大關嶺 地方에서 감자 파종후 疫病發生까지의 日數와 파종後 90日 收量으로 그해의 씨감자의 收穫量과 供給量을 미리 豫測할 수 있게 할 것으로 思料된다.

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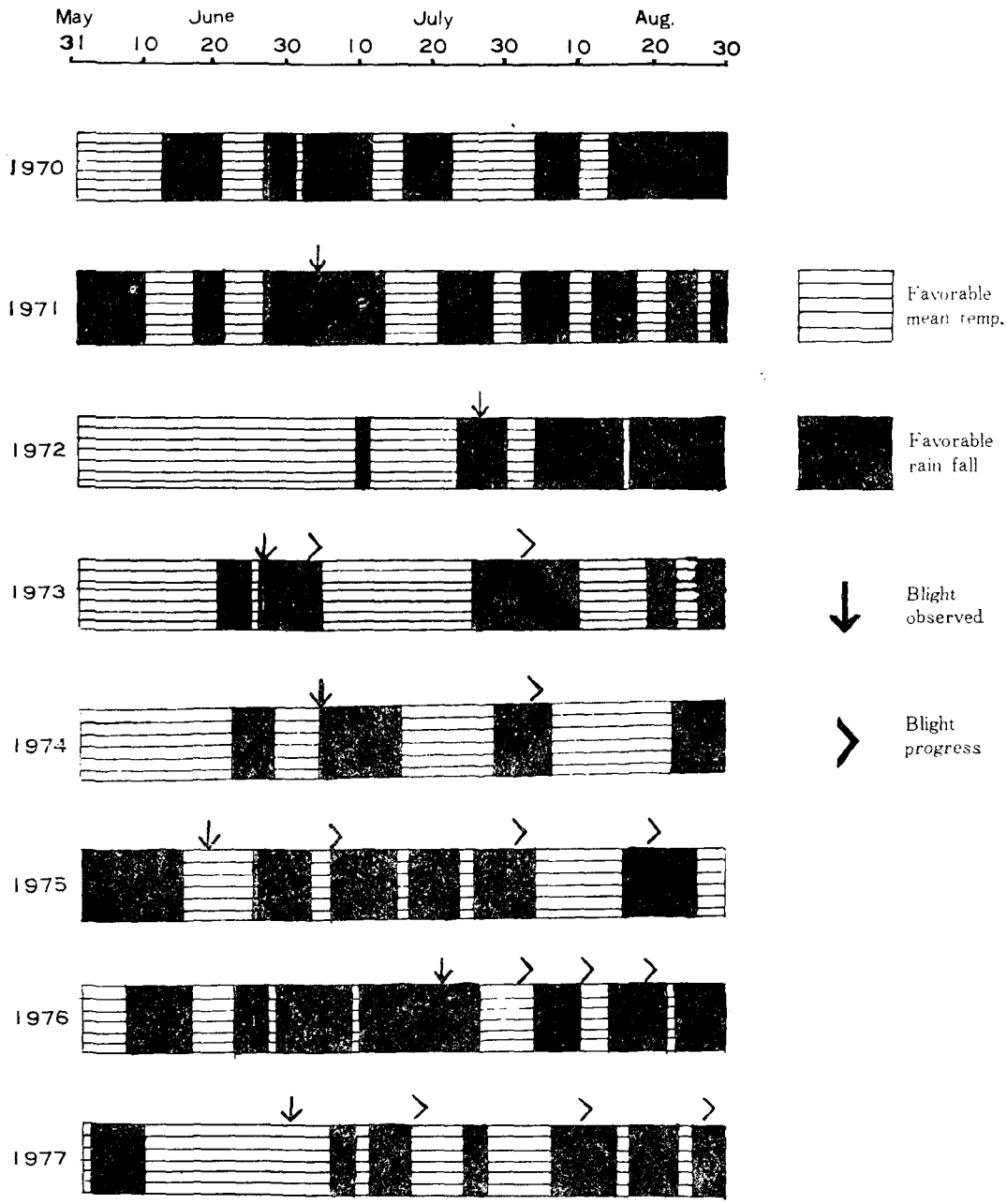

Fig. 1. Climatoloical data showing favorable periods and incidence of late blight with 7-day 'moving graph' for 1970-1977.

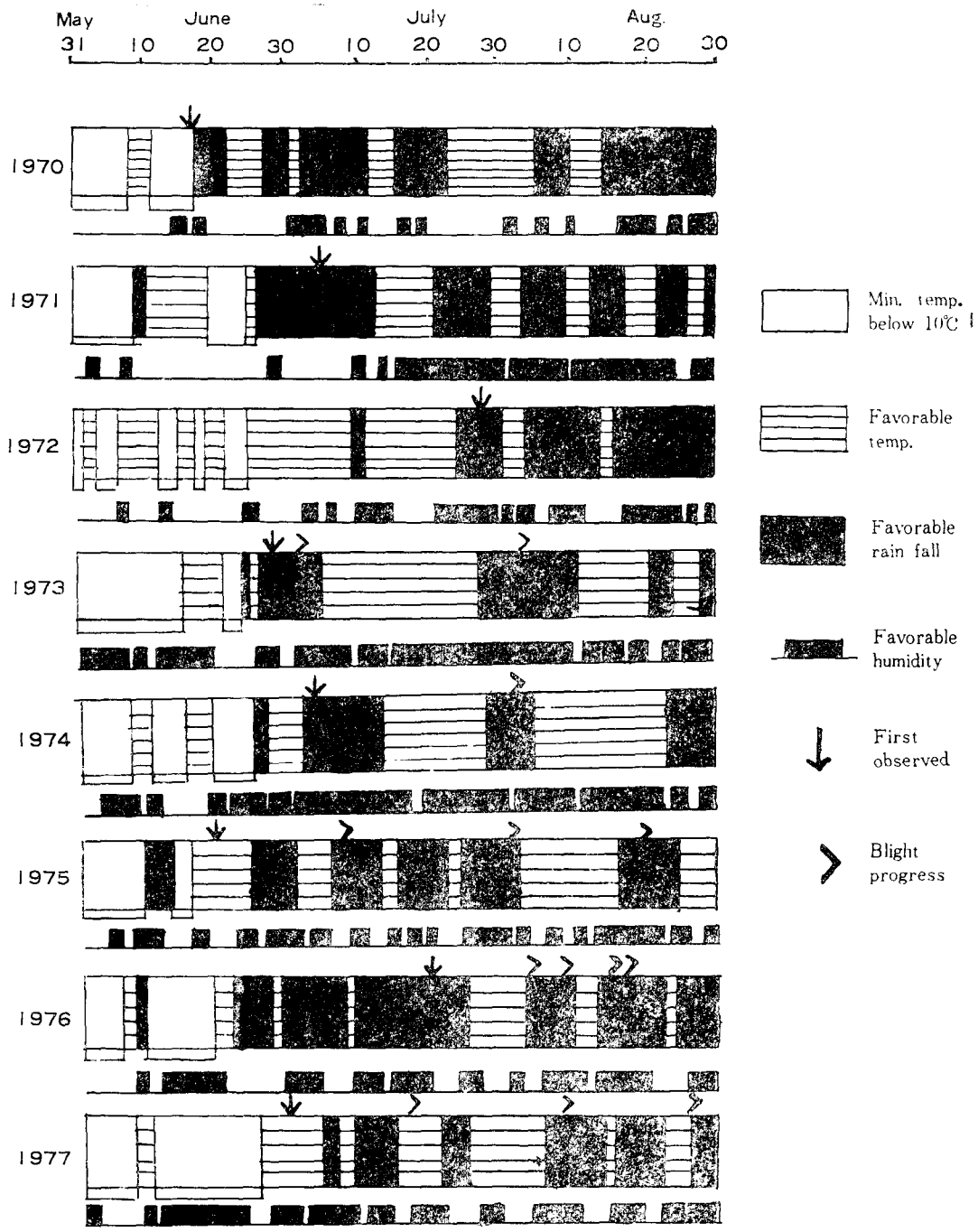

Fig. 2. Climatological data showing periods of favorable minimum temperature, rainfall and humidity and incidence of late blight based on 7-day, moving graph' for 1970-1977.