GEO-INFORMATICS AND SPACE TECHNOLOGY FOR MONITORING BLAST DISEASE OF OFF-SEASON RICE IN LOWER YOM BASIN, THAILAND

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ABSTRACT:

The severity and epidemic of blast had been studied on the off- season rice in the Low Yom Basin. The random paddy field surveys were sampled in the time period of Landsat 5 satellite had orbited pass through the study areas in Phitsanulok, Sukhothai, Phichit and Kamphaengphet provinces. The data had been collected from December 2008 to May 2009. Every study plots had been recorded the position by GPS, rice growth stages and blast disease severity. Difference Vegetation Index of rice in each period was created. The mean and variance in percentage of Difference Vegetation Index had been using for classification growth stages of off-season rice. The results of classification of data categories had been analyzed supervised classification method and maximum likelihood statistic could classify the paddy field areas in difference of rice growth stages in each month. The results showed that the rice blast severities were on December and rice growth was in the harvesting stage, on January and rice growth in tillering stage, on February and rice growth in flowering stage. The data from the field had been analyzed linear correlation and it showed that rice planting date and blast disease had inversion relationships with statistically significant. Equation could be expressed in Dbl = -.027PlantD + 0.044Age + 7.406

1. INTRODUCTION

Rice is the significant commodity for Thai's economy. It is the country's stable food, by-products of rice is also importance for human and animal consumption. Farmers enjoy their earning from selling rice as well as the country gains a large amount of foreign exchange from exporting of rice. Yom basin is 1 in 25 major river basins in Thailand. Many people who lived in this basin are farmer, mainly paddy field, horticulture and field crops. (Prakarnrat, 2010) One problem of rice production is plant diseases. Rice blast disease is the major disease in rainfed lowland area of Thailand. The causal fungus of this disease is *Pyricularia grisea* Sacc. Variation of this fungus was higher than other rice pathogens. (Mekwatanakarn and et al, 2007) Geographic information systems (GIS) had been used as a tool for estimation crop yield of many kinds of plant. In USA, Cromley (2003) had studied on GIS and disease in human. Geographic information systems (GIS) and related technologies like remote sensing are increasingly used to analyze the geography of disease, specifically the relationships between pathological factors (causative agents, vectors and hosts, people) and their geographical environments. GIS applications in the United States have described the sources and geographical distributions of disease agents, identified regions in time and space. (Cromley, 2003). Bernardi (2001) shows how the potential distribution of the western corn rootworm (Diabrotica virgifera LeConte) in Europe can be mapped with only meteorological parameters. Thomas et al. (2002) discuss semi-automated data analysis that predicts the risk of downy mildew disease (caused by *Plasmopara viticola*) for lettuce farmers. Geographic information systems (GIS) provide valuable tools in monitoring, predicting, managing and fighting the spread of pests and diseases. The tools offer opportunities for cost-effective and efficient targeting of control interventions. In monitoring, GIS can be used to determine the spatial extent of a disease, to identify spatial patterns of the disease and to link the disease to auxiliary spatial data. GIS can also be used to predict the projected spread of diseases, to provide input for risk assessment models in pest control and in quantifying changing thresholds of pests and diseases due to climate change. (Bouwmeester , 2008)

2. MATERIALS AND METHODS

2.1 Study area

The study areas is located in the Lower Yom Basin. The areas covered some parts of Sam Ngam district, Wachirabarami district, Pho Prathap Chang district and Muang Phichit district which all districts belonged to

Phichit province and covered Muang Phitsanulok district and Bang Rakhum district which all districts belong to Phitsanulok province.

2.2 Material

LANDSAT5 had been supported by Geo-Informatics and Space Technology Development Agency (Public Organization). The Satellite data, from December 2008 until May 2009, were collected in every 16 days.

2.3 Data collection

This study area had been defined by using Landsat 5 and sampling for 40 sampling plots which cover the Lower Yom Basin. Each study areas (A) in paddy field parcel (P) was recorded the coordinate at the survey target (T) by GPS. Each paddy field parcel had contained with the rice in different growing stages. The rice growing stages had been divided into 5 stages.

Stage 1: Seedling stage 1-30 days
Stage 2: Tillering stage 31-50 days
Stage 3: Flowering stage 51-80 days
Stage 4: Harvesting stage > 80 days
Stage 5: Land preparation or no seedling

In each period of rice diseases field survey data must be consistent with satellite data from Landsat 5. The data collection had been recorded the time of planting and harvesting, rice growing stage during the field survey, coordinate of each plot, planting date, life period (days) after sowing. Blast rice disease incidence had been assessed by visual assessment. The blast disease incidence on leaf blade had been divided in 10 scores and the levels of disease severity was showed in the Table 1. Infection pattern and percentage of disease severity was shown in Figure1. The total sampling points in the each study area was 12 points. There were one point in the each corner and 2 points in each sites of study area.

Table1 Score of rice disease severity assessment in the paddy field survey.

Scores of Disease incidence	Disease Incidence on leaf blade (%)	Level of Disease Severity
0	no	no
1	1-10%	lowest
2	11-20%	low
3	21-30%	moderate
4	31-40%	high
5	41-50%	highest
6	51-60%	highest
7	61-70%	highest
8	71-81%	highest
9	81-90%	highest
10	91-100%	highest

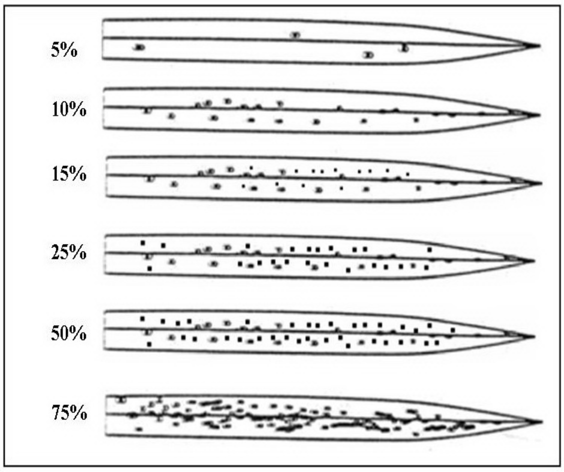

Figure 1 Rice blade with blast disease severity

The paddy field area in different growth stage had been classified from satellite data. Difference Vegetation Index (DVI) had derived from the near-infrared light (band 4) and red light (band 3) which had been corrected and adjusted the light intensity value from 0-255. Difference Vegetation Index values were calculated with formula expressed below;

$$DVI = \frac{NIR - VR}{NIR + VR}$$

Statistical values of Difference Vegetation Index was calculated in 3 periods which beginning from December 2008 until May 2009. Difference Vegetation Index of rice in each period was created. The mean and variance in percentage of Difference Vegetation Index had been using for classification growth stages of off-season rice. The results of classification of data categories had been analyzed supervised classification method and maximum likelihood statistic could classify the paddy field areas in difference of rice growth stages in each month. The paddy field areas in seedling stage, tillering stage, flowering stage and harvesting stage were classified and cut with paddy field areas in the Lower Yom Basin in the vector file. The total area of paddy field was 137,058 hectares. The correlation between the percentage of Difference Vegetation Index and life period (days) after sowing were analyzed. The data of blast disease severity in different period had been analyzed by GIS and showed as map of blast disease severity in each month in different growth stages of rice.

3. RESULTS

The new Difference Vegetation Index in 7 periods was corrected by the equation which showed in Table 2. From supervised classification paddy field in the low Yom Basin in December 2008 and May 2009 showed that the largest paddy field areas were in seedling stage or 55.15% and 60.90% of the total area, respectively. In January and February 2009, the largest paddy field areas were in tillering stage or 81.60% and 55.77 of the total area, respectively. In March and April 2009, the largest paddy field areas were in harvesting stage or 44.64 and 33.49 of the total area, respectively. (Figure 2 and 3)

Table 2 Seven periods of satellite data and their correction equations for new Difference Vegetation

Satellite Data (D/M/Y)	Correction Equations for New DVI	
	Band 3	Band 4
9/12/2551	Y = 5.930*X – 118.605	Y= 3.542*X – 70.833
10/1/2552	Y = 9.107*X – 145.714	Y= 3.269*X – 71.923
26/1/2552	Y = 6.375*X – 127.500	Y= 3.110*X – 62.195
11/2/2552	Y = 6.375*X – 127.500	Y= 3.112X – 82.792
27/2/2552	Y = 6.711*X – 167.763	Y= 3.864*X – 135.227
16/4/2552	Y = 2.452*X – 39.231	Y= 2.125*X – 34.000
18/5/2552	Y = 2.161*X – 69.153	Y= 2.602*X – 135.227

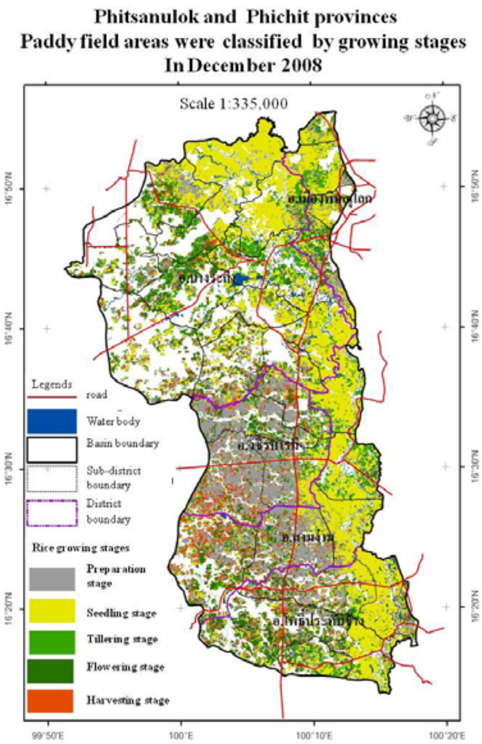

Figure 2 The large area in seedling stage in December 2008

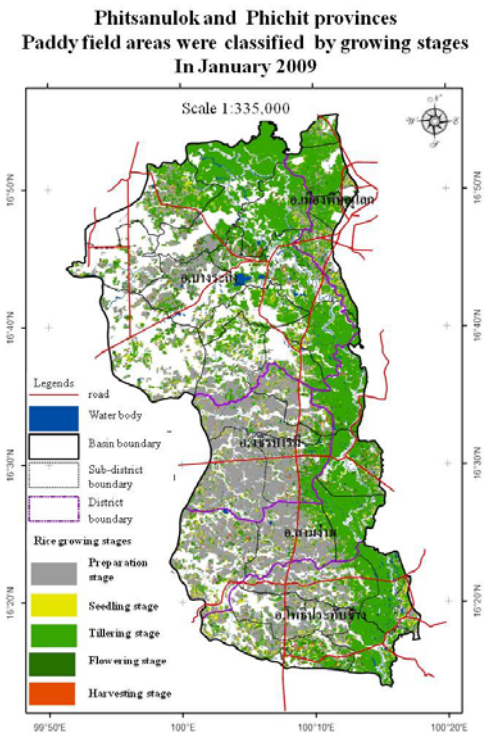

Figure 3 The large area in tillering stage in January 2009

Monitoring Blast disease and Geo-Informatics

From the field survey in December 2008, there was the lowest blast disease severity occurrence in every growing stage. Especially in the harvesting stage showed 10% disease incidence (Figure 4). In January 2009, the low blast disease severity was on tillering stage or 11.04% disease incidence. In February 2009, the low blast disease severity was on flowering and harvesting stages or 16.42% and 16.00% disease incidences, respectively (Figure 5). In March, April and May 2007, the lowest blast disease severity was on seedling stage or 6.17%, 1.13% and 1.30% disease incidence, respectively. And the low severity was on harvesting stage or 18.75%, 12.35% and 7.2% disease incidence, respectively. Consideration on monthly and blast disease severity in Lower Yom Basin area, it showed that the moderately disease severity occurred in Lower Yom Basin on December and disease severity was decreased from January to May. (Figure 6, 7, 8 and 9)

Correlation and equation of blast disease severity

The linear correlation was derived from 508 field survey data which consist of planting date, age or plant life period in seedling until harvesting. The result showed that planting date was effect on blast disease severity at 95% statistical significant. Rice was planted in December will be less severity than planted on January, February, March and May. The plant age was direct correlation to disease severity. Seedling stage was less blast infection or lowest disease severity and the highest disease severity was on harvesting stage. Life period of rice (age) or physiological of rice was highest effect to blast disease severity at 95% statistical significant. The equation of blast disease severity was showed as below

$$\mathbf{Dbl} = -.027PlantD + 0.044Age + 7.406 \quad ; R^2 = .150, F = 44.536\ Sig. = 0.000$$

$$(t = -5.467) \quad (t = -5.467) \quad (t = 9.432)$$

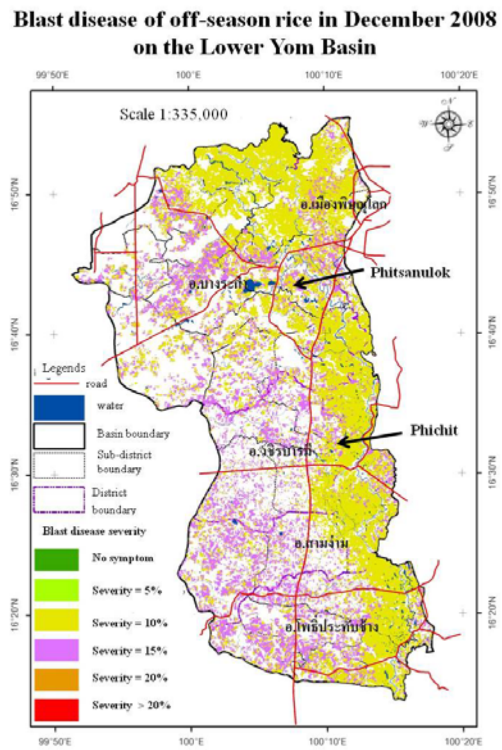

Figure 4 Blast disease severity in December 2008 infected on off-season rice at Phitsanulok and Phichit provinces

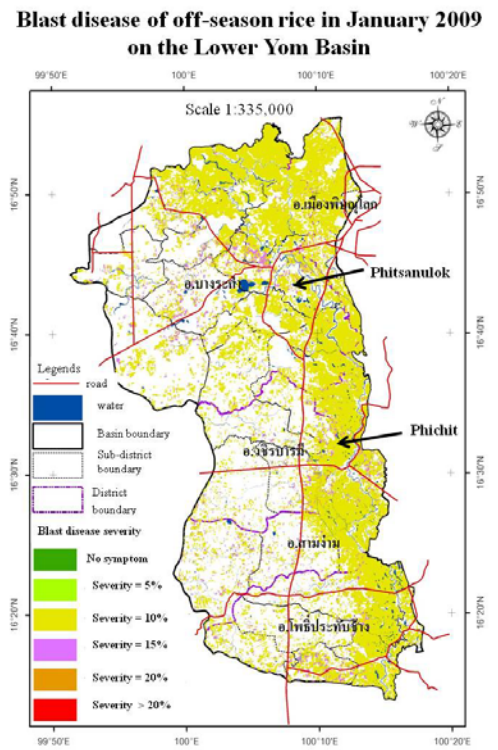

Figure 5 Blast disease severity in January 2009 infected on off-season rice at Phitsanulok and Phichit provinces.

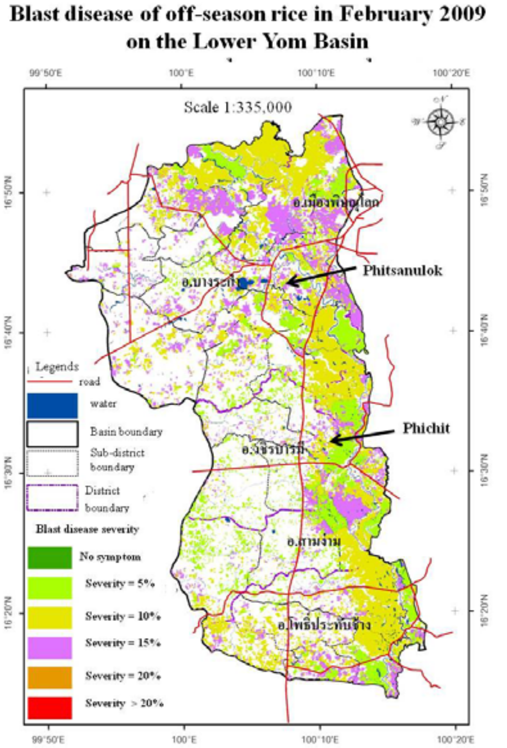

Figure 6 Blast disease severity in February 2009 infected on off-season rice at Phitsanulok and Phichit provinces

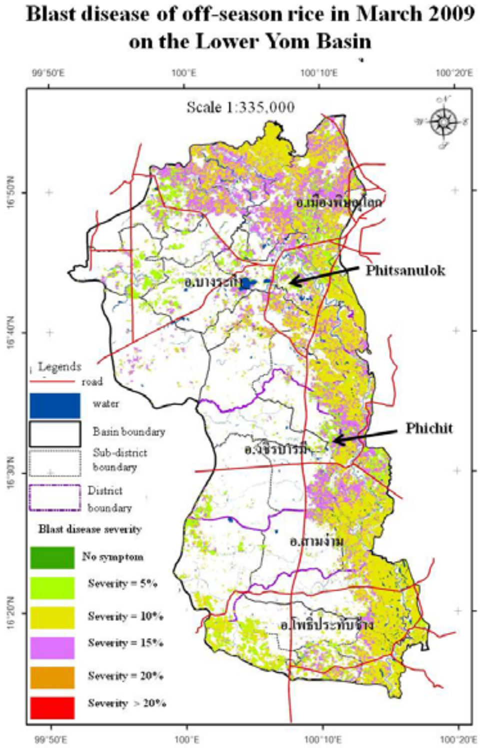

Figure 7 Blast disease severity in March 2009 infected on off-season rice at Phitsanulok and Phichit provinces.

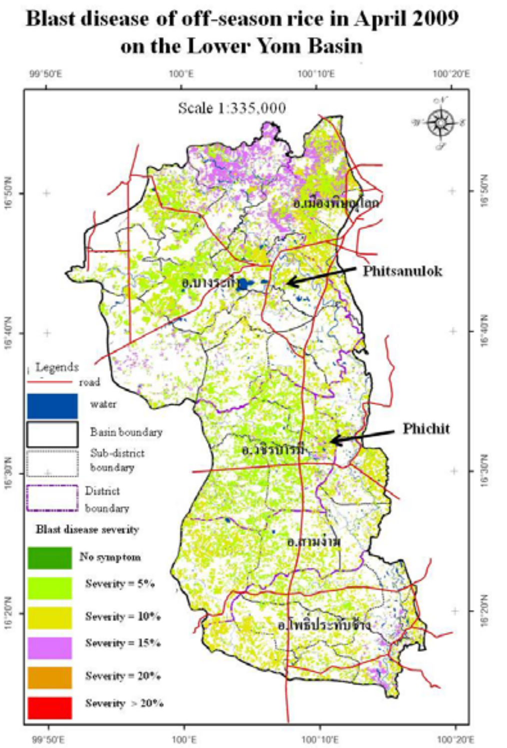

Figure 8 Blast disease severity in April 2009 infected on off-season rice at Phitsanulok and Phichit provinces

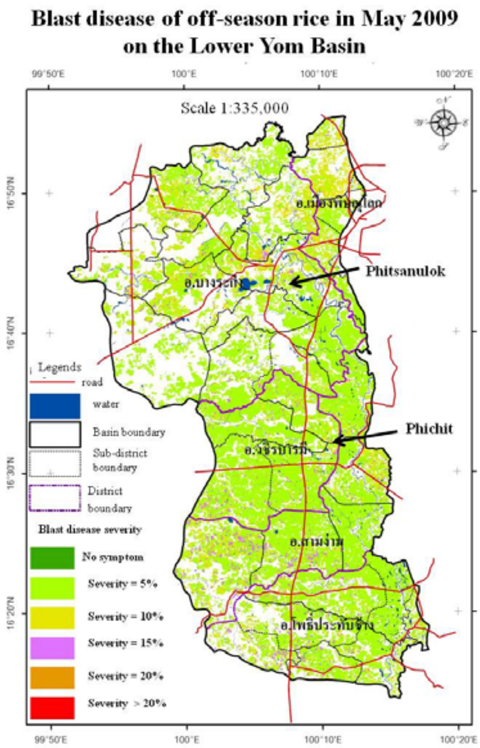

Figure 9 Blast disease severity in May 2009 infected on off-season rice at Phitsanulok and Phichit provinces.

4. CONCLUSION

The study on epidemic and severity of blast disease of off-season was located on Lower Yom Basin. Rice is the main agricultural production in that area. The disease severity assessment and field survey were done on seedling, tillering, flowering and harvesting stages from December 2008 until May 2009. All filed data was collected, processed, analyzed by GIS. Disease severity in each month, each area and each growth stage were showed as maps of blast disease severity. Landsat5 provided from GISTDA has been used for this study.

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