APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM WITH FIELD EXPERIMENT TO ASSESS SUITABLE ZONATION MAPPING FOR RICE CULTIVARS UNDER PROJECTED GLOBAL WARMING IN LOWER NORTHERN THAILAND

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ABSTRACT

The aims of this research were to assess the effects of increased temperature on total chlorophyll and grain yield of 5 commercial Thai rice cultivars (Chinat1, Pathumthani1, Phitsanulok2, KorKhor29, and Riceberry) in lower northern Thailand. Nine field-open top chambers (OTCs) with electric systems were applied from 2018 to 2020 in Phitsanulok to simulate projected 2 future temperature situations in 2100 which consistent with RCP4.5 and RCP8.5 scenarios (higher than ambient level by 2.6°C and 4.5°C, respectively).The results under field experiment revealed that the negative significant impacts on total chlorophyll were obvious appeared in KorKhor29 under RCP8.5 scenarios. In addition, results in grain yield indicated that decreases in yield were correlated with increased temperature under both of 2 situations. The high reduction in total grain yield (ton per ha) were also found in Riceberry and Phitsanulok 2 under RCP8.5 scenario by 88-95%. However, it seems that Chainat1 was heat-tolerant cultivars under both of 2 warming situations, by the way in which the property of increases in total chlorophyll and grain yield. Then all results were combined with the spatial temperature model and analyzed by the GIS to assess suitable zonation mapping for rice cultivars under projected global warming in lower northern area. As a result, we also found the positive effects of temperature rise on grain yields in Chainat1. These results are parallel to findings from the field experiment. The data indicated that under projected future temperature levels, it seemed that Tak province, Phitsanulok and Uttaradit provinces were suitable areas for rice cultivation. Chainat1 cultivar should be selected for cultivation in this area, especially in Tak province.

OBJECTIVE

To assess the **effects of increased temperature** on **total chlorophyll** and **grain yield** of 5 commercial Thai rice cultivars (Chinat1, Pathumthani1, Phitsanulok2, KorKhor29, and Riceberry) in lower northern Thailand.

METHODS

Field Warming Experiment & Rice Planting Management

Field-open top chambers (OTCs) with electric systems

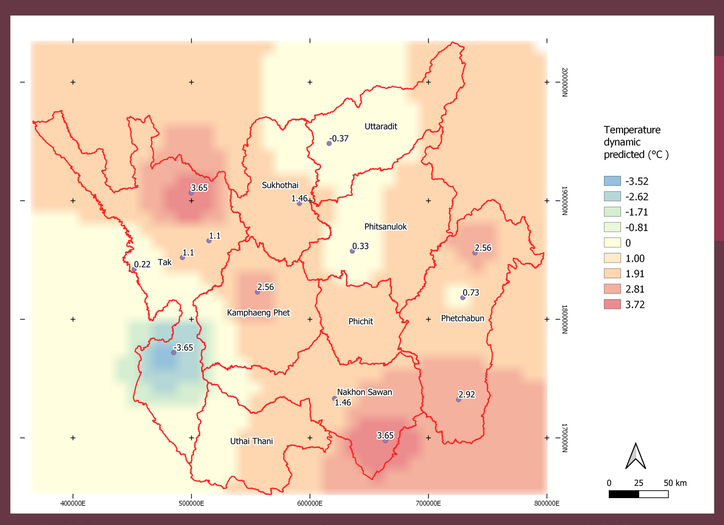
Chlorophyll Analysis
(UV-VIS spectrophotometer at 2 wavelengths :663 nm and 645 nm)

Total Chlorophyll (mg/g. fw) = (20.2 x λ645)+(8.02 x λ663)

UV-VIS spectrophotometer

Yield Component Analysis
(Total number of grains, filled grains [complete grains] and unfilled grains [incomplete grains] per panicle)

Grain yield (t/Ha)=no. of panicles per m2 x %filled grains per panicle x 1000 grain weight(g) x 10-5



IDW temperature change over next 100 years

Modeling and Zonation Mapping

Data anlysis & mapping tools

The unfilled grains

The filled grains

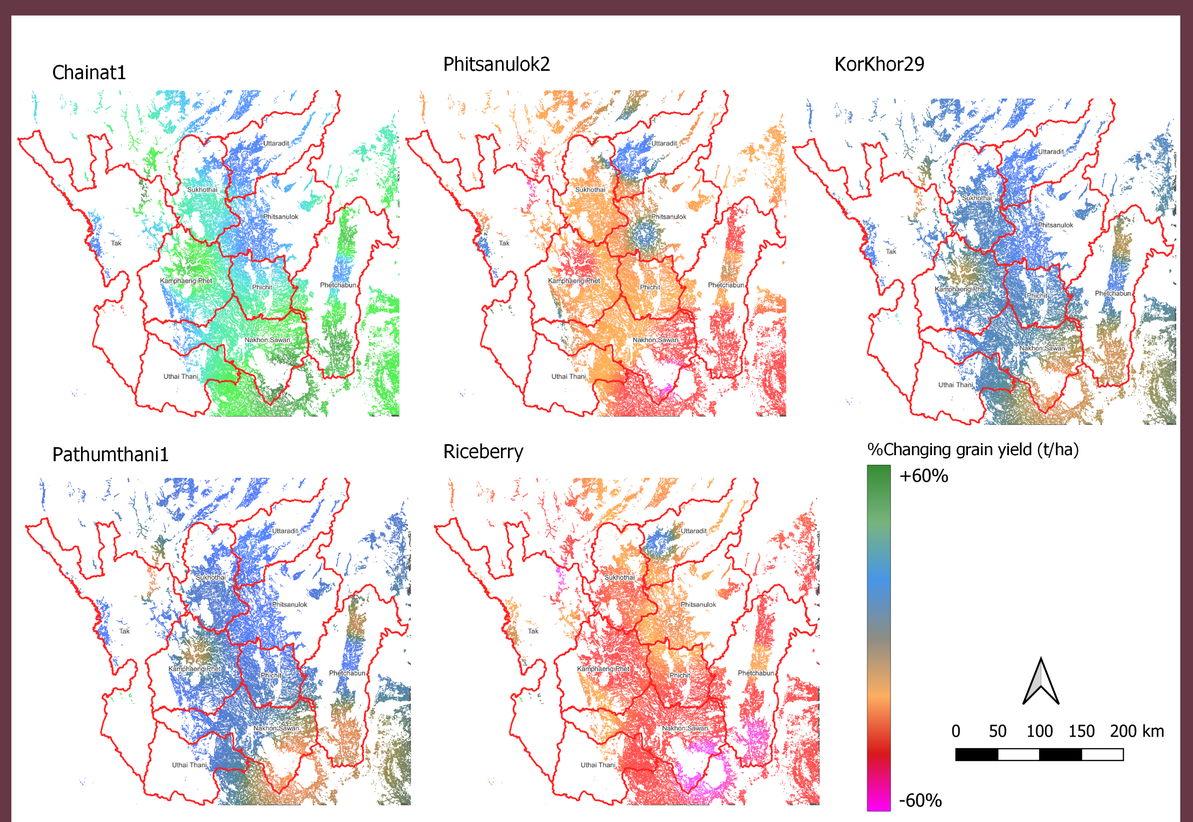
RESULTS

Table 1. Mean values (±SD) of total chlorophyll, percentage of filled seed. ear^{-1}, and grain yield observed from samples of 3 treatments and exposed to elevated air temperature levels in 5 rice cultivars.

Rice Cultivars	Treatment	total chlorophyll (mg. g fw^{-1})			filled seed. ear-1 (%)			grain yield (t/ha)		
		x̄	Change**	Sig.	x̄	Change**	Sig.	x̄	Change**	Sig.
Chainat1	CT	39.97±5.49^{a}			64.4±14.2^{a}			1.81±0.63^{a}		
	HT4.5	48.47±3.88^{b}	+21.27	p<0.05*	73.2±14.1^{b}	+13.62	p<0.05*	2.91±0.57^{b}	+60.77	p<0.05*
	HT8.5	47.73±0.98^{ab}	+19.41		55.7±10.5^{a}	-13.44		1.93±0.36^{a}	+6.62	
Pathum thani1	CT	35.51±5.25^{a}			63.7±16.4^{b}			1.55±0.73^{a}		
	HT4.5	36.35±6.99^{a}	+2.36	p>0.05	47.7±22.0^{a}	-25.08	p<0.05*	2.13±1.36^{a}	+37.42	p>0.05
	HT8.5	43.47±0.07^{a}	+22.43		49.1±15.2^{a}	-22.91		0.9±0.44^{a}	-41.94	
Phitsanulok2	CT	39.81±3.52^{a}			85.05±6.01^{c}			2.36±0.91^{b}		
	HT4.5	42.78±6.48^{a}	+17.31	p >0.05	64.43±4.56^{b}	-24.24%	p<0.05*	2.09±0.77^{b}	-11.44	p<0.05*
	HT8.5	41.44±4.88^{a}	+13.95		3.81±0.26^{a}	-95.52%		0.12±0.05^{a}	-94.92	
KorKhor 29	CT	44.06±0.76^{ab}			74.8±12.1^{a}			1.65±0.56^{a}		
	HT4.5	45.47±4.32^{b}	+3.19	p<0.05*	84.8±01.0^{a}	+13.36	p>0.05	1.94±0.35^{a}	+17.58	p>0.05
	HT8.5	39.10±0.57^{a}	-11.26		66.9±12.7^{a}	-10.55		1.18±0.25^{a}	-28.48	
Riceberry	CT	42.21±7.04^{a}			71.46±0.35^{c}			1.60±0.22^{c}		
	HT4.5	43.63±0.29^{a}	+3.36	p>0.05	51.77±10.59^{b}	-27.55	p<0.05*	0.83±0.21^{b}	-48	p<0.05*
	HT8.5	50.07±0.11^{a}	+18.63		12.06±2.48^{a}	-83.12		0.19±0.06^{a}	-88.13	

Note: The different letters for each treatment indicate a significant difference at ρ <0.05.

* A p-value less than 0.05 ($p \leq 0.05$) is statistically significant. ** Percentage change compared to control (CT)



Rice cultivar zonation mapping under projected global warming

CONCLUSIONS

The results from experiment with GIS showed that under projected future temperature levels based on RCP4.5 and RCP8.5 scenarios around the next 100 years, it seemed that Chainat1 is the tolerant cultivar, whereas Phitsanulok2 and Riceberry are susceptible cultivars. Finally, Tak province was the suitable areas for rice cultivation. Hence, Chainat1 cultivar should be selected for cultivation in this area, especially in Tak province.

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