Acclimation to midday photoinhibition of rice grown under upland condition in relation to drought stress

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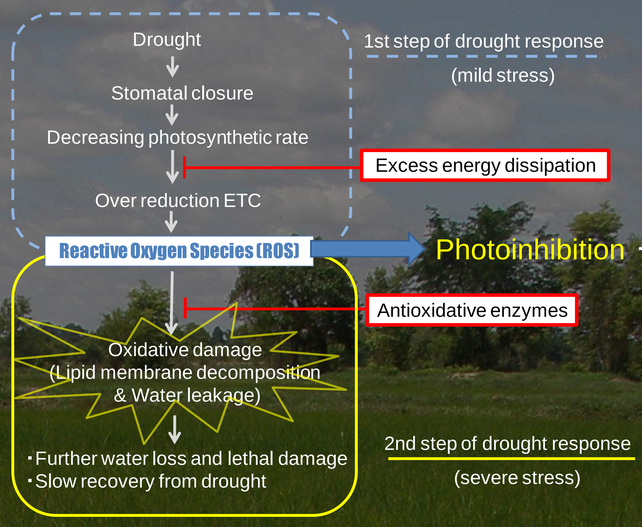
INTRODUCTION

The excess light energy in thylakoid membrane sometimes causes severe oxidative damage to cell membrane because of over reduction of molecular oxygen (Fig.1). The physiological mechanisms which alleviate over reduction of electron transport chain (ETC) thought to be important to avoid oxidative damage under environmental stress such as drought. The maximum quantum yield of photosystem Ⅱ (Fv/Fm) is easy measureable indicator of photoinhibition which closely relate to the rdox state in ETC. In this study, long term changes of midday Fv/Fm in rice grown under upland condition was monitored and surveyed its relation to oxidative damage to cell membrane.

CONCLUSION

From the observation of long term changes of midday Fv/Fm in rice under upland condition, we revealed that midday photoinhibition was progressively mitigated as the acclimation response to severe photoinhibition in the early period of growth (Fig. 2, 3). The varietal differences of Fv/Fm shows that this physiological mechanism which alleviates over reduction of ETC is important to avoid oxidative damage to lipid membrane and would contribute to well growing under drought environment (Fig. 4).



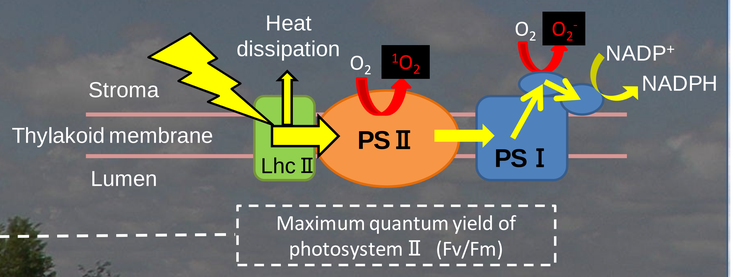


Fig. 1 Oxidative damage to lipid membrane cause water leakage from cells and promote leaf desiccation under drought stress.

RESULTS

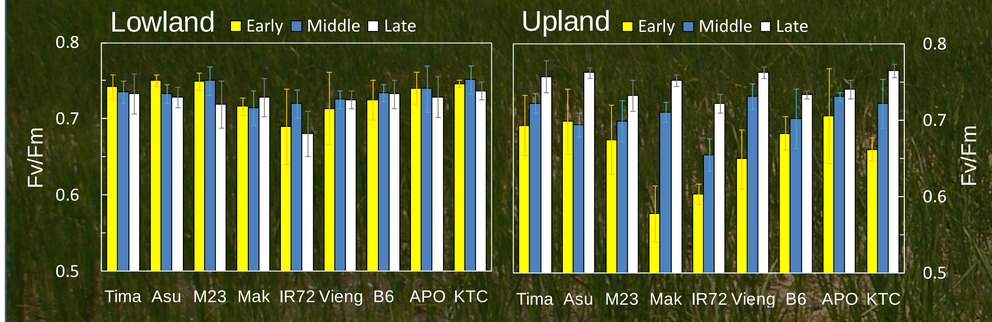


Fig. 2 The midday photoinhibition under upland condition was mitigated as the drought was progressed.

Changes of midday Fv/Fm in the nine rice varieties used in this experiment. Values of Fv/Fm was measured during from 10:00 am to 14:00 pm in sunny days and averaged with every four to six days for each growth period. Early; 25 Jun - 14 Jul, Middle; 23 Jul – 18 Aug, Late; 24 Aug – 10 Sep as shown in Fig. 5.

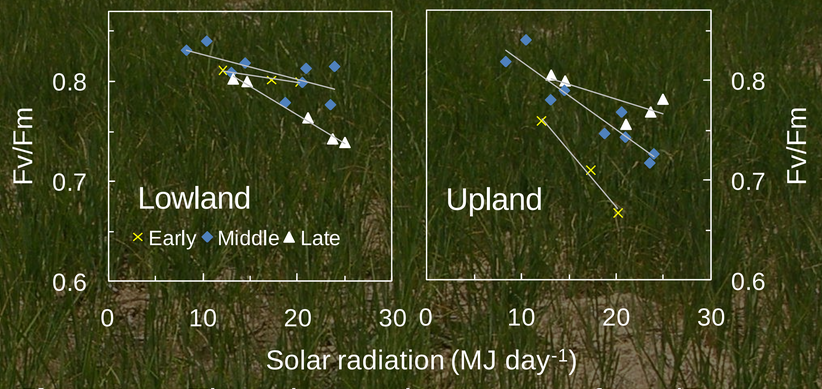


Fig. 3 The decreasing rate of Fv/Fm to increasing solar radiation was reduced in the middle and late periods under upland condition.

Midday Fv/Fm measured in the days with varieties of radiation in each growing period. Values of midday Fv/Fm are plotted to day radiation of each measurement day. Only the data of variety Milyang23 is shown in here.

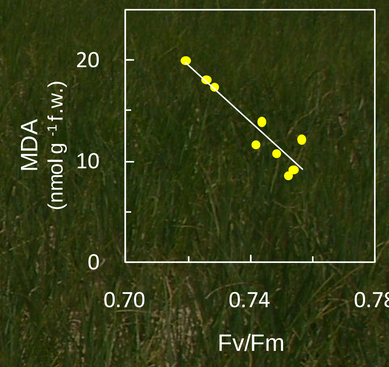


Fig. 4 The amount of lipid peroxide was high in the varieties of lower Fv/Fm.

Malondialdehyde content (MDA; the product of lipid peroxidation) in nine varieties measured at late period are plotted to midday Fv/Fm of the same day of leaf sampling for MDA analysis.

MATERIALS & METHOD

Table1 Nine rice (*Oryza sativa* L.) varieties from different countries in Asia were used for this experiment.

Abbreviation	Cultivar	Origin	Type	Subspecies
Mak	Mak hin sung	Laos	Local	Japonica
Vieng	Vieng	Laos	Local	Japonica
KTC	Khau Tan Chiem	Viet Nam	Local	Japonica
Tima	Tima	Bhutan	Local	Japonica
Asu	Asu	Bhutan	Local	Indica
IIR72	IR72	Philippines	Improved	Indica
APO	IR55423-01	Philippines	Improved	Indica
B6	B6144MR6-0-0	Indonesia	Improved	Indica
M23	Milyang 23	Korea	Improved	Indica

Rice seedlings were transplanted to each 2 m^2 plot with plant density of 22.2 plants m^{-2} in lowland and upland field. The lowland was continuously flooded, while the upland was rainfed after recovery from transplanting damage

Upland

Lowland

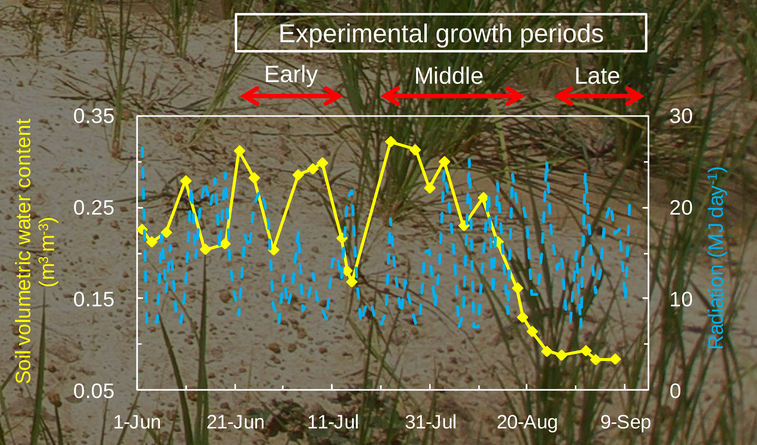


Fig. 5 Changes in the soil volumetric water content in the upland field and solar radiation during the experiment.