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Understanding effects of high temperature stress on head rice recovery in rice

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A B S T R A C T

High temperature affects yield by affecting both pollination and grain quality. Temperature during post fertilization periods determines compaction of starch granules which reflects recovery of rice grains during milling and polishing. This study was aimed at quantifying yield loss due to high temperature induced damages on head rice recovery in rice. Fifteen rice varieties were evaluated over 3 seasons and their head rice recovery was estimated. Results of this study revealed that day temperature had no influence on the head rice recovery whereas night temperature had negative impact on head rice recovery at $p < 0.05$.

Introduction

Rice is sensitive to high-temperature stress at almost all the stages of its growth and development. High temperature stress at ripening phase affects the grain quality and head rice recovery (%). Reduction in head rice recovery ultimately affects the farmers by reducing the gate and/or milled grain prices (Yamakawa*et al.*, 2007).

The study of the influence of high temperature on head rice recovery is critical to access the magnitude of the impact and for genetic enhancement. Hence the present study was carried out to access the impact of high temperature on head rice recovery (%) in rice.

Materials and Methods

Crop husbandry

Rice seeds were collected from Paddy breeding station, Coimbatore. And field trials were conducted in the Paddy breeding station, Coimbatore during Kharif 2012 and summer 2013. All the field operations were carried out as per TNAU crop production guide. Temperature data was obtained from the meteorological observatory in Paddy breeding station, Coimbatore. Temperature prevailed during the grain filling stage was calculated based on the procedure given by Lyman et al. (2013).

Head rice recovery (%)

The procedure for head rice recovery analysis was adapted from Singh et al. (2000). About 100 to 150 gram of rough rice was used for determination of head rice recovery per cent. The moisture content of the paddy or rough rice was determined using grain moisture meter (Wile 55, FUCO Company Ltd., Vietnam). The rough rice was processed using rice sheller (INDOSAW Rice Sheller, Model No. 6700, Osaw Industrial Products Pvt. Ltd., Haryana) for dehulling or dehusking and brown rice was obtained. The brown rice was subjected to milling in Rice Miller (INDOSAW Rice miller Mc Gill type, Model No. 6702, Osaw Industrial Products Pvt. Ltd., Haryana) for 30 to 40 sec. After milling the polished rice or milled rice was collected in a thick paper bag and sealed immediately.

The rice is allowed to cool before weighting. This procedure minimizes the grain cracking during cooling. The weight of total milled rice was recorded. The milled rice was manually processed to separate the head rice. Intact whole grains were considered as head rice and the head rice recovery was calculated with respect to milled rice using the formula given below:

$$\text{Head rice recovery (\%)} = \frac{\text{Weight of head rice}}{\text{Weight of milled rice}} \text{X } 100$$

Data analysis

Data analysis and graph preparation was done using the Microsoft office Excel 2010.

Results and Discussion

Head rice recovery during Kharif 2012 ranged from 87.7 % to 28.3 % with the average of 58.8 % and the day/night temperature ranged from 31.4/22.3 ^{o}C to 29.4/21.1 ^{o}C with the average of 30.5/21.8 ^{o}C. Similarly during summer 2013 the head rice recovery ranged from 67.2 % to 8.5 % with the average of 33.9 % and the day/night temperature ranged from 35.3/23.3 ^{o}C to 34.0/22.3 ^{o}C with the average of 34.9/23.0 ^{o}C (Table 1). The difference between head rice recovery (%) recorded during Summer 2013 and Kharif 2012 ranged from -4.2 to -62.3 % with average of -24.9 % and the day/night temperature difference between the two seasons varied from 5.6/2.1 ^{o}C to 2.8/0.1 ^{o}C with average of 4.4/1.2 ^{o}C (Table 2).

Empirically it can be observed from the differences between the two seasons that on an average 1.2^{o}C increase in night temperature had reduced the head rice recovery by 24.9 % whereas 4.4 ^{o}C increase in day temperature is required to produce the same effect on head rice recovery as that of night temperature. Hence a very small magnitude increase in night temperature affects the head rice recovery negatively. This can further noticed in the regression analyses by comparing the coefficient of determination (R^2) of day and night temperature with head rice recovery.

The regression analysis of head rice recovery with the temperature prevailed during the grain filling state of rice genotypes revealed the negative impact of temperature on head rice recovery. During Kharif 2012 the day temperature had no influence on the head rice recovery whereas night temperature had negative impact on head rice recovery at $p < 0.05$.

The negative impact of temperature on head rice recovery was stronger during summer 2013. The day and night temperature had a negative impact on head rice recovery at $p < 0.01$. Night temperature affects the head rice recovery more than the day temperature this can be evident from the coefficient of determination (R^2) obtained in the regression analyses (Fig. 1).

Fig.1 Regression analysis of Head rice recovery with temperature prevailed during the grain filling stage (a) Kharif 2012 (b) Summer 2013(* - p < 0.05; ** -p < 0.01; ns - Not significant)

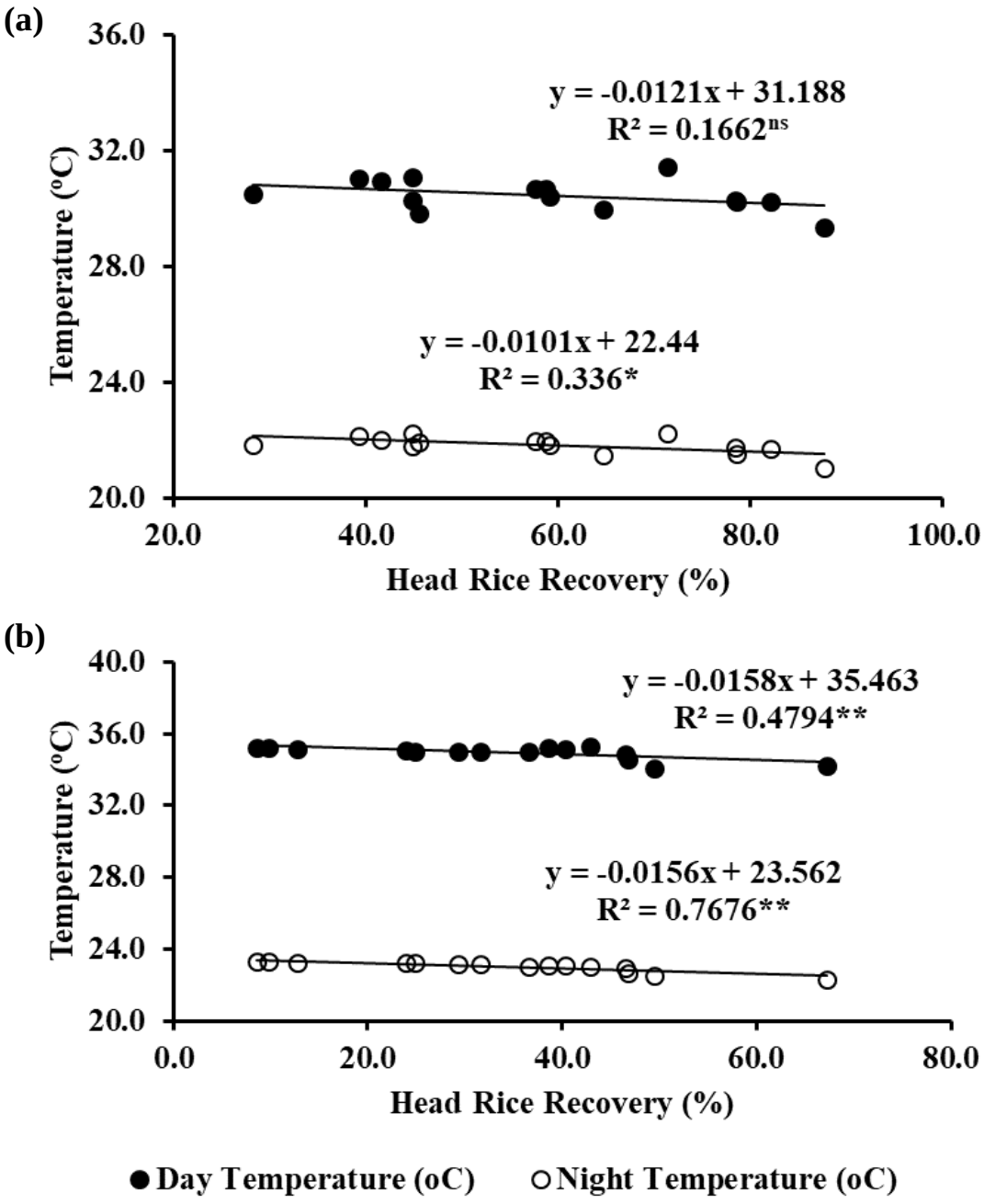

Table.1 Head rice recovery (%) and temperature prevailed during the grain filling stage of rice genotypes grown in Kharif 2012 and summer 2013

S. No.	Genotype	Kharif 2012				Summer 2013			
		HRR (%)	Temperature (°C)			HRR (%)	Temperature (°C)		
			Day	Night	Mean		Day	Night	Mean
1	IR5	57.6	30.7	22.0	26.3	8.5	35.2	23.3	29.3
2	IR20	39.2	31.1	22.1	26.6	29.3	35.0	23.2	29.1
3	IR28	71.4	31.4	22.3	26.8	67.2	34.2	22.4	28.3
4	IR36	82.0	30.3	21.7	26.0	49.4	34.0	22.5	28.3
5	IR43	44.8	31.1	22.2	26.7	38.5	35.2	23.1	29.1
6	IR64	58.7	30.7	22.0	26.3	46.5	34.8	23.0	28.9
7	IR72	64.7	30.0	21.5	25.7	24.0	35.0	23.2	29.1
8	APO	44.8	30.3	21.8	26.0	36.5	35.0	23.1	29.0
9	Cherivarappu	45.6	29.9	21.9	25.9	9.8	35.2	23.3	29.3
10	CO18	78.5	30.3	21.5	25.9	42.8	35.3	23.1	29.2
11	CO39	78.5	30.3	21.8	26.0	46.8	34.6	22.7	28.6
12	KALINGA III	28.3	30.5	21.9	26.2	12.7	35.2	23.2	29.2
13	MTU9	59.2	30.4	21.8	26.1	40.3	35.1	23.1	29.1
14	SONA	41.6	31.0	22.0	26.5	31.6	35.0	23.2	29.1
15	TKM6	87.7	29.4	21.1	25.2	24.9	35.0	23.2	29.1
	Max	87.7	31.4	22.3	26.8	67.2	35.3	23.3	29.3
	Min	28.3	29.4	21.1	25.2	8.5	34.0	22.4	28.3
	Average	58.8	30.5	21.8	26.2	33.9	34.9	23.0	29.0

Table.2 Differences in head rice recovery (%), temperature between Summer 2013and Kharif 2012

S. No.	Genotype	HRR (%)	Temperature (^{o}C)		
			Day	Night	Mean
1	IR5	-49.1	4.5	1.3	3
2	IR20	-9.9	3.9	1.1	2.5
3	IR28	-4.2	2.8	0.1	1.5
4	IR36	-32.6	3.7	0.8	2.3
5	IR43	-6.3	4.1	0.9	2.4
6	IR64	-12.2	4.1	1	2.6
7	IR72	-40.7	5	1.7	3.4
8	APO	-8.3	4.7	1.3	3
9	Cherivarappu	-35.8	5.3	1.4	3.4
10	CO18	-35.7	5	1.6	3.3
11	CO39	-31.7	4.3	0.9	2.6
12	KALINGA III	-15.6	4.7	1.3	3
13	MTU9	-18.9	4.7	1.3	3
14	SONA	-10	4	1.2	2.6
15	TKM6	-62.8	5.6	2.1	3.9
	Max	-4.2	5.6	2.1	3.9
	Min	-62.8	2.8	0.1	1.5
	Average	-24.9	4.4	1.2	2.8

These observations were further confirmed from the report of Counce*et al.*, 2005 which states that high night temperature significantly reduces head rice yield. Similarly Cooper *et al.*, 2008 reported that when night time temperature increases from 18 to 30^{o}C from 12 to 5 A.M., head rice yields significantly decreased. High night temperature alters the enzymatic activity during grain filling stage leading to irregular packing of starch results in chalkiness thereby reducing the head rice recovery (Ashida et al., 2009; Ishimaru et al., 2016). High night temperatures also reduce grain widths, amylose content (Cooper *et al.*, 2008).

References

Ashida K, Iida S, Yasui T. 2009. Morphological, physical, and chemical properties of grain and flour from chalky rice mutants. Cereal Chem., 86: 225–231

Cooper, N. T. W., Siebenmorgen, T. J., and Counce, P. A. 2008. Effects of nighttime temperature during kernel development on rice physicochemical properties. Cereal Chem. 85: 276–282.

Counce PA, Bryant RJ, Bergman CJ, Bautista RC, Wang YJ, Siebenmorgen TJ, et al. 2005. Rice

milling quality, grain dimensions, and starch branching as affected by high night temperatures. Cereal Chem., 82: 645–648.

Ishimaru, T., Hirabayashi ,H., Sasaki, K., Ye, C. and Kobayashi, A. 2016. Breeding efforts to mitigate damage by heat stress to spikelet sterility and grain quality. Plant Prod. Sci., 19: 12-21. doi: 10.1080/1343943X.2015.1128113

Lyman N. B., Jagadish, K. S. V., Nalley, L. L., Dixon, B. L. and Siebenmorgen, T. 2013. Neglecting rice milling yield and quality underestimates economic losses from high temperature stress. PLoS One 8:e72157

Singh, R. K., Singh, U. S., Khush, G. S. 2000. Aromatic Rices, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. 300p

Yamakawa, H., Hirose, T., Kuroda, M., and Yamaguchi, T. 2007. Comprehensive expression profiling of rice grain filling-related genes under high temperature using DNA microarray. Plant Physiol., 144, 258–277.

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