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EFFECT OF TEMPERATURE ON PHOTOSYNTHESIS, YIELD ATTRIBUTES AND YIELD OF AROMATIC RICE GENOTYPES

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ABSTRACT

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A pot experiment was conducted with five aromatic rice genotypes *viz*., BRRIdhan34, Ukunimadhu, RM-100/16, KD_5 18-150 and Kalozira in plant growth chamber at Bangladesh Institute of Nuclear Agriculture, Mymensingh in 2009 to see their temperature tolerance. Three temperature treatments *viz.*, Ambient, 34°C at booting stage and 34°C at grain filling stage were imposed and continued for 7 days. Photosynthetic rate, grain yield and harvest index decreased but leaf conductance and transpiration rate increased with high temperature (34°C) at both booting and grain filling stages. Total dry matter/plant was the lowest with the temperature (34°C) at booting stage Plant height and number of panicles/plant were not affected by the temperature treatments. KD_5 18-150 showed higher grain yield, total dry matter/plant and harvest index under temperature stress.

Key words: *high temperature, booting and grain filling stages, photosynthesis, yield, aromatic rice*

INTRODUCTION

There is a major consensus among scientists, except for some minor disagreements, that climate is changing and air temperature is rising due to increasing concentration of CO_2 and other atmosphere greenhouse gases (Weiss *et al*. 2003; Kerr 2005; IPCC 2007). Rice (*Oryza sativa* L.) is one of the major cereals produced worldwide and constitutes the staple food of more than half of the world population (FAO 2007). The rise in atmospheric temperature causes detrimental effects on growth, yield, and quality of the rice crop by affecting its phenology, physiology, and yield components (Singh 2001; Sheehy *et al*. 2005; Peng *et al*. 2004). The sensitivity of rice to high temperature varies with growth phase, an increase in day/night temperature, and genotype (Yoshida 1981; Singh 2001; Peng *et al*. 2004). The unusual rise in atmospheric temperature during different growth phases differentially affects rice growth and productivity. The quantitative assessment of such type of climatic variability on aromatic rice is meager. Keeping in view the significance of climatic variability on the growth and yield of the rice crop, an experiment was conducted using five aromatic rice mutants/varieties to assess the effects of high temperature during flowering and grain filling stages on photosynthetic rate, yield, and yield components.

MATERIALS AND METHODS

A pot experiment was conducted with five aromatic rice genotypes *viz*., BRRIdhan34, Ukunimadhu, RM-100-16, KD_5 18-150 and Kalozira in controlled plant growth chamber. The experiment was laid out in a Complete Randomized design with three replications. Thirty-day old seedlings were transplanted in plastic pots on 5 August 2009. Each pot contained 8 kg of soils (Silty loam, organic matter 1.05%, total N 0.07%, available P 14.3 ppm, exchangeable K 0.25 meq.per 100g soil, available S 13.2 and soil pH 6.67). Soils were fertilized with urea 1.36 g/pot, TSP 0.80 g/pot, MP 0.52 g/pot corresponding to urea 170 Kg/ha, TSP 135 kg/ha and MP 65 kg/ha, respectively. All TSP, MP and one-third of the urea were applied as basal dose. The remaining two-thirds of the urea were applied in two equal splits in each pot at 30 and 50 days after transplanting. Cultural practices were done whenever necessary. Three temperature treatments *viz.* Ambient, 34°C at booting stage and 34°C at grain filling stage were imposed and continued for 7 days. Data on photosynthetic parameters, yield attributes and yield were recorded.

RESULTS AND DISCUSSION

Result revealed that photosynthetic rate decreased but leaf conductance and transpiration rate increased with high temperature (34°C) at both booting and grain filling stages (Table 1). Reduced photosynthetic rate under high temperature stress is in conformity with Izumi *et al.* (2004). BRRIdhan34 had the highest photosynthetic rate followed by Ukunimadhu and KD_5 18-150. RM-100-16 showed the highest conductance and transpiration rate. Plant height and number of panicles/plant were not affected by the temperature treatments (Table 2). Grain yield and harvest index decreased similarly with the temperature (34°C) at booting and grain filling stages. High temperature reduced final weight by a reduction in grain growth rate in the early or middle stages of grain filling. The results are in conformity of those of Morita *et al*. (2005) and Singh *et al.* (2010) who observed reduced grain weight due to high temperature stress in rice. Total dry matter/plant was the lowest with the temperature (34°C) at booting stage. KD_5 18-150 showed higher grain yield, total dry matter/plant and harvest index under temperature stress. This mutant also showed the highest grain yield and total dry matter/plant at ambient condition (Table 2).

Table 1. Photosynthetic rate, conductance and transpiration rate of fine grain aromatic rice genotypes under high temperature (34°C) at booting and grain filling stages

Treatment	Pn	Cond	Tr
Temperature			
Ambient (T0)	23.2a	0.29b	3.81c
34°C at booting stage (T1)	16.7b	0.38a	5.26b
34°C at grain filling stage (T2)	13.5c	0.38a	5.82a
Genotypes			
BRRIdhan34 (V1)	20.7a	0.35b	4.40c
Ukunimadhu (V2)	18.2b	0.36b	5.06b
RM-100-16 (V3)	16.4c	0.40a	5.89a
KD5 18-150 (V4)	17.6b	0.31c	4.37c
Kalozira (V5)	16.2c	0.33bc	5.09b

Values having common letter(s) in a column do not differ significantly at 5% level as per DMRT

Where, Pn= Photosynthetic rate ($\mu molCO_2m^{-2}s^{-1}$), Cond= Conductance ($molH_2Om^{-2}s^{-1}$), Tr= Transpiration rate ($molH_2Om^{-2}s^{-1}$)

Table 2. Yield and yield attributes of fine grain aromatic rice under high temperature (34°C) at booting and grain filling stages

Treatment	Plant height (cm)	Panicles/ plant	Grain yield/ plant (g)	Total dry matter/ plant (g)	Harvest Index
Temperature					
Ambient (T0)	156	27.2	39.8a	153a	25.7a
34°C at booting stage (T1)	158	27.9	25.6b	125c	20.7b
34°C at grain filling stage (T2)	153	24.6	24.1b	135b	18.0c
Varieties					
BRRIdhan34 (V1)	166	25.6ab	28.2b	132b	21.6
Ukunimadhu (V2)	153	28.4ab	29.0b	132b	22.7
RM-100-16 (V3)	161	25.8ab	27.9b	129bc	21.1
KD5 18-150 (V4)	160	29.0a	37.9a	172a	21.0
Kalozira (V5)	154	24.0b	26.2b	123c	21.0
Interaction					
T0 V1	170	28.0abc	31.7cd	144d	22.1bc
T0 V2	150	30.0ab	21.6fg	150cd	14.3efg
T0 V3	168	20.3c	44.1b	149cd	29.5a
T0 V4	174	30.6ab	59.9a	198a	30.1a
T0 V5	164	27.3abc	41.4b	126fg	32.5a
T1 V1	168	27.0abc	27.0def	148cd	18.1cde
T1 V2	150	27.3abc	30.9cde	104h	29.5a
T1 V3	153	34.6a	13.5i	76i	17.6def
T1 V4	163	28.3abc	34.5c	180b	19.1cd
T1 V5	157	22.3bc	22.3fg	116gh	19.1cd
T2 V1	159	22.0bc	25.7ef	104h	24.5b
T2 V2	159	28.0abc	34.4c	141de	24.3b
T2 V3	163	22.6bc	26.0def	161c	16.1def
T2 V4	144	28.0abc	19.5gh	140de	13.8fg
T2 V5	142	22.3bc	14.9hi	129ef	11.5gh

Values having common letter(s) in a column do not differ significantly at 5% level as per DMRT

CONCLUSION

High temperature (34°C) at both booting and grain filling stages decreased photosynthetic rate grain yield and harvest index of aromatic rice genotypes. The genotype KD_5 18-150 showed the best yield performance under temperature stress.

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