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DROUGHT TOLERANCE OF NERICA RICE MUTANTS

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ABSTRACT

Zohora FT, Islam MT, Baten MA (2016) Drought tolerance of NERICA rice mutants. *Int. J. Sustain. Crop Prod.* 11(1), 4-8.

A pot experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, during March-July, 2015 to study the drought tolerance in Aus rice genotypes *viz.* N_{10}/350/P-5-4, N_4/250/P-1(2), N_4/250/P-2(6)-26, N_4/250/P-4(5) and Binadhan-17. The plants were grown under three drought levels *viz.* 100% FC (control), 60% FC and 40% FC. Number of effective tillers/plant, panicle length, number of grains/panicle, and grain yield/plant decreased with the increase in water stress levels as compared to the control. Plant height and number of tillers/plant decreased similarly with both the stress levels. Thousands grain weight decreased only with the higher stress. Higher and statistically similar grain yield were observed in four genotypes, N_{10}/350/P-5-4, /250/P-2(6)-26, N_4/250/P-4(5) and Binadhan-17 than N_4/250/P-1(2). Photosynthetic rate at booting stage decreased similarly both at 60 and 40% FC compared to control. But photosynthetic rate at flowering stage decreased only at 40% FC. The grain weight/grain also decreased with the increase of drought level compared to control and the genotype N_4/250/P-4(5) showed the highest grain weight/grain under the treatment. Grain dry weight increased significantly from fertilization to 24 days.

Key words: *drought, photosynthesis, grain growth, rice yield*

INTRODUCTION

Rice (*Oryza sativea* L.) is one of the most important cereal crops providing food for nearly half of the human population of the world (Hoffman 1991). About 40% of the world population consumes rice as a major source of calorie (Banik *et al*. 1999). In Bangladesh Agriculture is dominated by intensive rice cultivation. Rice is sensitive to different abiotic stresses like drought, salinity and cold. Among these stresses drought is more complex phenomenon than others as it can occur at any point during production. Rice is a notoriously drought-susceptible crop due in part to its small root system, rapid stomatal closure and little circular wax during mild water stress (Hirasawa 1999). Bangladesh is on the average, experience drought almost once in every five years. There are three kind of rice in Bangladesh named as- Aus, Aman and Boro, which are cultivated during April to July, August to December and January to May, respectively. Drought affects Aus rice at vegetative phase. It also affects Boro and Aman crops mainly at their reproductive phase depending on the intensity and period of drought. Drought affects every aspects of plant life and inhibits growth, development and productivity. The effect of water stress on photosynthesis, conductance, transpiration, water use efficiency and grain growth may vary with four high yielding rice varieties developed at the Bangladesh Institute of Nuclear Agriculture (BINA) and thus help in identifying water stress tolerant variety for further development.

MATERIALS AND METHODS

A pot experiment was conducted at the pot yard of Bangladesh Institute of Nuclear Agriculture, Mymensingh, during March to July 2015. Each pot contained 8.5 kg of soil and was 21 cm deep with 24 cm diameter at the top. Five genotypes of rice namely N_{10}/350/P-5-4, N_4/250/P-1(2), N_4/250/P-2(6)-26, N_4/250/P-4(5) and Binadhan-17 were included in the study to assess their performance on photosynthesis, morphological yield attributes and yield under different drought levels (100% FC, 60% FC and 40% FC) imposed at 25 days after direct sowing. The two-factor experiment was laid out in a Completely Randomized Design (CRD) with three replications. The one factor was drought levels and another was genotypes. Recommended doses of fertilizers were applied and other cultural practices were followed as and when necessary. Water stress treatment was imposed at tillering stage and continued up to maturity. At the beginning before stress imposition, all treatments maintained at field at field capacity (100%) level, determined through gravimetric method. The water stress treatments were maintained by adding water to the assigned pots the help of well precision weighting balance at two days interval. These measured amount of water were multiplied by 1.00, 0.60 and 0.40 to know their amount of water required to maintain 100% FC, 60% FC and 40% FC, respectively. Control and 40% FC treatments were imposed at flowering stage for grain growth studies. Ten grains of selected panicles of the rice genotypes under control and water stress were harvested at 3 days interval and their dry weights were recorded. Photosynthetic rate at booting and flowering stage was recorded by using portable photosynthesis system (Li-6400XT). Grain dry matter of 10 grains from selected panicles was recorded from fertilization to maturity for grain growth studies. The data were collected and analyzed statistically and the means were adjudged by DMRT.

RESULTS AND DISCUSSION

Results revealed that the effect of different levels of drought was significant on plant height, total number of tillers/plant, total number of effective tillers/plant, panicle length, number of grains/panicle, 1000-grain weight, photosynthetic rate and total grain yield/plant. Results indicated that most of the parameters decreased with increased drought levels. The highest plant height, total number of tillers/plant, photosynthetic rate, number of effective tiller/hill, panicle length, panicle dry weight, number of filled grains/panicle, 1000-grain weight and grain yield/plant were observed in control (100% FC) plant. The lowest values of the above parameters were observed at 40% FC.

Plant height, number of effective tiller/plant, number of grains/panicle, panicle length, 1000-grain weight, grain yield/plant and grain weight/grain were significant among the studied varieties. Total no of tiller/plant was not significant among the studied varieties. The genotype followed by N_{10}/350/P-5-4 showed the highest grains/panicle and lowest plant height, N_4/250/P-1(2) showed the lowest grains/panicle and 1000-grain weight, N_4/250/P-2(6)-26 showed the highest tiller/plant, effective tiller/plant, grain yield/plant and the lowest panicle length, N_4/250/P-4(5) showed the highest 1000-grain weight, grain yield/plant and the lowest tillers/plant, effective tiller/plant, Binadhan-17 showed the highest plant height and panicle length under the treatment. The photosynthesis rate both in booting and flowering stage was not significant among the studied genotypes.

Interaction between drought and genotypes had significant effect on plant height, total number of tillers/plant, total number of effective tillers/plant, panicle length, number of grains/panicle, 1000-grain weight, photosynthetic rate and total grain yield/plant. Total number of tillers/plant, total number of effective tillers/plant and number of grains/panicle showed the highest result in the treatment combination of N_4/250/P-2(6)-26 × 100% FC. Plant height, panicle length, photosynthesis rate at booting and flowering stage and grain yield/plant showed highest result in the treatment combination of Binadhan-17 × 100% FC. N_4/250/P-4(5) × 60% FC treatment combination showed the highest result for 1000-grain wt.

Table 1. Effect of water stress on morphological, yield attributes and yield of Aus rice genotypes

Treatments	Plant height (cm)	Tiller/ plant	Effective tiller/plant	Grains/ panicle	Panicle length (cm)	1000 grain wt. (g)	Grain yield/ plant (g)
Control (T_0)	79.13a	15.27a	13.87a	136.5a	24.16a	22.89a	13.52a
60% FC (T_1)	76.60b	12.07b	10.07b	92.67b	22.87b	22.57a	11.18b
40% FC (T_2)	75.53b	12.67b	8.933c	64.33c	21.07c	21.99b	8.071c
Genotypes							
N_{10}/350/P-5-4 (V_1)	70.00d	13.11	10.89b	105.00a	23.76ab	22.89b	10.89a
N_4/250/P-1(2) (V_2)	79.56ab	13.56	10.67b	89.89c	23.09b	21.52c	9.216b
N_4/250/P-2(6)-26 (V_3)	76.89c	14.22	12.33a	102.56a	20.73c	21.71c	11.55a
N_4/250/P-4(5) (V_4)	78.44bc	12.22	10.11b	98.67ab	21.73c	24.71a	11.46a
Binadhan-17 (V_5)	80.56a	13.56	10.78b	93.00bc	24.19a	21.57c	11.51a
Interaction							
T_0 V_1	71.00e	14.67abc	14.00ab	136.67ab	24.97a	23.33b	13.10b
T_0 V_2	80.33b	15.33ab	13.00bc	139.00a	25.10a	22.22cde	11.36bcd
T_0 V_3	76.33d	16.67a	15.33a	146.67a	22.40cd	22.10cde	15.15a
T_0 V_4	80.00b	14.33abc	13.00bc	123.67b	23.03bcd	24.67a	12.47bc
T_0 V_5	88.00a	15.33ab	14.00ab	136.33ab	25.30a	22.10de	15.54a
T_1 V_1	69.67e	11.33bc	9.333de	107.33c	23.83abc	22.97bc	12.00bcd
T_1 V_2	79.67bc	12.67abc	10.33d	86.00def	23.87abc	21.83def	9.250efg
T_1 V_3	77.67bcd	12.67abc	12.00c	90.00de	20.83e	21.60def	10.96cde
T_1 V_4	78.67bcd	11.67bc	9.667d	97.67cd	21.57de	24.93a	11.89bcd
T_1 V_5	77.33bcd	12.00bc	9.000de	82.33efg	24.23ad	21.50def	11.83bcd
T_2 V_1	69.33e	13.33abc	9.333de	71.00gh	22.47cd	22.37cd	7.573gh
T_2 V_2	78.67bcd	12.67abc	8.667de	44.67i	20.30ef	20.50g	7.037h
T_2 V_3	76.67cd	13.33abc	9.667d	71.00gh	18.97f	21.43ef	8.547fgh
T_2 V_4	76.67cd	10.67c	7.667e	74.67fg	20.60e	24.53a	10.03def
T_2 V_5	76.33d	13.33abc	9.333de	60.33h	23.03bcd	21.10fg	7.170h

Values having common letters or without letters in a column of specific treatments do not differ significantly at 5% level as per DMRT

Decreased plant height under water stress was found by Rahman *et al.* (2002) and Islam *et al.* (2005). They stated that plant height increased in full irrigated condition and decreased in moisture deficits. Reduced plant height under soil moisture stress might be due to inhibition of cell division and cell enlargement. Zubaer *et al.* (2007); Zoinolabedin *et al.* (2008) also found the similar result. Number of tiller plant^{-1} decreased due to water stress was reported by many workers eg. Manneh and Ndjiondjop (2006); Zubaer *et al.* (2007) and Sikuku *et al.* (2010). The number of grains panicle^{-1} and length of panicle decreased with increased drought levels was also observed by Islam *et al.* (1994), Rahman (2001), and Zubaer (2004). Results revealed that 1000-seed weight decreased with the highest water stress (40%). Reduced 1000-seed weight under drought condition might be due to lower amount of assimilate translocation from leaf to grain. Islam (2010) observed that stress during grain filling stage reduced the weight of individual grain. Similar result was also reported by many researchers Shao *et al.* (2004); Zubaer *et al.* (2007) and Zoinolabedin *et al*. (2008). Reduced grain yield under lower soil moisture levels might be due to inhibition of photosynthesis and less translocation of assimilates towards reproductive parts due to soil moisture stress. Similar results also reported by Hossain (2001); Rahman *et al.* (2001); Zubaer (2004) and they reported that grain yield was decreased with decreasing soil moisture levels. Photosynthesis at booting stage was significantly influenced under water stress. Photosynthesis both at flowering and grain filling stages was significantly influenced under water stress. Grain dry weight increased from the fertilization to 24 days. The result suggested that physiological maturity of grain was achieved in 24 days. Similar results were also observed by Islam and Gretzmacher (2001). Begum (1990) found that water stress after flowering decreased the individual grain weight.

Table 2. Grain yield reduction % of rice genotypes under different soil moisture stress conditions

Genotypes	**Control**	**60% FC**	**Yield reduction % over control**	**40% FC**	**Yield reduction % over control**
N_{10}/350/P-5-4	13.10	12.00	9.16	7.573	42.21
N_4/250/P-1(2)	11.36	9.250	18.57	7.037	38.12
N_4/250/P-2(6)-26	15.15	10.96	27.66	8.547	43.63
N_4/250/P-4(5)	12.47	11.89	4.65	10.03	19.57
Binadhan-17	15.54	11.83	23.87	7.170	53.86

Table 3. Effect of water stress on chlorophyll content and photosynthesis at booting and flowering stages of Aus rice genotypes

Treatments	**Photosynthesis at booting stage ($\mu molCO_2m^{-2}s^{-1}$)**	**Photosynthesis at flowering stage ($\mu molCO_2m^{-2}s^{-1}$)**
Control (T_0)	35.94a	37.01a
60% FC (T_1)	31.07b	37.99a
40% FC (T_2)	32.46b	32.99b
Genotypes		
N_{10}/350/P-5-4 (V_1)	33.21	35.00
N_4/250/P-1(2) (V_2)	31.83	34.58
N_4/250/P-2(6)-26 (V_3)	32.38	36.63
N_4/250/P-4(5) (V_4)	34.09	37.09
Binadhan-17 (V_5)	34.28	36.69
Interaction		
T_0 V_1	33.30bcde	33.90cdefg
T_0 V_2	32.63cde	36.13bcdef
T_0 V_3	35.77abc	36.80bcd
T_0 V_4	38.13ab	36.63bcde
T_0 V_5	39.87a	41.60a
T_1 V_1	31.40cde	39.20ab
T_1 V_2	33.80bcde	35.57bcdefg
T_1 V_3	29.57e	39.40ab
T_1 V_4	30.83cde	38.50abc
T_1 V_5	29.77de	37.27abcd
T_2 V_1	34.93abcd	31.90fg
T_2 V_2	29.07e	32.03efg
T_2 V_3	31.80cde	33.70defg
T_2 V_4	33.30bcde	36.13bcdef
T_2 V_5	33.20bcde	31.20g

Values having common letters or without letters in a column of specific treatments do not differ significantly at 5% level as per DMRT

Table 4. Effect of water stress on grain weight/grain of Aus rice genotypes

Treatments	**Grain wt/grain (mg)**
Control	14.0a
40% FC	12.0b
Genotypes	
N_{10}/350/P-5-4 (V_1)	14.77b
N_4/250/P-1(2) (V_2)	12.62c
N_4/250/P-2(6)-26 (V_3)	11.88d
N_4/250/P-4(5) (V_4)	16.07a
Binadhan-17 (V_5)	9.67e
Days after fertilization	
0	3.25h
4	4.39g
8	6.69f
12	12.79e
16	14.86d
20	18.84c
24	21.79a
28	21.39b

Values having common letters or without letters in a column of specific treatments do not differ significantly at 5% level as per DMRT

CONCLUSION

Yield and yield attributes of aus rice decreased with soil moisture stress. Soil moisture of 100% FC was found suitable for better growth and yield of aus rice genotypes compared to 60% and 40% FC. Physiological maturity of grain was achieved in 24 days after fertilization for genotypes. N_4/250/P-4(5) showed more tolerance to water stress and Binadhan-17 showed less tolerance.

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