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GRAIN GROWTH AND YIELD PERFORMANCE OF AROMATIC RICE GENOTYPES UNDER DIFFERENT SOIL MOISTURE REGIMES

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ABSTRACT

Hafiz MA, Islam MT, Karim MA (2015) Grain growth and yield performance of aromatic rice genotypes under different soil moisture regimes. *Int. J. Sustain. Crop Prod.* 10(2), 44-47.

A pot experiment was conducted at Bangladesh Institute of Nuclear Agriculture, Mymensingh during July to December 2007 to assess the effect of moisture stress on morphological characters, grain growth and yield performance of five promising fine grain rice genotypes *viz*., KD_5-18-150, UD_5-100-6, RM-100-16, RM-100-5 and Ukunimadhu. The soil moisture levels 100, 80, 60, and 40% field capacity were imposed at panicle initiation, booting and flowering stages of the genotypes. These treatments were also maintained from panicle emergence to maturity to study grain growth pattern of the rice genotypes. All the morphological parameters and yield were decreased with the stress. Plant height, number of panicle, panicle length, 1000-grain weight, grain yield $hill^{-1}$, total dry matter $hill^{-1}$ and harvest index decreased with increasing water stress. However, varieties responded differently for all the characters studied and they had different degrees of reduction. Among the genotypes Ukunimadhu produced the highest yield, number of panicle and panicle length. Grain dry matter accumulation linearly increased from fertilization to 21 days after fertilization, thereafter it did not increase significantly.

***Key words**: grain growth, yield, aromatic rice, soil moisture regimes*

INTRODUCTION

In Bangladesh, fine rice as well as aromatic rice has received importance now since people's income is increasing. This led them to buy better quality rice. An increase in income, people normally shift from coarse rice to fine rice as well as others quality food. So, demand for high-quality rice is increasing with rising standard of living. Demand for aromatic rice in recent years has increased greatly for consumption as well as export (Singh *et al*. 2000). There are two types of fine quality rice, aromatic and non-aromatic. Aromatic rice varieties Kalijira, Kataribhog, Chinigura, Badshabhog are grown in small pockets all over the country. More than 37 aromatic rice varieties are grown in Bangladesh (Anon. 2004). Aromatic rice is an important commodity in international market. Among the aromatics, those with long slender grain and high lengthwise volume expansion after cooking are popularly called Basumati rice. These varieties have helped countries, India, Pakistan and Thailand to earn considerable foreign exchange. The Basumati-type varieties have excellent grain quality and aroma. However, they are traditionally tall varieties that have low yield potential and are highly susceptible to diseases and insect pests (Joseph *et al*. 2004).

The performance of rice varieties under water stress conditions at different growth stages varies. There is an interaction effect of the morphological and physiological characters of the rice plants with environmental factors (Chang *et al*. 1982). The metabolic process is affected directly or indirectly by water supply. Water plays essential roles in plants as a constituent, a solvent, a reactant in various chemical processes and in the maintenance of turgidity. Several researchers (Islam 2001; Islam and Gretzmacher, 2001; Rahman *et al*. 2002) observed that yield losses resulting from water deficit are particularly severe when drought strikes at booting stage. Water stress at or before panicle initiation reduces the most potential spikelet number and grain filling rate which decreases grain weight and increases empty grains (RRDI 1999). Drought at the reproductive phase had reduced the number of spikelets (BRRI 1985). This means drought at any growth stage affects yield. Rice plant is more sensitive to water deficit during reduction division at the reproductive stage.

Under the above circumstances, it is important to investigate the changes that occur in the physiological events of plant development which are related to decrease in total dry matter production as well as yield. However, different ability to respond to drought conditions, in terms of growth and development. Therefore, the objectives of this study were to observe the effect of water stress on morphological characters, grain growth, and yield of some aromatic rice genotypes; and identify relative water stress tolerant genotypes.

METERIALS AND METHODS

An experiment was conducted in plastic pots with 5 rice genotypes *viz.*, KD_5-18-150, UD_5-100-6, RM-100-16, RM-100-5 and Ukunimadhu at the pot yard of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during July to December 2007. Each pot contained 9 kg of soil. Soils were fertilized with urea 1.05 g/pot, TSP 0.87 g/pot, MP 0.42 g/pot corresponding to urea 170 Kg/ha, TSP 135 Kg/ha and MP 65 Kg/ha, respectively. All TSP, MP, 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 (DAT). The 40 days old seedlings were transplanted in the pots on 10 August 2007. In first experiment, stress treatments were imposed as 100, 80, 60 and 40% field capacity (FC) at panicle initiation, booting and flowering stages and discontinued

after completion of respective stage. The water stress treatments were maintained by adding water to the assigned pots with the help of well precision weighting balance at two days' interval. At maturity, data on plant height (cm), number of panicle hill^{-1}, panicle length (cm), number of grains panicle^{-1}, 1000-grain weight (g), grain yield hill^{-1} (g), total dry matter hill^{-1} (g) and harvest index (%) were recorded.

The second experiment for grain growth studies was consisted of the above four soil moisture levels and five rice genotypes. Dry matters of 10 grains were collected from fertilization to 24 days at 3 days' interval. The two experiments were conducted in Randomized Complete Block Design (RCBD) with three replications. The collected data were analyzed statistically following the design with the help of MSTAT Computer packages (Russell 1986). The mean differences were compared by Duncan's Multiples Range Test (DMRT) at 5% level of significance.

RESULTS AND DISCUSSION

Plant height, number of grains penicle^{-1}, 1000-grain weight, total dry matter hill^{-1}, harvest index, dry matter accumulation in grain and yield were decreased with stress (Table 1). However, different genotypes had different degrees of reduction in those parameters and in certain genotype, the reduction effect was less compared to other studied genotypes for which that genotype performed better under water stress condition. The highest number of panicle hill^{-1}, 1000-grain weight hill^{-1} and total dry matter hill^{-1} were found in variety KD_5-18-150. Ukunimadhu had higher panicle length; number of grains panicle^{-1}, grain yield hill^{-1} and harvest index and RM-100-16 produced longer plants. The values of those parameters were the highest in the panicle initiation stage. Interaction effect between genotypes and soil moisture levels on the studied parameters was significant (Table 2). The highest grain yield hill^{-1} was observed in Ukunimadhu at 100% FC which indicated that this genotype performed better at 100% FC. Furthermore, the lowest grain yield was the highest in UD_5-100-6 under water stress condition due to highest number of unfilled grains panicle^{-1} at 40% FC. In most cases, interaction effect between growth stage and soil moisture level was significant (Table 3). The highest grain yield hill^{-1} was observed in panicle initiation stage at 100% FC which indicated that this stage performed better at 100% FC. Furthermore, the lowest grain yield at booting stage under water stress condition was due to the highest number of unfilled grains per panicle^{-1} at 40% FC. Interaction effect between genotypes and growth stage on the studied parameters was significant (Table 4). The highest grain yield hill^{-1} was observed in Ukunimadhu at panicle initiation stage which indicated that this genotype performed better in panicle initiation stage. In grain growth studies, dry matter accumulation in individual grain was lower under water stress condition compared to control throughout the grain growth period (Table 5). Dry weight of individual grain was significantly increased from fertilization to 21 days thereafter it did not increase significantly. The physiological maturity of grain was three days earlier under water stress condition compared to 80% FC. The results agreed with Islam and Gretzmacher (2001) and Islam (2010).

Table 1. Yield and yield attributes of aromatic rice genotypes under water stress at different growth stages

Treatments	Plant height (cm)	No. of panicle hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	1000-grain wt. (g)	Grain yield hill^{-1} (g)	Total dry matter hill^{-1} (g)	Harvest Index (%)
Field capacity (%)								
100	157 a	25.24 a	28.11 a	253 a	11.26 a	68.86 a	174 a	39.30 a
80	152 b	24.62 a	27.91 a	229 b	11.61 a	62.09 b	160 b	38.67 a
60	150 b	23.78 a	27.35 a	221 bc	11.17 a	56.83 bc	148 c	38.05 ab
40	146 c	24.93 a	27.35 a	210 c	10.51 b	52.12 c	146 c	35.54 b
Genotypes								
KD_5-18-150	140 d	31.01 a	25.63 c	144 c	12.22 a	54.00 c	173 a	31.20 c
UD_5-100-6	149 c	21.47 b	30.27 a	244 b	10.62 c	54.12 c	145 b	36.40 b
RM-100-16	158 a	23.22 b	27.41 b	245 b	10.60 c	58.23 bc	144 b	39.71 a
RM-100-5	156 ab	23.69 b	25.61 c	230 b	11.18 b	60.92 b	152 b	39.55 a
Ukunimadhu	154 b	23.83 b	29.47 a	278 a	11.07 bc	72.61 a	169 a	42.59 a
Stages of stress imposition								
Panicle initiation	154 a	25.36 a	27.81 a	236 a	11.36 a	63.81 a	164 a	38.84 a
Booting	152 a	24.26 a	27.86 a	228 a	11.22 a	59.71 ab	155 b	38.31 a
Flowering	147 b	24.30 a	27.36 a	221 a	10.83 b	56.40 b	152 b	36.52 a

Values having common letter(s) in a column do not differ significantly at 5% level of significance by DMRT

Table 2. Interaction effect between soil moisture levels and rice genotypes on yield and yield attributes

Treatments	Plant height (cm)	No. of panicle hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	1000-grain wt. (g)	Grain yield hill^{-1}	Total dry matter hill^{-1} (g)	Harvest Index (%)
%FC × Genotype								
100 × KD_5-18-150	147 ef	32.66 a	26.00ef	170fg	12.00bc	65.20 b-e	193 a	34.59 bc
100 × UD_5-100-6	158 abc	20.44 d	30.66 a	273abc	11.11 c-f	61.28cde	157 c-f	38.10 ab
100 × RM-100-16	161 a	26.66 a-d	26.88cde	262 a-d	10.33efg	67.90bc	166 cd	39.97 ab
100 × RM-100-5	157 a-d	22.11 d	27.22 b-e	253 b-e	11.40 b-e	66.36bcd	165cde	39.65 ab
100 × Ukunimadhu	159 ab	24.33 bcd	29.77ab	306 a	11.48bcd	83.53 a	189ab	44.18 a
80 × KD_5-18-150	139 g	30.11ab	26.33 e	135gh	12.98 a	51.95 d-g	166 cd	31.11 c
80 × UD_5-100-6	150 cde	22.55 d	29.66ab	247cde	11.32 b-e	59.77 c-f	155 c-f	38.33 ab
80 × RM-100-16	160 ab	22.44 d	27.88 b-e	234cde	11.55bcd	58.29 c-g	142 d-g	40.48 ab
80 × RM-100-5	159 ab	24.77bcd	26.22 e	237cde	11.06 c-f	64.72 b-e	159 c-f	40.41 ab
80 × Ukunimadhu	155 a-e	23.22 cd	29.44 abc	294 ab	11.12 c-f	75.71 ab	175 abc	43.04 a
60 × KD_5-18-150	139 g	29.27 abc	26.55 de	149 gh	12.40 ab	52.78 d-g	171 bc	30.84 c
60 × UD_5-100-6	148ef	22.11 d	29.88 ad	217 de	10.48 d-g	51.47 efg	131 g	37.76 ab
60 × RM-100-16	158 a-d	22.55 d	27.55 b-e	241 cde	10.47 d-g	55.52 c-g	143 d-g	38.47 ab
60 × RM-100-5	154 a-e	22.66 d	23.22 g	222 de	11.43 b-e	56.37 c-g	141 efg	39.60 ab
60 × Ukunimadhu	149 de	22.33 d	29.55 abc	276 abc	11.08 c-f	68.03 bc	155 c-f	43.56 a
40 × KD_5-18-150	134 g	32.00 a	23.66 fg	125 h	11.52 bcd	46.07 fg	165 cde	28.27 c
40 × UD_5-100-6	141 fg	20.77 d	30.88 a	238 cde	9.56 g	43.94 g	138 fg	31.42 c
40 × RM-100-16	154 a-e	21.22 d	27.33 b-e	242 cde	10.05 fg	51.19 efg	127 g	39.90 ab
40 × RM-100-5	152 b-e	25.22 bcd	25.77 ef	209 ef	10.85 def	56.24 c-g	144 d-g	38.54 ab
40 × Ukunimadhu	152 b-e	25.44 bcd	29.11 a-d	236 cde	10.56 d-g	63.16 b-e	158 c-f	39.57 ab

Values having common letter(s) in a column do not differ significantly at 5% level of significance by DMRT

Table 3. Interaction effects between soil moisture levels and growth stages on yield and yield attributes

Treatments	Plant height (cm)	No. of panicle hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	1000-grain wt. (g)	Grain yield hill^{-1}	Total dry matter hill^{-1} (g)	Harvest Index (%)
% FC × Stage of stress imposition								
100 x Panicle initiation	157 a	25.66 a	28.73 a	260 a	11.28 abc	71.33 a	184 a	38.43 ab
100 x Booting	157 a	25.60 a	28.60 a	244 ab	11.14 bc	66.73 ab	167 b	39.72 ab
100 x Flowering	156 a	24.46 a	27.00 a	255 a	11.37 abc	68.51 ab	171 ab	39.74 ab
80 x Panicle initiation	153 ab	24.33 a	28.33 a	231 a-d	11.41 abc	59.67 bc	160 bc	37.10 abc
80 x Booting	156 a	24.33 a	27.66 a	228 a-d	12.08 a	63.18 ab	159 bc	39.75 ab
80 x Flowering	148 bcd	25.20 a	27.73 a	229 a-d	11.34 abc	63.42 ab	160 bc	39.17 ab
60 x Panicle initiation	153 ab	25.40 a	27.20 a	224 a-d	11.74 ab	63.17 ab	158 bc	40.10 a
60 x Booting	151 abc	23.00 a	27.53 a	234 abc	10.98 bc	58.08 bcd	148 cd	39.30 ab
60 x Flowering	145 de	22.96 a	27.33 a	204 cd	10.80 c	49.26 de	139 d	34.74 abc
40 x Panicle initiation	153 ab	26.06 a	27.00 a	228 a-d	11.02 bc	61.07 abc	153 bcd	39.71 ab
40 x Booting	145 cde	24.13 a	27.66 a	207 bcd	10.70 c	50.87 cde	147 cd	34.48 bc
40 x Flowering	141 e	24.60 a	27.40 a	194 d	9.80 d	44.42 e	139 d	32.42 c

Values having common letter(s) in a column do not differ significantly at 5% level of significance by DMRT

Table 4. Interaction effects between rice genotypes and growth stages on yield and yield attributes

Treatments	Plant height (cm)	No. of panicle hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	1000-grain wt. (g)	Grain yield hill^{-1}	Total Dry matter hill^{-1} (g)	Harvest index (%)
Genotypes x Stage of stress imposition								
KD_5-18-150 x Panicle initiation	143 d	36.33 a	26.16def	149 c	11.99 abc	63.60 b-e	186 a	34.95 de
KD_5-18-150 x Booting	142 d	28.25 b	25.66def	161 c	12.48 a	54.59 def	170abc	32.43 e
KD_5-18-150 x Flowering	134 e	28.45 b	25.08 f	124 c	12.20 ab	43.81 f	165 bcd	26.23 f
UD_5-100-6 x Panicle initiation	151 bc	20.91 c	30.08 a	264 ab	10.65 efg	56.10 cde	153 cde	36.24 cde
UD_5-100-6 x Booting	152 bc	20.66 c	31.08 a	244 ab	10.75 d-g	52.48 ef	140 e	37.12 b-e
UD_5-100-6 x Flowering	144 d	22.83 bc	29.66ab	224 b	10.45 fg	53.77 def	144 e	35.85 cde
RM-100-16 x Panicle initiation	160 a	20.33 c	27.66bcd	250 ab	11.36 b-f	55.26 def	145 e	37.51 b-e
RM-100-16 x Booting	158 ab	25.91 bc	27.00 c-f	236 b	10.42 fg	61.27 b-e	147 de	41.16 abc
RM-100-16 x Flowering	156 abc	23.41 bc	27.58 b-e	247 ab	10.02 g	58.15 cde	141 e	40.46 a-d
RM-100-5 x Panicle initiation	160 a	24.08 bc	25.33ef	235 b	11.63 a-d	66.08 bcd	159 b-e	41.17 abc
RM-100-5 x Booting	158 ab	23.75 bc	26.50def	223 b	10.98 def	58.38 cde	151 cde	38.26 b-e
RM-100-5 x Flowering	149 cd	23.25 bc	25.00 f	232 b	10.95 d-g	58.30 cde	147 de	39.22 a-d
Ukunimadhu x Panicle initiation	156 abc	25.16 bc	29.83ab	280 a	11.18 c-f	78.00 a	175 ab	44.32 a
Ukunimadhu x Booting	152 bc	22.72 bc	29.08abc	276 a	11.50 b-e	71.85 ab	168 abc	42.60 ab
Ukunimadhu x Flowering	153 abc	23.58 bc	29.50ab	277 a	10.51 fg	67.97 abc	165 bcd	40.84 a-d

Values having common letter(s) in a column do not differ significantly at 5% level of significance by DMRT

Table 5. Grain growth of aromatic rice genotypes under different soil moisture regimes

Treatments	Weight grain^{-1} (mg)
%Field Capacity	
100	7.543 b
80	7.748 a
60	7.237 c
40	6.744 d
Days	
0	2.035 h
3	3.485 g
6	5.280 f
9	6.487 e
12	7.968 d
15	9.320 c
18	10.197 b
21	10.630 a
24	10.460 ab
Genotypes	
KD_5-18-150	6.939 c
UD_5-100-6	7.623 a
RM-100-16	7.183 b
RM-100-5	7.710 a
Ukunimadhu	7.134 bc

Values having common letter(s) in a column do not differ significantly at 5% level of significance by DMRT

CONCLUSION

From the above study it may be concluded that the water stress affected more or less at every growth stage causing a reduction of yield components and yield. However, different genotypes and growth stages had different degrees of reduction. The genotypes Ukunimadhu may be used as developing suitable variety for drought prone areas of Bangladesh because it showed the best performance under water stress condition among the studied genotypes.

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