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Research Article

Comprehensive Analysis of Effect of Submergence on Rice Grain Quality

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Abstract

Flash flooding is one of the major problems in rice growing areas of South and Southeast Asia and it severely limits rice yield in these areas. This experiment was performed to check cultivated varieties with resistance against submergence and check best varieties which give better grain quality after affected by submergence. Chenab Basmati one of the cultivated varieties proved best performer in this experiment and is recommended for cultivation in areas affected by flood in Pakistan.

Introduction

Rice is one of the important crops in cereals. Rice is staple food of 50% population all around the world. Its higher production and good taste are two main parameters for many breeding projects but, in contrary to disease and insect resistance, grain yield and quality are both managed by quantitative trait loci (QTLs) highlighting continuous phenotypic difference in rice offspring [1]. So, it is hard for breeders to upgrade rice grain yield and quality using conventional techniques, due to a lack of distinct phenotypic segregation in the offspring. As rice grain quality is an endosperm characteristic, its heredity can be more complex because the genetic expression of an endosperm trait in cereal seeds is conditioned not only by the triploid endosperm genotype, but also by the diploid maternal genotype and any additional possible cytoplasmic differences [2-4]. Quality of rice grain comprises of cooking, milling, appearance and nutritional qualities. But appearance and cooking quality is mostly focused by people [5]. The appearance quality is often judged in China by the percentage of grain with a white core and a square of white core. Climate change is enhancing submergence stress, which is one of the main hurdles in increasing rice yield in rice growing areas of world. The most common and devastating type of flooding is short-time inundation (up to 2 weeks), also known as flash floods. 20 million hectare of rice growing area is affected by this kind of flooding in Asia (excepted China) as well as many lowland areas of Africa [6-10]. Moreover, due to disastrous effects from climate change, these seasonal flash floods are adversely unpredictable and can occur at any growth period of the rice crop [11]. Rice is submerged in monsoon season in South and Southeast Asia, which adversely limits rice yield and causes one billion U.S dollars losses annually [12].

Material and Methods

There were two sets of genotypes used in this experiment 1st set was grown in control environment, while 2nd was grown in submerged environment in water tank (Table 1). Screw guage was used to measure the grain dimensions like length, width and breadth of controlled and submerged material to study the effect of submergence on grain length, width, breadth and other quality parameters (Table 2).

Table 1: Quality parameters data for submerged material (mm).

Entries	R1			R2			R3		
	Length	Width	Breadth	Length	Width	Breadth	Length	Width	Breadth
V1	5.4	1	1.5	5.3	1.7	2	6.5	1.6	2.4
V2	6.3	1.5	2	6.3	1.5	1.8	7.2	1.7	2.2
V4	5.7	1.3	2.2	5.6	1.2	1.7	5.7	1.4	2.2
V5	6.8	1.6	2.2	6.7	1.6	2	7.1	2.1	2.5
V6	7.2	1.6	2.2	7	1.6	2.3	6.7	1.7	2.2
V7	71	1.6	2.5	7.2	1.7	2.6	5.5	1.5	2.6
V8	5	1.4	1.7	5.6	1.3	2.2	5.4	1.7	1.8
V9	4.6	1.2	1.4	6	1.3	1.8	5.2	1.4	1.8
V10	6.4	1.5	1.7	5.4	1.3	1.8	5.7	1.5	1.8
V11	5.9	1.2	1.8	5.7	1.3	1.7	5.2	1.7	2.2
V12	6	1.4	1.9	6.2	1.5	1.7	6.4	1.3	1.6
V13	6.6	1.7	2.2	5.7	1.7	2.3	6	1.5	2.3
V14	6.8	1.6	2.2	7.3	1.8	1.8	7	1.6	2.2
V15	6.1	1.6	2.2	5.7	1.7	2.2	6.1	1.3	1.8
V16	7.6	2.3	2.6	6.6	2	2.7	7.3	2.3	2.4
V17	7.4	2.3	2.7	7.5	2.2	2.6	7.4	2.3	2.4
V18	7.1	2.1	2.3	7.3	1.8	2.5	7.5	2.3	2.6
V19	6.8	1.4	2.3	6.7	1.7	2.2	6.2	1.8	2.3
V20	6.7	2	2.3	7.3	2.2	2.7	7.2	2.4	2.4
V21	6.8	2.2	2.4	7	1.8	2.5	6.9	2	2.4
V22	7.2	1.7	2.6	7.3	1.7	2.2	6.8	1.6	2.3
V23	6.9	2	2.4	6.9	1.4	2	7	1.6	2.2
V24	6.7	1.5	2	7.2	1.6	2.3	6.4	1.7	2
V25	5.8	1.7	2.3	6	1.6	1.8	5.6	1.9	2.7
V26	6.7	1.5	2.2	6.3	1.7	2.4	6.6	1.9	2.3
V27	6.4	1.7	2.4	6.7	1.5	2.3	6.7	1.8	2.2
V28	7.5	1.7	1.8	6.3	1.5	1.7	6.2	1.7	2.2
V29	6.7	1.2	1.8	6.6	1.2	1.6	7	1.5	2
V30	6.7	1.7	2.3	6.3	1.8	2.4	6.7	1.6	2.5
V31	7.2	1.7	2.5	7.2	1.8	2.5	7.2	1.8	2.4
V32	7.4	2.3	2.6	7.2	1.8	2.4	7.2	1.5	1.8
V33	6.8	1.8	2.4	6.7	1.3	2.3	6.3	1.2	2
V34	6.3	1.4	2.4	6	1.7	2.2	5.2	1.3	1.6
V35	6.7	2	2.2	6.7	1.7	2	6.5	1.7	2.2
V36	6.2	1.6	2.3	7	2	2.6	7.1	2.2	2.6
V37	6.8	2.3	3	7.5	2.2	2.6	7.2	2.1	3.2
V38	8	2.7	3	7.7	2.6	3.5	7.1	2.3	2.7
V39	6.8	1.8	2.4	5.7	1.2	2.3	5.3	0.8	1.4
V40	7.6	1.8	2.5	7.2	1.6	2.3	7.1	1.5	2.3
V41	7.1	1.7	2	6.6	1.5	2.3	6.7	1.3	1.8
V42	6.8	1.6	2.2	6.7	1.6	2	7	2.1	2.5
V43	6.8	1.8	2.5	7.2	1.7	2.4	7	1.7	2.4
V44	6	1.6	2.3	6.1	1.4	2.2	6	1.2	2.2
V45	6.5	1.7	2.3	7	1.5	2.4	6.3	1.6	2
V46	7.7	2	2.4	6.6	1.8	2.7	6.2	1.7	2.6

V47	7.4	2	2.6	6.6	1.4	2.4	7.3	1.8	2.5
V48	5.7	1.3	2.2	7.3	1.4	2	5.4	1.5	1.7
V49	6.7	1.4	2	6.8	1.4	2	7.1	1.6	1.8
V50	7.8	1.8	2.7	7.5	2.1	2.8	7.2	2.3	2.6

Table 2: Quality parameters data of control material (mm).

Entries	R1			R2			R3		
	Length	Width	Breadth	Length	Width	Breadth	Length	Width	Breadth
V1	7.4	2.3	2.5	7.5	1.7	2.2	7.4	2	2.5
V2	8.4	2.5	3.3	8.2	2.6	2.7	8.3	2.7	3.1
V3	6.3	2.2	2.7	6.6	2.4	2.6	6.9	2.5	3.2
V4	7.5	3.1	3.4	7.3	3	3.1	6.8	2.5	2.5
V5	6.2	1.3	2.2	5.8	1.4	2.1	6.5	1.8	2.3
V6	7.5	1.8	2.4	7.3	2.1	2.2	7.5	1.9	2.2
V7	7.8	2.9	3.1	8.2	2.8	3.4	8.3	2.7	3.7
V8	7.6	2.4	3.1	7.7	2.5	3.3	7.9	2.4	3.1
V9	6.4	2.4	3	6.7	2.7	3.2	6.5	2.7	3.1
V10	6.4	2.5	3.2	7.3	2.7	3.5	7	2.6	3.5
V11	6.2	1.8	2.5	6.4	2.1	2.6	6.2	2	2.6
V12	7.7	2.7	3.1	7.5	2.4	3.1	7.9	2.5	3.1
V14	6.7	1.8	2.4	7.2	1.9	2.5	8	1.9	2.3
V16	6.6	1.7	2.3	6.7	1.7	2.2	7.2	1.9	2.2
V19	8.2	2.9	3.5	7.8	2.7	2.8	8.5	2.6	3.2
V20	7.1	1.6	2.2	7.2	1.4	2.3	7.1	1.7	2.5
V21	7.4	1.8	2.4	7.2	1.3	2.4	7	1.8	2.3
V24	6.3	1.9	2.2	6.3	1.6	2.1	6.3	1.8	2.1
V25	6.3	1.6	2.5	6.4	1.7	2.1	6.4	1.2	2.2
V26	7.3	1.9	2.4	7.1	1.8	2.1	7.2	1.6	2.4
V27	7.1	1.7	2.4	6.6	1.7	2.2	7.1	2.1	2.5
V28	7.8	1.9	2.1	7.8	1.7	2.3	6.9	1.4	2.3
V30	7.4	1.8	2.5	7.3	1.6	2.4	6.8	1.7	2.2
V31	7.7	2.1	2.4	7.2	1.9	2.4	7.9	1.8	2.4
V32	7.2	1.7	2.6	7.2	1.4	2.5	7.5	1.9	2.3
V33	8.3	3.2	3.6	8.4	3	3.6	8.1	3.2	3.5
V35	7.4	1.7	2.2	7.3	1.5	2.2	7	1.8	2.3
V37	7.4	1.7	2.3	7.7	1.6	2.1	7.6	1.7	2.2
V38	7.7	1.7	2	7.3	1.7	2.2	6.5	1.6	2.2
V40	7.5	1.6	2.2	7.2	1.4	2.2	7.6	1.6	2.1
V42	7.1	1.6	2.3	6.5	1.6	2.4	7	1.5	2.2
V43	6.8	1.6	2.1	7.3	1.9	2.4	7.1	1.9	2.3
V44	6.3	1.6	2.4	6.6	1.7	2.5	5.9	1.6	2.1
V45	7.2	1.6	2.3	7.1	1.6	2.2	6.5	1.5	2.1
V46	7.4	1.6	2.4	7	1.8	2.4	7.1	1.7	2.2
V47	7.1	2.8	3.5	7.2	3.1	3.7	6.5	3	3.4
V49	6.8	1.5	2.2	7.4	1.6	2.1	6.7	1.8	2.3
V50	5.8	1.4	1.7	6.5	1.7	2.5	6.2	1.7	2.1

Material

(Table 3).

Table 3.

Code NO	Variety Name
V1	IR-6
V2	Super Basmati
V3	NIAB IRRI 9
V4	KSK-133
V5	KSK-434
V6	Basmati 370
V7	Basmati Pak
V8	Basmati 198
V9	Basmati 385
V10	KS-282
V11	Basmati 2000
V12	Shaheen Basmati
V13	Basmati 515
V14	PS-2
V15	PK 386
V16	Kisan Basmati
V17	Shadab
V18	Punjab Basmati
V19	PK 8892-4-2-1-1
V20	PK 8892-4-1-3-1
V21	PK 9194
V22	RRI 3
V23	PK BB15-1
V24	PK BB15-6
V25	PKBB8
V26	PK 10355
V27	Kashmir Basmati
V28	DR-82
V29	DR-83
V30	Sada Hayat
V31	DR-92
V32	Khushbo-95
V33	Chenab Basmati
V34	Shua-92
V35	Sarshar
V36	Jhona 349
V37	Mushkan-41
V38	Sathra-278
V39	Mahlar-346
V40	Palman 246
V41	C-622
V42	IRRI Pak (IR8)
V43	PK177
V44	KS282

V45	Kashmir Nafees
V46	Rachna Basmati
V47	Jhona MF
V48	Pakhal
V49	Swat 1
V50	Swat 2

Results and Discussion

Submerged genotypes showed great amount of difference among each other in three characteristics of grain width, length and breadth. Genotype 2 showed highest value of mean in case of grain length and maintained 8th rank in grain width. On other hand genotype 5 showed less gain in grain length. In case of grain width genotype 33 gave maximum width and ranked 2nd in case of grain length. Similarly, smallest mean of grain width was shown by genotype 42. Genotype 33 highlighted maximum grain breadth while genotype 31 was lowest ranked with minimum grain breadth.

Overall, genotype 33 gave best results and proved best performer under submergence because it secured 1st position in case of grain width and breadth and at 2nd position in case of grain length. On other hand, if we compare the grain width, breadth and length of genotypes 33 between controls and submerged, we conclude that submerged genotype is enough close to control. So, genotype 33 (Chenab Basmati) is recommended for cultivation in areas affected by flash flooding in Pakistan. While genotype 42 was poor performer because of minimum values for grain length, width and breadth in comparison to all submerged genotypes as well as its control.

Appendix

(**Appendix 1**)

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