The Pharma Innovation Journal 2021; 10(12): 3150-3153

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(12): 3150-3153

www.thepharmajournal.com
Received: 03-10-2021
Accepted: 10-11-2021

Bharathi Ayyenar
Department of Plant Biotechnology, Centre for Plant Molecular Biology and Biotechnology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Veera Ranjani Rajagopalan
Department of Plant Biotechnology, Centre for Plant Molecular Biology and Biotechnology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Rohit Kambale
Department of Plant Biotechnology, Centre for Plant Molecular Biology and Biotechnology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Raveendran Muthurajan
Department of Plant Biotechnology, Centre for Plant Molecular Biology and Biotechnology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Corresponding Author:
Raveendran Muthurajan
Department of Plant Biotechnology, Centre for Plant Molecular Biology and Biotechnology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Characterization of rice lines for head rice recovery under high temperature stress

Bharathi Ayyenar, Veera Ranjani Rajagopalan, Rohit Kambale and Raveendran Muthurajan

Abstract
Rice production is influenced by temperature since it affects both pollination and grain quality. Starch granule compaction, which influences rice grain recovery during milling and polishing, is affected by high temperatures during the fertilizations and also post-fertilization phase. Reduced head rice recovery has an impact on farmers by lowering milled grain revenues. To meet consumer and market demands, the most important goal is to improve grain quality. As a result, rice breeders all over the world are concentrating their efforts on generating rice varieties with desirable milling and appearance characteristics. The goal of this study was to determine the high temperature-induced damage to head rice recovery in rice using different accessions and to estimate the variability present in the collections that can be used as donors for the grain quality improvement. The maximum temperature during wet season 2016 was observed as 30.3 °C and during dry season 2017 it was observed as 33.7 °C. The HRR % ranged from 11.6 - 87.2 during wet season 2016 and 2.2 - 83.4 during dry season 2017. The variability parameters PCV, GCV, heritability, and GAM indicated greater values for head rice recovery %.

Keywords: Rice, Head rice recovery %, high temperature

Introduction
Rice (*Oryza sativa* L.) is a major cereal food crop that feeds over 3 billion people and serves as a source of nutrition (Rasheed *et al.,* 2020) [14]. Rice has traditionally been farmed as a fully flooded crop, providing calories to more than half of the world's population as well as providing a source of income for many small and marginal farmers in Asia and Africa. With a major increase in rice production during the 1960s (Green Revolution), followed by a period of stagnation in the late 1990s, it is clear that greater productivity is required to keep up with population growth. According to the FAO, India's rice production will need to increase to 125 million tonnes by 2030. By 2030, global food grain demand must have increased by 40%, and by 2050, demand must have increased by 70%. Considering the global harvested area, climate models predict that, by 2030, 16% of the rice-growing area would be exposed to at least 5 degrees of temperatures above the critical threshold during the reproductive period, with a non-linear increase to 27% by 2050 (Gourdji *et al*., 2013) [6]. Despite being a temperature-loving crop, rice is susceptible to heat stress (temperatures above 35 °C), especially during gametogenesis, flowering (Jagadish *et al.,* 2010) [7] and grain filling stage (Bhaskaran and Sebastian 2017) [2]. During flowering/anthesis, high temperature affects anther dehiscence and pollination, resulting in reduced spikelet fertility and also affects grain quality (Nakagawa *et al*., 2003; Jagadish *et al*., 2010) [12, 7]. High temperature stress at ripening phase affects the grain quality and head rice recovery (%).
Head rice recovery (%) is defined as the proportion of paddy rice that retains 75% of its length after milling. The HRR of a new rice variety must satisfy consumer needs of at least 55 percent or higher in order for it to be accepted and accepted by farmers. As a result, HRR is an important criterion for selecting new varieties for release (Lapis *et al.,* 2019) [8]. High temperature reduces rice productivity and quality, especially during the grain filling stage. To assess the magnitude of the influence and to understand the genetics behind head rice recovery %, researchers must investigate the impact of high temperatures on head rice recovery. Therefore, the current study was conducted to determine the impact of high temperature on head rice recovery percentage in rice.

Materials and Methods
To investigate the influence of temperature on head rice recovery percentage (HRR %), 50 rice

accessions were tested under completely irrigated, flooded conditions during two seasons, *kharif* (WS-2016) and summer (DS-2017). The details of rice accessions used in the study are given in table 1.

Twenty one day old seedlings were transplanted with a 20 x 20 cm spacing, and all 50 lines were replicated three times. The seed materials were harvested 30 days after flowering and the grains were dried to reduce the moisture content. The optimum moisture content for the grains is 13-14% to measure the head rice recovery. The head rice recovery analysis approach was adapted from Singh *et al.* (2000) [17]. The head rice recovery percentage was calculated using 100 to 150 gram of rough rice. Milled rice was obtained by dehulling or dehusking the rough rice with a rice sheller (Rice Polishing Machine LTJM-2099, Garg Instrumentation, Haryana). Milled rice kernels were separated into head rice and broken kernel fractions with different sized separator/ sieves. Full kernel and ¾ size kernels were considered as head rice and weighed for calculating HRR percentage. Head rice recovery percentage was calculated as

$$\text{Head rice recovery (\%)} = \frac{\text{Weight of full kernel}}{\text{Weight of rough rice}} \text{ X } 100$$

Table 1: Details of rice accessions used in the study

S. No	Genotype name	Country	S. No	Genotype name	Country
1	Ea Houm	Laos	26	Norunkan	Sri Lanka
2	Gopal	Nepal	27	NS113	Madagascar
3	Hao Hom	Laos	28	NS1611	Madagascar
4	Icta Polochic	Guatemala	29	Panakali	Sri Lanka
5	Iniap 415	Ecuador	30	Patchaiperumal	Sri Lanka
6	IR 32453-20-3-2-2	Philippines	31	Pawhtun	Burma
7	IR 43	Philippines	32	Piconegro	Ecuador
8	IR 59469-2B-3-2	Philippines	33	Pinursigi	Philippines
9	IR 74371-3-1-1	Philippines	34	Purbia (Kalansar)	Nepal
10	IR 77298-14-1-2	Philippines	35	Qing Gu	China
11	IR 77384-12-35-3-12-1-B	Philippines	36	Qing Shui Zao	China
12	J 104	Cuba	37	Race	Sri Lanka
13	Jariyu	India	38	Raj Bhog	Bangladesh
14	Jinling 78-102	China	39	Rathkandiram	Sri Lanka
15	Kanni Murunga	Sri Lanka	40	Red Pie Bold 17-214	Bangladesh
16	Kinandang Puti	Philippines	41	RR 166-645	India
17	Lal Bagdar	Bangladesh	42	Sada Danga Boro	Bangladesh
18	Lalbajam	Bangladesh	43	San Du BaI Mi Hong Gu	China
19	Liu Xu	China	44	San Ri Qi	China
20	Loku Samba	Sri Lanka	45	Shonth	India
21	Menakely	Madagascar	46	Sokou Malsira	Bangladesh
22	Motta Samba	Sri Lanka	47	Suduwee	Sri Lanka
23	Nakabawa	Kenya	48	Surmaniya	India
24	Narguni	India	49	Suthuwee	Sri Lanka
25	NCS130	India	50	T26	India

The percentage of head rice recovery was calculated for both the seasons (Wet season 2016, Dry season 2017) as well as the temperature pattern during grain filling was recorded for all genotypes. To assess the diversity of the trait, descriptive statistics and frequency distribution for the trait Head rice recovery (%) were calculated. TNAUSTAT software (Manivannan, 2014) [11] was used to calculate variability parameters.

Results and Discussion

Head rice recovery percentage during wet season 2016 ranged from 11.6 - 87.2 with the average of 58.3% (Table.2) and the temperature during grain filling stage was ranged from 29.9 – 31.2 °C with the average of 30.3 °C. Likewise during summer 2017 the head rice recovery ranged from 2.2 – 83.4% with an average of 34.4% and the temperature for this season ranged from 31.3 – 35.1°C with an average of 33.7 °C. From these results, the rise in temperature of 3.4 °C lowered the head rice recovery by 40.9%. As a result, even a minor increase in temperature has a negative impact on head rice recovery %. It was reported that the 4.4°C increases in day temperature resulted in 24.9% reduction in head rice recovery % (Bhaskaran and Sebastian 2017) [2]. Similarly Liu *et al.*, (2013) [9] reported that the high air temperature during grain filling significantly reduces the head rice recovery. In another report showed that the milling quality specifically, the head rice recovery may be affected by high temperature during grain filling stage (Abayawickrama *et al.*, 2017) [1]. From frequency distribution analysis, the difference in head rice recovery (%) is more between the seasons (Figure 1). In WS2016, 14 genotypes recovered more than 70% of their head rice and in DS2017 three genotypes had a head rice recovery of more than 70%. This indicates that the high temperature during grain filling has an impact on the percent of head rice recovered.

Table 2: Descriptive statistics variability parameters for head rice recovery percentage

Parameters	WS 2016		DS 2017	
	Temp (°C)	HRR (%)	Temp (°C)	HRR (%)
Grand Mean	30.3	58.3	33.7	34.4
S.E.	0.04	2.6	0.12	2.8

Range	29.9 – 31.2	11.6 - 87.2	31.3 - 35.1	2.2 - 83.4
CD (5%)	-	4.2	-	4.5
CV (%)	-	4.5	-	8.3
PCV (%)	-	31.7	-	57.8
GCV (%)	-	31.5	-	57.1
h^2 (%)	-	98.0	-	97.9
GAM (%)	-	64.2	-	116.5

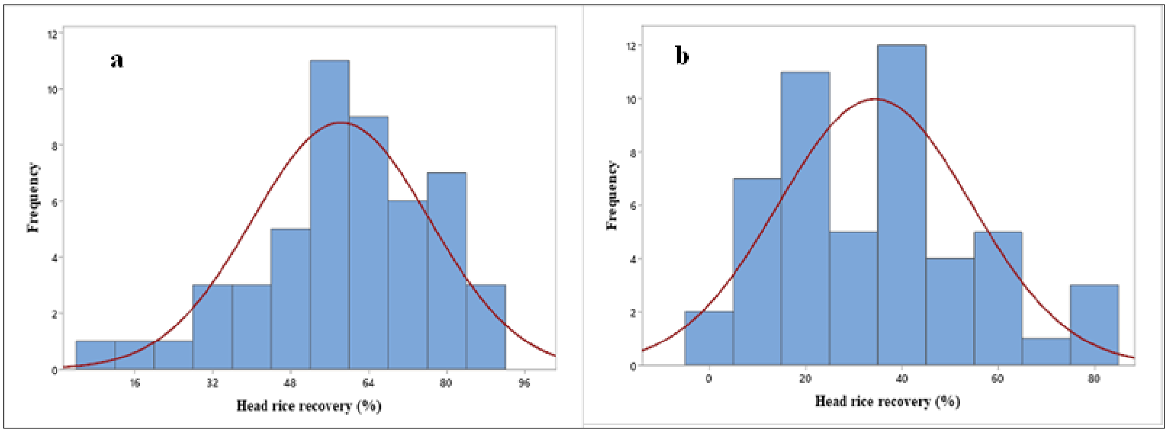

Fig 1: Frequency distribution of head rice recovery (a) wet season and (b) dry season

Genetic variability parameters such as genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2), genetic advance as per cent of mean (GAM) was analyzed for all 50 rice accessions. High PCV and GCV values were observed during all the three seasons (Table. 2). Estimates of PCV was higher than their corresponding GCV, which signifies that environmental interaction influences the expression of traits. Higher GCV and PCV values indicate that the traits are genetically controlled and this information is useful for identifying traits during selection. This also means that head rice recovery percentage could be improved in rice breeding programs through hybridization and selection for greater yield performance (Bisne *et al*., 2009) [3].

Broad sense heritability is considered as high if shows value >60%, medium >50–60% and as low if the value is <50% (Girma *et al*., 2018) [5]. The presence of high heritability was evident during all the seasons, which accelerates the selection process and HRR % can be improved through direct selection. Our results showed that the head rice recovery % can be improved as it had showed heritability values above 60% in both seasons. Unless it is investigated using genetic advance as per cent of mean, heritability estimates alone cannot provide the complete practical importance. Heritability estimation combined with genetic advance as per cent of mean is more effective for selection since heritability does not always signify genetic gain. The genetic advance as percent of mean (GAM) is categorized into low (0-10%), medium (10.1-20%), and high (>20%) as described by Johnson *et al*. (1955). GAM was high in both the seasons *viz.* wet season 2016 (64.2%), dry season 2017 (116.5%). Previous studies also indicated that head rice recovery has showed higher heritability with the high GAM (Singh *et al*., 2021) [16]. Similarly, Devi *et al*., (2016) [4] reported high heritability % (94%) for head rice recovery. Nirmaladevi *et al*., (2015) [13] and Subudhi *et al*., (2011) [18] also observed higher heritability (above 88%) for head rice recovery. Our results showed higher heritability and high GAM for head rice recovery during all seasons. From these results, it can be suggested that the lines which showed higher head rice recovery % during each season can be used for further improvement of varieties and development of breeding lines with high head rice recovery as HRR has showed higher heritability and GAM.

References

1. Abayawickrama ASMT, Reinke RF, Fitzgerald MA, Harper JD, Burrows GE. Influence of high daytime temperature during the grain filling stage on fissure formation in rice. Journal of Cereal Science. 2017;74:256-262.
2. Bhaskaran M, Sebastian A. Understanding effects of high temperature stress on head rice recovery in rice. Int. J Curr. Microbiol. App. Sci. 2017;6(11):5476-5481.
3. Bisne R, Sarawgi AK, Verulkar SB. Study of heritability, genetic advance and variability for yield contributing characters in rice. Bangladesh Journal of Agricultural Research. 2009;34(2):175-179.
4. Devi KR, Parimala K, Venkanna V, Lingaiah N, Hari Y, Chandra BS. Estimation of variability for grain yield and quality traits in rice (*Oryza sativa* L.). Int. J Pure App. Biosci. 2016;4(2):250-255.
5. Girma BT, Kitil MA, Banje DG, Biru HM, Serbessa TB. Genetic variability study of yield and yield related traits in rice (*Oryza sativa* L.) genotypes. Adv. Crop. Sci. Tech. 2018;6(4):381.
6. Gourdji SM, Sibley AM, Lobell DB. Global crop exposure to critical high temperatures in the reproductive period: historical trends and future projections. Environmental Research Letters. 2013;8(2):024041.
7. Jagadish SVK, Muthurajan R, Oane R, Wheeler TR, Heuer S, Bennett J *et al*. Physiological and proteomic approaches to address heat tolerance during anthesis in rice (*Oryza sativa* L.). Journal of experimental botany. 2010;61(1):143-156.
8. Lapis JR, Cuevas RPO, Sreenivasulu N, Molina L. Measuring head rice recovery in rice. In Rice Grain Quality. Humana Press, New York, NY, 2019,89-98p.
9. Liu Q, Wu X, Ma J, Li T, Zhou X, Guo T. Effects of high air temperature on rice grain quality and yield under field condition. Agronomy Journal. 2013;105(2):446-454.

10. Lyman NB, Jagadish KS, Nalley LL, Dixon BL, Siebenmorgen T. Neglecting rice milling yield and quality underestimates economic losses from high-temperature stress. PloS one. 2013;8(8):e72157.
11. Manivannan N. TNAUSTAT-Statistical package, 2014. Retrieved from https://sites.google. com/site/tnaustat
12. Nakagawa H, Horie T, Matsui T. Effects of climate change on rice production and adaptive technologies. In Rice science: innovations and impact for livelihood. Proceedings of the International Rice Research Conference, Beijing, China, 16-19 September 2002. International Rice Research Institute (IRRI), 2003, 635-658p.
13. Nirmaladevi G, Padmavathi G, Kota S, Babu VR. Genetic variability, heritability and correlation coefficients of grain quality characters in rice (*Oryza sativa* L.). SABRAO journal of Breeding and Genetics. 2015;47(4):424-433..
14. Rasheed A, Fahad S, Aamer M, Hassan MU, Tahir MM, Wu Z. Role of genetic factors in regulating cadmium uptake, transport and accumulation mechanisms and quantitative trait loci mapping in rice. a review. Applied Ecology and Environmental Research. 2020;18(3):4005-4023.
15. Siddiqui SU, Kumamaru T, Satoh H. Pakistan rice genetic resources-I: Grain morphological diversity and its distribution. Pakistan Journal of Botany. 2007;39(3):841-848.
16. Singh B, Gauraha D, Sao A, Nair SK. Assessment of genetic variability, heritability and genetic advance for yield and quality traits in advanced breeding lines of rice (*Oryza sativa* L.). The Pharma Innovation. 2021;10(8):1627-1630.
17. Singh RK, Singh US, Khush GS, Rohilla R, Singh JP, Singh G, *et al*. Small and medium grained aromatic rices of India. Aromatic Rices. Oxford & IBH, New Delhi, 2000,155-177.
18. Subudhi HN, Das S, Swain D, Singh ON. Variability, correlation and path analysis for quality characters in rice. ORYZA - An International Journal on Rice. 2011;48(4):319-323.