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Research Article

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Evaluation of Grain Quality Traits in High Altitude Rice Hybrids (*Oryza sativa* L.)

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ABSTRACT

Rice is the staple cereal crop of many ethnic populations of the world. Usually rice is milled and cooked before consumption. Consumers exhibit a varied preference for rice quality depending on their geographical location, culture and nature of culinary use. Therefore, achieving good grain quality in rice varieties has become extremely important for plant breeders. Rice grain quality is decided by physical traits, amylose, gelatinization temperature, alkali spread value, grain types, chalk and sensory evaluation. In the present study, 34 pollen donors and four CMS lines along with their 10 best heterotic cross combinations were analysed for cooking and other quality attributes. The analysis of variance indicated the presence of sufficient variability for cooking quality. Phenotypic and genotypic coefficient of variability, heritability (broad sense), and genetic advance was estimated. It was observed that gel consistency showed highest PCV, GCV, heritability and genetic advance. There is a considerable scope for selection of heterotic rice hybrids with desirable quality.

Key words: *Rice, Quality traits, Heterosis, PCV, GCV, Heritability and Genetic advance*

INTRODUCTION

Rice quality includes all characteristics of rice and its products which decide the consumer demand and preference (Siddiqui et al., 2007). Rapid change in consumer demand for quality rice is due to better living conditions and concomitant preferences for taste in various rice consuming countries. As consumer income increases and markets become more liberalized, consumer's preferences for rice have been shown to shift from lower to higher quality (Juliano et al., 1964; Cuevas & Fitzgerald, 2012). Hybrid rice is a first generation cross between two inbreds and grain produced from hybrid rice is an outcome of single meiotic cycle and, therefore, the phenomenon is liable to hamper the quality of a rice hybrid, in case the participating parents are divergent enough in terms of rice quality.

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Thus, evaluation of derived rice hybrids is going to be of utmost importance.

Grain quality features consists of the physical, physiological and its biochemical characteristics (Sattari et al., 2015). Rice grain quality is a composite of several characteristics including appearance, milling, cooking, and eating characteristics. The physicochemical and cooking properties include grain shape, hulling recovery, degree of milling, grain appearance, milling recovery, head rice recovery, kernel shape, gel consistency (GC), alkali digestion, amylose content (AC) and aroma (Sattari et al., 2015). Unlike preferences for cooking and eating quality, which vary markedly from region to region (Calingacion et al., 2014; Champagne et al., 2010), the requirements for milling recovery and appearance are universal. A high grain quality variety should have high head rice yield after milling and should have low chalkiness (Nelson et al., 2012; Anacleto et al., 2015).

There happens to be a marked influence of growing environment on rice appearance, milling, and eating quality (Li et al., 2015). On the basis of amylose content rice varieties have been classified under groups, waxy (0-2%), very low (3-9%), low (10-19%), intermediate (20-25%) and high amylose types (>26%) (Kumar & Khush, 1986). Waxy rice is highly sticky, firm and less preferable due to low volume expansion. High amylose content is related to high volume expansion and a high degree of flakiness, cooks dry, less tender and become hard upon cooling whereas intermediate rice varieties are preferable as rice cooks moist, tender with good expansion and does not harden upon cooling. Gel consistency measures the cold paste viscosity of cooked milled rice flour and is used as an index in distinguishing cooked rice texture of high amylose genotypes (Cagampang et al., 1973). Genotypes are grouped based on the length of the gel as: hard (length of gel <40 mm), medium (length of gel 41 – 60 mm), and soft (length of gel > 61 mm) (Graham, 2002). Association of starch polymers in the aqueous phase determines weak and rigid gels (Wang et al., 2007; Fan et al., 2005). Alkali hydrolysis of milled rice grain is an indirect procedure to estimate GT. Environmental conditions such as high ambient temperature during grain ripening often lead to starch with higher GT (Dela Cruz et al., 1989). The GT of rice varieties may be classified as low (55 to 69 ^{0}C), intermediate (70 to 74 ^{0}C) and high (> 74^{0}C). Present study involves 34 pollen donors and four CMS lines along with their 10 best heterotic cross combinations that were analysed for cooking and other quality attributes.

MATERIALS AND METHODS

A set of 38 parents and derived heterotic hybrids were grown under irrigated conditions. Recommended packages of practices were adopted to raise a vigorous crop. The data was recorded on various quality traits viz., hulling (%), milling (%), head rice recovery (%), kernel length before cooking (mm), kernel breadth before cooking (mm), length breadth ratio, kernel length after cooking (mm), kernel breadth after cooking (mm), kernel elongation ratio, kernel elongation index, aroma, gelatinization temperature, amylose content (%) and gel consistency (mm). The lines were classified into slender, medium, bold and round as per shape categorization of SES-IRRI (2012). KLBC (mm), KLAC (mm), KBBC (mm), KBAC (mm), LBR and KER were calculated on graph paper with the help magnifying glass. Chemical properties like AC (%), GC (mm) and ASV were evaluated following the standard protocols along with some modifications described and published by Little et al (1958); Juliano et al. (1971) and Cagampang et al. (1973). The presence of aroma was detected through panel test as suggested by IRRI (1971). The ANOVA and variability parameters were computed with the help of Window Stat 9.1 Software.

RESULTS AND DISCUSSION

Quality characteristics of heterotic hybrids

Of the 10 heterotic hybrids evaluated, nine hybrids viz., SKUA-7A X RL- 2, SKUA-7A X

RL -3,SKUA-7A X RL-7,SKUA-11A X RL-7,SKUA-11A X RL-5, SKUA-21A X RL-14,SKUA-21A X RL-12, SKUA-21A X RL-11 and SKUA-21A X RL-9 were of medium short type and only a cross, SKUA-19A x RL-5 was of long grain type. The pattern may be attributed to dominance of short grain phenotype over long grain (Fig 2). Eight hybrids showed hard Gel consistency namely, SKUA-7A x RL-7 ,SKUA-11A x RL-7 ,SKUA-11A x RL-5 ,SKUA-19A x RL-5, SKUA-21A x RL-14 ,SKUA-21A x RL-12 ,SKUA-21A x RL-11 and SKUA-21A x RL-9 while one each had medium (SKUA-7A x RL-2) and soft GC (SKUA-7A x RL-3). The hard GC is dominant over medium which in turn is dominant over soft GC as reported by Tang et al (1991), however, soft GC is desirable. Heterotic hybrids along with parents showed intermediate amylose content which is preferable and besides, these hybrids showed intermediate ASV.

Analysis of Variance

The significant mean squares were recorded for the traits studied (Table 1). Highest PCV (%) and GCV (%) was recorded for gel consistency on the basis of scale given by Juliano et al. (1971) while, the lowest PCV (%) and GCV (%) was recorded for hulling percentage. The difference between genotypic and phenotypic coefficient of variation was relatively less for all characters studied. The GCV approaching to PCV was also reported by Mustafa and Isheikh (2007), Kole et al. (2008) and Syoum et al. (2012) and happens to be because of low influence of environment. In such a scenario, selection on the basis of phenotype alone can be effective for the improvement of these traits.

Heritability

High estimates of heritability were exhibited for all the traits under study (Table 2.) Heritability is classified as high (above 60%), medium (30%-60%) and low (below 30%). All the characters namely, Hulling recovery (%) [0.970], Milling recovery (%) [0.974], Head rice recovery (%) [0.965], Kernel length before cooking (mm) [0.992], Kernel breadth before cooking (mm) [0.915], Length breadth ratio before cooking [0.977], Kernel length after cooking (mm) [0.992], Kernel breadth after cooking (mm) [0.954] , Length breadth ratio after cooking [0.983], Kernel elongation ratio [0.972], Kernel elongation index[0.909], G.C [0.994], ASV[0.996] and Amylose content[0.858] exhibited high heritability. High heritability values indicate that the characters under study are less influenced by environment and genotypes can be selected with greater confidence.

Genetic advance

Among the traits studied the high, moderate and low estimates of genetic advance as percent of mean was recorded. The genetic advance as percentage of mean was highest for G.C. followed by ASV and lowest was recorded for Hulling percentage. The estimates of genetic advance as per cent of mean provide more reliable information regarding the effectiveness of selection in improving the traits. Genetic advance denotes the estimate of improvement in the genotypic value of the new population over the original population (Table 2).

Since broad sense heritability includes both additive and epistatic effects. It will be reliable only when accompanied by high genetic advance. Heritability estimates along with genetic advance is more useful than heritability alone in predicting the effectiveness of selection (Johnson et al., 1955). In the present study the characters which showed high heritability associated with high genetic advance are alkali spreading value and gel consistency. The characters that show high heritability coupled with high genetic advance are controlled by additive gene action (Panse & Suhatme, 1957) and can be improved through simple or progeny selection methods while the characters which showed high heritability coupled with moderate or low genetic advance can be improved by intermitting superior genotypes of segregating population developed from combination breeding (Samadhia, 2005).

Table 1: Analysis of variance for various quality traits

Source of variation	df	H	M	HR	GL	GB	KLB	KBB	LBRBC	KLA	KBA	LBRAC	ER	EI	ASV	GC	Am
Replication	2	1.9	6.48*	0.39	0.009	0.002	0.043	0.014	0.004	0.004	0.007	0.008	0.002	0.004	0.037	2.5	0.9
Treatment	47	85.1**	136.0**	126.0**	2.538**	0.174*	1.55**	0.108**	1.07**	2.84**	0.30**	1.29**	0.057**	0.059**	4.096**	1031.0**	10.6**
Error	94	0.86	1.19	1.4	0.009	0.004	0.004	0.003	0.008	0.008	0.004	0.007	0.005	0.001	0.008	1.5	0.55

Hulling (H), Milling (M), Head rice recovery (HR), Grain length (RL), Grain breadth (GB), Kernel length before cooking (KLB), Kernel breadth before cooking (KBB), Length breadth ratio before cooking (LBRBC), Kernel length after cooking (KLA), Kernel breadth after cooking (KBA), Length breadth ratio after cooking (LBRAC), Elongation ratio (ER), Elongation index (EI), Alkali spread value (ASV), Gel consistency (CG), Amylose content (Am)

Table 2: Estimates of Variability, heritability & genetic advance

Traits	GCV	PCV	h^2 (Broad Sense)	Gen. Adv as % of Mean
Hulling (H)	7.293	7.404	0.970	14.796
Milling (M)	10.788	10.931	0.974	21.933
Head rice recovery (HR)	12.364	12.584	0.965	25.023
Grain length (RL)	10.196	10.254	0.989	20.884
Grain breadth (GB)	8.344	8.616	0.938	16.647
Kernel length before cooking (KLB)	11.610	11.654	0.992	23.826
Kernel breadth before cooking (KBB)	8.896	9.299	0.915	17.532
Length breadth ratio before cooking (LBRBC)	19.909	20.140	0.977	40.543
Kernel length after cooking (KLA)	10.544	10.589	0.992	21.629
Kernel breadth after cooking (KBA)	10.379	10.627	0.954	20.881
Length breadth ratio after cooking (LBRAC)	21.086	21.271	0.983	43.061
Elongation ratio (ER)	9.209	9.342	0.972	18.699
Elongation index (EI)	13.242	13.886	0.909	26.013
Alkali spread value (ASV)	27.326	27.414	0.994	56.111
Gel consistency (CG)	42.903	42.994	0.996	88.191
Amylose content (Am)	8.253	8.908	0.858	15.749

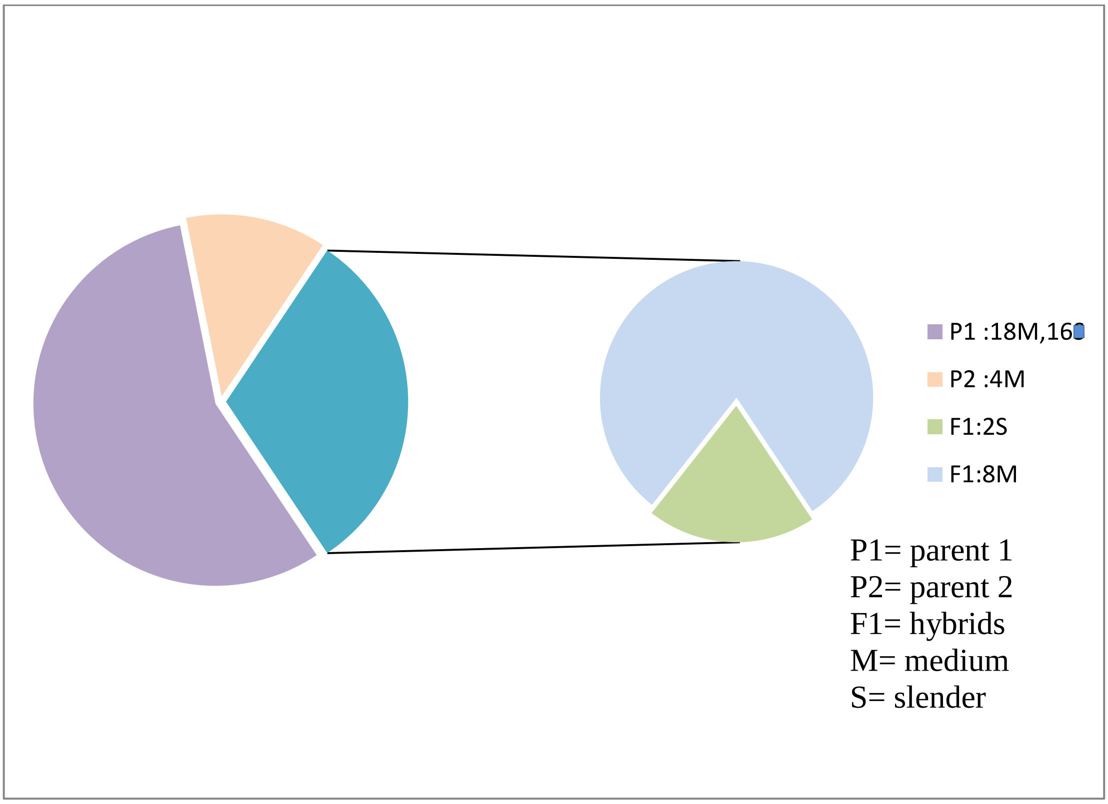

Fig. 1: Kernel shape of Parents and Hybrids

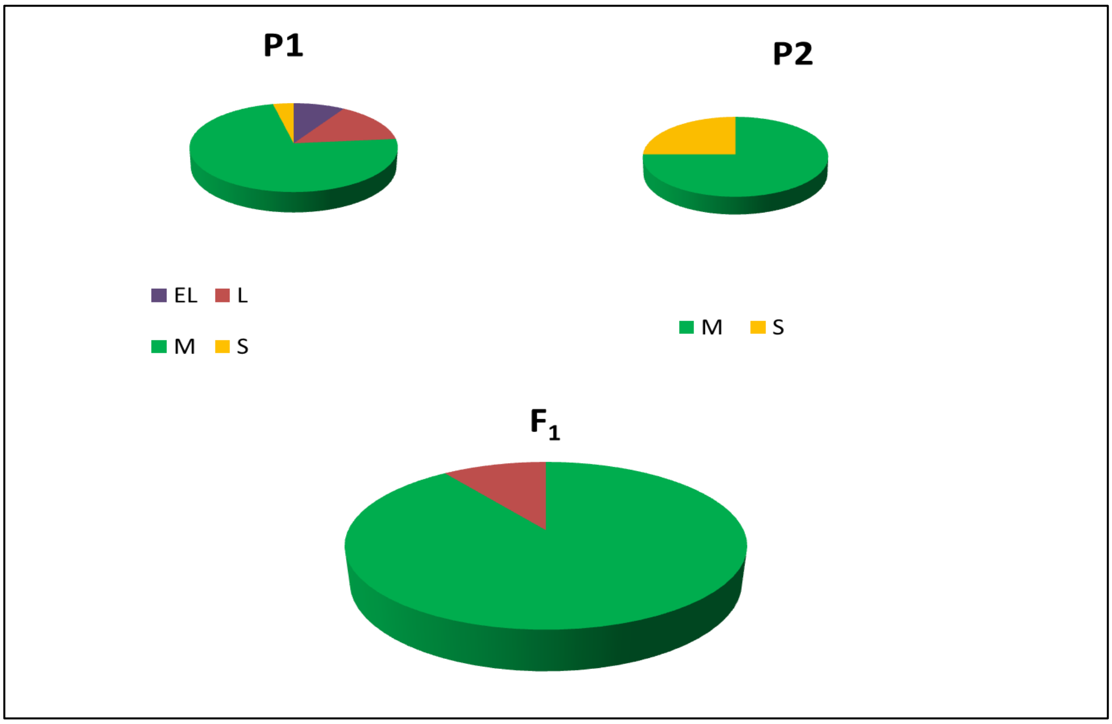

Fig. 2: Kernel length of Parents and F_1s

CONCLUSION

Most of heterotic hybrids were of medium short grain type except SKUA-19A x RL-5 which showed long grain type. All heterotic hybrids were non aromatic with intermediate amylose content. Only one cross combination SKUA-7A x RL-3 possessed desirable GC (soft). Most of hybrids showed intermediate ASV except SKUA-21A x RL-14 which exhibited high ASV.

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