Correlation among various grain quality characteristics in rice

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ABSTRACT

To understand the association of various quality traits among themselves. Selected maintainers and restorers were analyzed for various grain quality and physico-chemical characters in order. Hulling percentage showed positive significant correlation with milling percentage and head rice recovery indicating that the genotypes with higher hulling percentage also recorded higher estimates for milled rice and head rice. Head rice recovery also showed negative but non-significant correlation with grain L/B ratio. Negative significant association of kernel length with kernel breadth indicates that grain length and slenderness are inherited independently resulting in long slender grain types. Positive significant correlation between kernel length and water uptake indicates that genotypes with longer kernels showed enhanced water absorption. Correlation of amylase content with volume expansion ratio, alkali spreading value and gel consistency was positive but non-significant.

Key words: *Rice, quality characteristics, correlation, path analysis*

Hybrid rice technology has proved to be one of the most feasible and readily adoptable approaches to break the current yield barrier. With increase in yield, there is also a need to look into the quality aspects to have better consumer acceptance. The nature and magnitude of association between various grain quality characters needs to be studied to select suitable parents to develop hybrids with better grain quality. The present investigation was undertaken to study the association of various quality characters among themselves in selected maintainers and restorers.

MATERIALS AND METHODS

The material consisted of 67 maintainers and103 restorers grown during July-December, 2000 and the grains harvested were used for quality analysis during February 2001. Thirteen physico-chemical characters which include hulling percentage (HP), milling percentage (MP), head rice recovery (HRR), kernel length (KL), kernel breadth (KB), L/B ratio, kernel length after cooking (KLAC), elongation ratio (ER), water uptake (WU), volume expansion ratio (VER), alkali spreading value (ASV), gel consistency (GC) and amylose content (AC) were analyzed following standard procedures.

RESULTS AND DISCUSSION

Hulling percentage showed positive significant correlation with milling percentage (rp = 0.8218; rg =0.8691) and head rice recovery (rp=0.3451; rg=0.3819). However, this trait showed negative non-significant correlation with kernel dimensions (Table 1). Head rice recovery exhibited positive non-significant association with alkali spreading value and amylose content. Kernel length showed positive significant association with L/B ratio (rp= 0.6910; rg=0.7100), kernel length after cooking (rp=0.5961; rg=0.6410) and water uptake and negative significant correlation with kernel breadth, elongation ratio and amylose content. Negative significant association of kernel breadth was observed with L/B ratio (rp=-0.8366; rg=-0.8381), water uptake (rp=-0.2654; rg=-0.3009) and alkali spreading

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Table 1. Estimates of phenotypic and genotypic correlation coefficients for various quality characters (*kharif* 2000)

	Hulling (%)	Milling (%)	HRR (%)	K L (mm)	K B (mm)	L/B ratio	KLAC (mm)	ER	WU (ml)	VER	ASV	GC (mm)	AC (%)
HHulling (%)	**1.000**	0.8218** (0.8691)	0.3451** (0.3819)	0.0448 (0.0524)	-0.1121 (-0.1131)	0.1050 (0.1111)	-0.0147 (-0.0206)	-0.0557 (-0.0833)	0.0688 (0.0815)	-0.0915 (-0.1136)	0.0244 (0.0168)	0.0727 (0.1004)	0.0529 (0.0728)
Milling (%)		**1.000**	0.5761** (0.6085)	0.0350 (0.0491)	-0.1123 (-0.1093)	0.1086 (0.1120)	-0.0362 (-0.0568)	-0.0557 (-0.1211)	0.0688 (0.0868)	-0.0915 (-0.1032)	0.0244 (0.0325)	0.0727 (0.0441)	0.0529 (0.1272)
HRR (%)			**1.000**	-0.0787 (-0.0808)	0.1321 (0.1355)	-0.1438 (-0.1503)	-0.0651 (-0.0687)	0.0126 (0.0060)	0.0264 (0.0315)	-0.0418 (-0.0541)	0.0932 (0.0952)	0.0396 (0.0315)	0.1827* (0.1922)
K L (mm)				**1.000**	-0.2098* (-0.2280)	0.6910** (0.7100)	0.5961** (0.6410)	-0.3036** (-0.2907)	0.2605** (0.2823)	-0.0312 (-0.0919)	0.0934 (0.0949)	-0.0443 (-0.0476)	-0.2368** (-0.2492)
K B (mm)					**1.000**	-0.8366** (-0.8381)	-0.0733 (-0.0944)	0.1324 (0.1352)	-0.2654** (-0.3009)	-0.0219 (-0.0436)	-0.1679 (-0.1757)	-0.1326 (-0.1462)	0.0289 (0.0310)
L/B ratio						**1.000**	0.3575** (0.3942)	-0.2787** (-0.2838)	0.3357** (0.3726)	-0.0077 (-0.0216)	0.1745* (0.1806)	0.0834 (0.0856)	-0.1470 (-0.1538)
KLAC (mm)							**1.000**	0.5712** (0.5586)	0.1422 (0.1627)	-0.0393 (-0.0647)	0.0156 (0.0196)	-0.0350 (-0.0437)	-0.1319 (-0.1413)
ER								**1.000**	-0.1059 (-0.1101)	-0.0309 (-0.0209)	-0.0874 (-0.0883)	0.0089 (0.0011)	0.0832 (0.0958)
WU (ml)									**1.000**	-0.0344 (-0.0489)	0.6278** (0.6580)	-0.0452 (-0.0457)	-0.0489 (-0.0529)
VER										**1.000**	-0.0488 (-0.0472)	-0.0200 (-0.0024)	0.0283 (0.0046)
ASV											**1.000**	-0.0655 (-0.0619)	0.1274 (0.1307)
GC (mm)												**1.000**	0.0666 (0.0724)
A.C. (%)													**1.000**

Figures in parenthesis are genotypic correlation coefficients
* Significant at 5% level
** Significant at 1% level

Table 2. Direct and indirect effects of various quality traits on amylose content (*kharif* 2000)

	Hulling (%)	Milling (%)	HRR (%)	K L (mm)	K B (mm)	L/B ratio	KLAC (mm)	ER	WU (ml)	VER	ASV	GC (mm)	AC (%)
Hulling (%)	-0.0707 (-0.0864)	0.6988 (0.1367)	0.0362 (0.0383)	0.0083 (0.0256)	-0.0027 (-0.0321)	0.0060 (0.0487)	0.0009 (-0.0010)	-0.0046 (-0.0022)	-0.0099 (-0.0140)	-0.0034 (0.0000)	0.0056 (0.0042)	0.0044 (0.0062)	0.0529 (0.0728)
Milling (%)	-0.0576 (-0.0757)	0.1203 (0.1573)	0.0605 (0.6100)	-0.0065 (-0.0240)	-0.0027 (-0.0310)	0.0062 (0.0491)	0.0021 (-0.0029)	-0.0069 (-0.0032)	-0.0098 (-0.0149)	-0.0026 (0.0000)	0.0076 (0.0082)	0.0021 (0.0027)	0.0529 (0.1272)
HRR (%)	-0.0242 (-0.0330)	0.0693 (0.0957)	0.0149 (0.1002)	0.0145 (0.0394)	0.0032 (0.0384)	-0.0083 (-0.0659)	0.0036 (-0.0035)	0.0011 (0.0002)	-0.0038 (-0.0054)	0.0016 (0.0000)	0.0215 (0.0240)	0.0024 (0.0019)	0.1827* (0.1922)
K L (mm)	-0.0031 (-0.0045)	0.0042 (0.0077)	-0.0083 (-0.0081)	-0.1849 (-0.4881)	-0.0051 (-0.0647)	0.0397 (0.3111)	-0.0344 (0.3324)	-0.0253 (-0.0077)	-0.0374 (-0.0484)	-0.0012 (0.0000)	0.0216 (0.0239)	-0.0027 (-0.0029)	-0.2368** (-0.2492)
K B (mm)	0.0079 (0.0098)	-0.0135 (-0.0172)	0.0139 (0.0136)	0.0388 (0.0113)	0.0241 (0.2837)	-0.0480 (-0.3672)	0.0042 (-0.0048)	0.0110 (0.0036)	0.0381 (0.0515)	0.0008 (0.0000)	-0.0387 (-0.0443)	-0.0080 (-0.0090)	-0.0289 (0.0310)
L/B ratio	-0.0074 (-0.0096)	0.0131 (0.0176)	-0.0151 (-0.0151)	-0.1278 (-0.3465)	-0.0201 (-0.2378)	0.0574 (0.4382)	-0.0206 (0.0199)	-0.0232 (-0.0075)	-0.0482 (-0.0638)	-0.0003 (0.0000)	0.0403 (0.0456)	0.0050 (0.0053)	-0.1470 (-0.1538)
KLAC (mm)	0.0010 (0.0018)	-0.0043 (-0.0089)	-0.0065 (-0.0069)	-0.1102 (-0.3129)	-0.0018 (-0.0268)	0.0205 (0.1727)	-0.6577 (0.6505)	0.0475 (0.0148)	-0.0204 (-0.0279)	-0.0015 (0.0000)	0.0036 (0.0049)	-0.0021 (-0.0027)	-0.1319 (-0.1413)
ER	0.0039 (0.0072)	-0.0100 (-0.0190)	0.0013 (0.0006)	0.0561 (0.1419)	0.0032 (0.0384)	-0.0160 (-0.1243)	-0.0333 (0.0282)	0.0832 (0.0264)	0.0152 (0.0189)	-0.0012 (0.0000)	-0.0202 (-0.0223)	0.0005 (-0.0001)	0.0832 (0.0958)
WU (ml)	-0.0048 (-0.0070)	0.0082 (0.0136)	0.0028 (0.0032)	-0.0482 (-0.1378)	-0.0064 (-0.0854)	0.0193 (0.1633)	-0.0082 (0.0082)	-0.0088 (-0.0029)	-0.1436 (-0.1713)	-0.0013 (0.0000)	0.1449 (0.1860)	-0.0027 (-0.0028)	-0.0489 (-0.0529)
VER	0.0064 (0.0098)	-0.0083 (-0.0162)	-0.0044 (-0.0054)	0.0058 (0.0448)	-0.0005 (-0.0124)	-0.0004 (-0.0094)	0.0023 (-0.0033)	-0.0026 (0.0006)	0.0049 (0.0084)	0.0376 (0.0002)	-0.0113 (-0.0119)	-0.0012 (-0.0002)	0.0283 (0.0046)
ASV	-0.0017 (-0.0015)	0.0040 (0.0051)	0.0098 (0.0095)	-0.0173 (-0.0463)	-0.0040 (-0.0498)	0.0100 (0.0791)	-0.0009 (0.0010)	-0.0073 (-0.0023)	-0.0702 (-0.1127)	-0.0018 (0.0000)	0.2308 (0.2524)	-0.0039 (-0.0038)	0.1274 (0.1307)
GC (mm)	-0.0051 (-0.0087)	0.0042 (0.0069)	0.0042 (0.0032)	0.0082 (0.0232)	-0.0032 (-0.0415)	0.0048 (0.0375)	0.0020 (-0.0022)	0.0007 (-0.0000)	0.0065 (0.0078)	-0.0008 (0.0000)	-0.0151 (-0.0156)	0.0602 (0.0617)	0.0666 (0.0724)

Underlined values are direct effects and all other values are indirect effects. Figures in parenthesis are genotypic estimates. Bold values indicate correlation coefficients.

value (rp=-0.1679; rg=-0.1757). Kernel length after cooking had positive significant association with elongation ratio (rp=0.5712; rg=0.5586). Among cooking quality traits, water uptake showed positive significant association with alkali spreading value, kernel length and L/B ratio, while volume expansion ratio did not show significant correlation with any of the quality parameters. Alkali spreading value showed positive significant correlation with water uptake and negative non-significant correlation with gel consistency. Gel consistency showed positive but non-significant correlation with amylose content (rp=0.0666; rg=0.0724).

Hulling percentage showed negative direct effect on amylose content at phenotypic level (Table 2). Positive indirect effects of this trait were manifested through milling percentage, head rice recovery, kernel length, L/B ratio, kernel length after cooking and gel consistency. Positive direct effect of head rice recovery was observed with amylose content. Kernel length showed negative direct effect coupled with negative significant correlation with amylose content. Among cooking quality traits, elongation ratio and volume expansion ratio had positive direct effects on amylose content. The important physico-chemical traits viz., alkali spreading value and gel consistency had positive direct effects coupled with positive association with amylose content.

In the present study, hulling percentage showed positive significant correlation with milling percentage and head rice recovery indicating that the genotypes with higher hulling percentage also recorded higher estimates for milled rice and head rice. Similar results were reported by Tejpal (1987), Viraktamath (1987), Sarkar *et al.*, (1994) and Chauhan *et al.*, (1995). Head rice recovery showed negative but non-significant correlation with grain L/B ratio. This kind of inverse relationship has also been reported by Gopala Krishna *et al.*, 1982, Tejpal 1987, Viraktamath 1987 and Malik 1989. During polishing, there is a constant friction among the kernels and thus genotypes with long slender grains are more prone to breakage than those possessing short bold grains. Negative significant association of kernel length with kernel breadth in the present study indicates that grain length and slenderness are inherited independently resulting in long slender grain types.

Positive significant association of water uptake with alkali spreading value indicates that genotypes with high water uptake had low gelatinization temperature which is in accordance with the results of Tomar and Nanda (1982), Tomar and Nanda (1987), Chauhan *et al.*, (1995) and Choi *et al.*, (1999). The study also showed positive but non-significant correlation of gel consistency with amylose content indicating that higher amylose content may lead to the recovery of genotypes with soft gel consistency. This knowledge on the association of various quality traits would serve as a guideline for careful choice of parents for development of hybrids with better quality.

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