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COMBINING ABILITY ANALYSIS OF THE PHOTO-THERMOSENSETIVE GENIC MALE STERILITY LINES (PTGMS) OF JAPONICA RICE.

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ABSTRACT

Combining ability and genetic parameters analysis for agronomic, yield and its component characters were carried out in rice through line x tester analysis of 20 hybrid rice combinations developed by crossing four Photo-Thermosensitive Genic Male Sterility (PTGMS) lines (females) with five male lines / varieties along with parents and check. The 20 hybrids with nine parents were grown in a randomized complete block design with three replications. The experiments were conducted at RRTC in 2010 and 2011growing seasons. Data analysis of variance for combining ability revealed a significant differences among PTGMS lines for plant height, panicle length, panicle weight and filled grains panicle^{-1}, indicating the importance of additive genetic variance in the inheritance of these characters. The mean squares due to female PTGMS lines were found non-significant for days to heading, tillers plant^{-1}, spikelet fertility%, 100-grain weight and grain yield characters, indicating the prevalence of non-additive genetic variance and suggesting the importance of heterosis breeding for improvement of rice. An overall appraised of GCA effects revealed that among females; PTGMS-80 and PTGMS-51 had a good general combiners for most characters. Among PTGMS and the tester lines, PTGMS-80 and the tester line JRL-252 had favorable genes for grain yield and the most of desirable characters under study.

The hybrid combinations PTGMS-80 x JRL-252 followed by PTGMS-51 x Giza 177 were the best specific hybrid combinations which have significant values for grain yield with desirable characters.

Keywords: Hybrid Rice, Photo-Thermosensitive Genic Male Sterility (PTGMS), GCA, SCA, Genetic Parameters.

INTRODUCTION

Hybrid rice technology is one such innovative breakthrough that can further increase rice production leading to food security and reduction of poverty in Egypt. Hybrid rice varieties can out yield conventional cultivars by at least 15% under the same input levels. Hence, this technology can be used to break the current yield plateau in rice, where yield levels of the conventional cultivars released have stabilized (El-Mowafi *et al.*, 2005).

Combining ability analysis is one of the powerful tool available to estimate the combining ability effects and aids in selecting the desirable parents and hybrids for the exploitation of heterosis (Sarker *et al.*, 2002, Rashid *et al.*, 2007 and Bagheri and Jelodar 2010). The study of combining ability is of great significance for hybrid breeding program. It may be easier to obtain strong heterosis by testing of SCA effects when GCA effects have been tested.

The aim of the present study is to estimate combining ability for yield and its components in F_1 hybrids developed using four Photo-Thermosensitive Genic Male Sterility (PTGMS) lines and five Egyptian Indica and Japonica restorer lines.

MATERIALS AND METHODS

Four Photo-Thermosensetive Genic Male Sterility (PTGMS) Viz., PTGMS-51, PTGMS-56, PTGMS-62 and PTGMS-80 were crossed with five elite lines/varieties; Giza 177R, Giza 182R, JRL-95, JRL-97 and JRL-252 (Table 1) were to generate 20 hybrid combinations in line x tester mating design. Hybrids were evaluated along with parents in a randomized complete block design with three replications at Rice Research and Training Center (RRTC) during 2010 and 2011 seasons. Thirty-day old seedlings were transplanted in 5 m. long, 20 cm apart 20cm spaced and one seedling hill^{-1}. Each test entry consisted of three rows of 5m length.

Table 1: Photo-Thermosensitive Genic Male Sterility lines(PTGMS) and tester lines/varieties used for the experiment.

Genotypes	Source	Characters
PTGMS lines (female)	cross breeding Nongken 58s/Sakha101 then acquired by anther culture and selected by El-mowafi, 1999.	
PTGMS-51		Japonica type
PTGMS-56		Japonica type
PTGMS-62		Japonica type
PTGMS-80		Japonica type
Tester lines (male) Giza 177R	Egypt (Giza 171/yoni no.1//Pi no.4)	Japonica type, early maturing, semi dwarf, short grain, resistance to blast
Giza 182R	Egypt (Giza 181/IR39422-163-1-2//Giza181)	Indica type, early maturing, semi dwarf, long grain, resistance to blast
JRL-95	Cross breeding China – Egypt collaboration then selection.	Prospective restoreres and maintainer for hybrid rice breeding materials.
JRL-97		
JRL-252		

Observations were recorded on five plants plant^{-1} taken at random from each entry in each replication for five agronomic traits (days to heading, plant height, tillers plant^{-1}, panicle length and primary branches panicle^{-1}) and five yield and its components characters (grain yield plant^{-1} , 100-grain weight (g), spikelet fertility% , panicle weight (g) and filled grains panicle^{-1}). Five individual plants were harvested from each entry in each replication to determine grain yield plant^{-1}.

Combining ability analysis was carried out as suggested by Kempthorne model (1957) for random lines representing certain population.

RESULTS AND DISCUSSION

Analysis of variance and genetic parameters :-

Analysis of variance showed that effects of genotypes, parents and hybrids were highly significant for all studied characters (Table 2). Parents vs hybrids mean square indicated that average heterosis was significant in all hybrid combinations for all studied characters under this study.

Analysis of variance for combining ability given in Table (2) revealed significant differences among PTGMS lines for plant height, panicle length, panicle weight and filled grains panicle^{-1}, indicating the importance of additive variance in the inheritance of these characters. On the other hand, the mean squares due to female lines (PTGMS) were found non-significant for days to heading, tillers plant^{-1}, primary branches panicle^{-1} , spikelet fertility %, 100-grain weight and grain yield plant^{-1} characters. Thus, suggesting the importance of heterosis breeding for rice improvement. However, non-significance of the mean squares was due to PTGMS lines indicates the prevalence of non-additive genetic variance (Singh and Kumar, 2004; El-Mowafi *et al.,* 2005 and Bagheri and Jelodar, 2011). The testers exhibited highly significant differences for all traits. Significant and highly significant mean squares of lines x testers for all characters except panicle length character, indicated that they interacted and produced markedly different combining ability effects and this might be due to the wide genetic diversity of lines and testers (El-Mowafi *et al.*, 2005).

Variance estimated due to GCA was higher than that of SCA for days to heading, plant height, panicle length, primary branches panicle^{-1}and spikelet fertility % suggesting that greater importance of additive genetic variance which agreed with the results of El-Mowafi *et al.,*(2003), El-Mowafi *et al.* (2005), Abd El-Hadi and El-Mowafi (2005).

The estimates of genetic parameters for the agronomic and yield and its components characters (Table 3) revealed that the additive variance (σ^2 A) and relative importance of GCA% for days to heading, plant height, panicle length, primary branches panicle^{-1}, panicle weight, filled grains panicle, 100-grain weight and spikelet fertility %, were greater than dominace variance (σ^2 D) and relative importance of SCA% for these characters. these results indicate that the former characters were largely governed by additive gene action. The importance of the additive gene action for the inheritance of these characters as agreed with findings of Singh and Kumar (2004) El-Mowafi *et al.,* (2005) Bagheri and Jelodar (2011). Both GCA and SCA genetic variance were important for the inheritance of tillers plant^{-1}. It further revealed the importance of additive and non-additive types of gene action. High estimates of dominance genetic variance and its relative magnitude of SCA% were found to be more than those of the additive genetic variance for grain yield plant^{-1}, which is in collaboration with earlier findings of Vanaja *et al.* (2003), Anand kumar *et al.* (2004) and Saravanan *et al.* (2006).

Heritability estimates in broad sense were high for all agronomic and yield characters except primary branches panicle^{-1} which showed moderate indicating that most of phenotypic variability in each character was due to genetic factors affecting those traits.

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Narrow sense heritability estimates were high for days to heading, plant height, panicle length, panicle weight, filled grains panicle^{-1} and spikelet fertility%. While, were low for tillers plant^{-1}, 100-grain weight and grain yield plant^{-1}, this suggested that a major part of the total phenotypic variance for the first characters was due to additive genetic variance while for the second characters indicated that a major part of the total phenotypic variance for these characters was due to dominance genetic variance and environmental effects. These results in general agreement with those reported by El-Mowafi *et al.* (2005) and Mirarab *et al.* (2011).

General Combining Ability (GCA) Effects:-

GCA effects for different characters are given in Table (4). The estimates of GCA effects showed that parental lines with high GCA effects differed for various traits. None of PTGMS lines were found to be significant or good combiners for days to heading, primary branches panicle^{-1} and spikelets fertility% characters. Among the PTGMS lines, PTGMS-80 had favorable genes for grain yield plant^{-1} and other traits including days to heading (earliness), plant height (dwarfiness), tillers plant^{-1}, filled grains panicle^{-1} and panicle weight. PTGMS-51 was the best combiner for panicle length, panicle weight and filled grains panicle^{-1}. PTGMS-56 was the best combiner for 100-grain weight and spikelet fertility%. An overall appraisal of GCA effects (Table 4) revealed that females of PTGMS-80 and PTGMS-51 were the good general combiners for most studied characters. Among the testers or restorer lines (Table 4), JRL-252 possessed the desirable genes for grain yield plant^{-1} , plant height (dwarfiness), tillers plant^{-1}, panicle weight, filled grains panicle^{-1}, 100-grain weight and spikelet fertility%, whereas JRL-97 for days to heading (earliness), plant height (dwarfiness), primary branches panicle^{-1}, panicle weight, filled grains panicle^{-1}, 100-grain weight and spikelet fertility%. Giza 177 was the best general combiner for earliness and good combiner for dwarfiness and spikelet fertility%. Giza 182 was best combiner for panicle length and good combiner for tillers plant^{-1} and grain yield plant^{-1}. While, JRL-95 was best general combiner for primary branches panicle^{-1} and spikelet fertility% and good combiner for days to heading (earliness), plant height (dwarfiness), panicle weight and filled grains panicle^{1}.

According to the kind of breeding objective , it is possible to use parents with a high positive or negative GCA in breeding programs. For example, parents which have a high positive GCA for grain yield plant^{-1}, tilles plant^{-1}, panicle length, primary branches panicle^{-1}, panicle weight, filled grains panicle^{-1}, 100-grain weight and spikelet fertility% could be used in breeding programs. While for days to heading (earliness) and plant height (dwarfiness), parents with high negative GCA could be used.

Specific Combining Ability (SCA) Effects:

The data of the SCA effects were calculated for the 20 F_1 hybrid rice combinations for agronomic and yield characters and the results are given in Table (5).

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The results indicated that there are some superior combinations with respect to days to heading, plant height, tillers plant^{-1} and panicle length three, four, five and one hybrid combinations showed significant effects in the desired direction for the previous four agronomic characters, respectively. In the same time all hybrids showed insignificant for primary branches panicle^{-1}. For yield characters, two hybrids for panicle weight, four hybrid combinations for filled grains panicle^{-1}, six hybrids for 100-grain weight, one hybrid combination for spikelet fertility% and seven hybrid combinations for grain yield plant^{-1} were superior in SCA effects. The hybrid combination PTGMS-80 x JRL-252 was the best specific hybrid combination for the highest and significant for grain yield with desirable characters for tillers plant^{-1}, panicle weight and filled grains panicle^{-1}. The hybrid PTGMS-51 x Giza 177 for grain yield plant^{-1}, days to heading (earliness), tillers plant^{-1}, panicle length, panicle weight and filled grains panicle^{-1}. PTGMS-62 x Giza 182 for grains yield plant^{-1}, tillers plant^{-1} and filled grains panicle^{-1}. It was followed by PTGMS-56 x JRL-97 for grain yield plant^{-1} and filled grains panicle^{-1}.

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تحليل القدرة علي التوافق للسلالات العقيمة ذكريا نتيجة الحساسية للفترة الضوئية ودرجة الحرارة (PTGMS) في الأرز الياباني

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تم تقييم القدرة علي الإئتلاف والمكونات الوراثية المختلفة للصفات الحقلية والمحصولية في الأرز من خلال تحليل السلالة x الكشاف لعشرون هجين من الأرز ناتجة من تهجين أربعة سلالات عقيمة الذكر (PTGMS) مع خمسة سلالات وأصناف. تم زراعة الهجن والآباء في تصميم قطاعات كاملة العشوائية في ثلاثة مكررات. وقد تمت هذه التجارب في مركز البحوث والتدريب في الأرز خلال مواسم النمو 2010 ، 2011. أوضح تحليل التباين للقدرة علي الإئتلاف وجود فروق معنويه بين السلالات العقيمة لكل من صفات طول النبات ، طول الدالية، وزن الدالية و عدد الحبوب الممتلئة في الدالية والتي أوضحت أهمية التباين المضيف في توارث هذه الصفات. وقد أوضحت نتائج تحليل متوسط المربعات للسلالات العقيمة عدم وجود فروق معنوية لصفات عدد الأيام حتي التزهير،عدد الفروع للنبات ، النسبة المئوية لخصوبة السنيبلات ، وزن المائة حبة و صفات المحصول مما يشير الي اهمية التباين غير المضيف والتوصية باستغلال ظاهرة قوة الهجين في تربية وتحسين صفات المحصول في الأرز.

أظهرت النتائج أنه من بين السلالات العقيمة الذكر والمستخدمة كأمهات كانت السلالة (PTGMS-80) والسلالة (PTGMS-51) لها قدرة عامة علي التآلف لمعظم الصفات محل الدراسة. وبصفة عامة كانت السلالة PTGMS-80 من السلالات عقيمة الذكر والمستخدمة كأم والسلالة JRL-252 من السلالات المستخدمة كأب كانتا لهما دور كبير في تحسين محصول الحبوب وبعض الصفات الأخري. كما أظهرت النتائج أن الهجين PTGMS-80 x JRL-252 متبوعا بالهجين PTGMS-51 x Giza 177 كانا لهما قدرة خاصة علي التآلف عالية ومعنوية لصفة محصول الحبوب وبعض الصفات المفضلة.

قام بتحكيم البحث

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Table 2: Mean square estimates of line x tester analysis for agronomic, yield and its component characters.

S.O.V	d. f.	Agronomic characters					Yield and its component characters				
		HDG (day)	Ht (cm)	Ti/P	PnL (cm)	PB/Pn	Yld/P (g)	100-GW (g)	SpFrt%	PnW (g)	FG/Pn
Replications	2	12.986	0.354	16.250	0.525	1.569	170.166	0.004	45.397	0.153	53.705
Genotypes	28	73.494**	388.949**	113.402**	17.208**	12.447**	1289.457**	0.074**	948.293**	3.906**	5597.857**
Parents	8	130.572**	260.703**	33.130**	39.764**	16.821**	214.191**	0.052**	148.629**	1.907**	3346.594**
crosses	19	52.852**	228.808**	143.564**	8.493**	7.136**	1446.133**	0.063**	1228.640**	3.494**	5111.933**
Parents vs. crosses	1	9.076*	4457.601**	182.490**	2.340*	78.381**	6914.740**	0.449**	2019.009**	27.724**	32840.524**
Females (Lines)	3	0.728	102.506**	30.526	3.112**	1.104	870.806	0.024	38.609	2.168**	2290.878**
Males (Testers)	4	225.317**	941.171**	417.371**	35.965**	26.858**	3809.125**	0.180**	5662.034**	14.430**	21332.298**
Females × Males (F × M)	12	8.394**	22.929**	80.554**	0.680	2.069*	802.301**	0.034**	48.350*	0.181*	410.409**
Error	56	2.018	5.412	6.577	0.464	0.841	36.741	0.007	24.970	0.077	76.004
CV %		1.38	2.17	11.48	3.69	6.20	9.00	3.13	6.35	6.38	5.86

Days to Heading (HDG), Plant Hieght(Ht), Tillers Plant^{-1} (Ti/P), Panicle Length (PnL), Primary Branches Panicle^{-1} (PB/Pn), Grain Yield Plant^{-1} (Yld/P), 100-Grain Weight (100-GW), Spikelet Fertility% (SpFrt%), Panicle weight (PnW), Filled Grains Panicle^{-1} (FG/Pn).
*** , ** Significant at 0.05 and 0.01 levels, respectively.**

Table 3: Genetic parameters for agronomic, yield and its components characters.

Genetic Parameters	Agronomic characters					Yield and its component characters				
	HDG (day)	Ht (cm)	Ti/P	PnL (cm)	PB/Pn	Yld/P (g)	100-GW (g)	SpFrt%	PnW (g)	FG/Pn
Additive variance (σ^2 A)	17.566	81.825	24.733	3.103	2.001	255.136	0.012	467.158	1.320	1868.855
Dominant variance (σ^2 D)	2.125	5.839	24.659	0.072	0.409	255.187	0.009	7.793	0.035	111.468
Environmental variance (σ^2 E)	2.018	5.412	6.577	0.464	0.841	36.741	0.007	24.970	0.077	76.004
Genotypic variance (σ^2 G)	19.691	87.664	49.392	3.175	2.411	510.322	0.021	474.951	1.355	1980.324
Phenotypic variance (σ^2 P)	21.709	93.076	55.969	3.639	3.252	547.063	0.028	499.921	1.432	2056.328
Broad sense heritability (h_2b) %	90.704	94.185	88.249	87.248	74.137	93.284	74.545	95.005	94.621	96.304
Narrow sense heritability (h_2n) %	80.914	87.912	44.190	85.269	61.549	46.637	41.818	93.446	92.200	90.883
Relative importance of gca %	89.207	93.339	50.075	97.732	83.020	49.995	56.098	98.359	97.441	94.371
Relative importance of sca %	10.793	6.661	49.925	2.268	16.980	50.005	43.902	1.641	2.559	5.629

Days to Heading (HDG), Plant Hieght(Ht), Tillers Plant^{-1} (Ti/P), Panicle Length (PnL), Primary Branches Panicle^{-1} (PB/Pn), Grain Yield Plant^{-1} (Yld/P), 100-Grain Weight (100-GW), Spikelet Fertility% (SpFrt%), Panicle weight (PnW), Filled Grains Panicle^{-1} (FG/Pn).

Table 4: Estimates of GCA effects of the PTGMS and their Tester lines for agronomic, yield and its component characters.

Genotype	Agronomic characters					Yield and its component characters				
	HDG (day)	Ht (cm)	Ti/P	PnL (cm)	PB/Pn	Yld/P (g)	100-GW (g)	SpFrt%	PnW (g)	FG/Pn
Female (Lines)										
PTGMS- 51	0.250	2.483**	-0.308	0.450**	0.175	0.957	-0.048*	0.813	0.268**	12.067**
PTGMS- 56	-0.017	1.217*	0.558	0.030	-0.058	0.743	0.049*	1.690	0.103	1.233
PTGMS- 62	0.050	-0.117	-1.808**	-0.630**	-0.358	-10.103**	-0.008	-1.984	-0.561**	-17.200**
PTGMS- 80	-0.283	-3.583**	1.558*	0.149	0.242	8.403**	0.007	-0.519	0.190**	3.900*
LSD 5 %	**0.734**	**1.201**	**1.324**	**0.352**	**0.474**	**3.130**	**0.043**	**2.580**	**0.143**	**4.502**
1 %	**0.976**	**1.598**	**1.761**	**0.468**	**0.630**	**4.163**	**0.057**	**3.432**	**0.191**	**5.988**
Male (Tester)										
Giza 177 R	-3.283**	-4.242**	-6.642**	-0.367*	-1.342**	-24.407**	-0.122**	6.584**	-0.640**	-13.817**
Giza 182 R	6.867**	15.800**	9.108**	2.900	-1.342**	10.852**	-0.090**	-38.714**	-1.440**	-66.983**
JRL- 95	-1.883**	-3.992**	-2.933**	-1.338	1.617**	-9.565**	-0.032	11.220**	0.410**	19.475**
JRL- 97	-3.217**	-4.658**	-1.058	-1.284	1.575**	1.623	0.066**	11.075**	0.216**	21.350**
JRL- 252	1.617**	-2.908**	1.525*	0.090	-0.508*	21.498**	0.178**	9.835**	1.454**	39.975**
LSD 5%	**0.820**	**1.343**	**1.481**	**0.393**	**0.529**	**3.500**	**0.048**	**2.885**	**0.160**	**5.033**
1%	**1.091**	**1.786**	**1.969**	**0.523**	**0.704**	**4.654**	**0.064**	**3.837**	**0.213**	**6.694**

Days to Heading (HDG), Plant Hieght(Ht), Tillers Plant^{-1} (Ti/P), Panicle Length (PnL), Primary Branches Panicle^{-1} (PB/Pn), Grain Yield Plant^{-1} (Yld/P), 100-Grain Weight (100-GW), Spikelet Fertility% (SpFrt%), Panicle weight (PnW), Filled Grains Panicle^{-1} (FG/Pn).
*** , ** Significant at 0.05 and 0.01 levels, respectively.**

Table 5: Estimates of SCA effects of the 20 hybrid combinations for agronomic, yield and its component characters.

Hybrid combinations	Agronomic characters						Yield and its component characters				
	HDG (day)	Ht (cm)	Ti/P	PnL (cm)	PB/Pn		Yld/P (g)	100-GW (g)	SpFrt%	PnW (g)	FG/Pn
PTGMS- 51 x Giza 177	-2.417**	1.975	7.308**	0.837*	0.242		12.993**	-0.140**	-4.330	0.335*	10.683*
PTGMS- 51 x Giza 182	1.333	-2.900*	-3.608**	0.404	-0.425		8.252*	-0.033	5.385*	0.152	4.517
PTGMS- 51 x JRL- 95	1.417*	-1.775	-3.233*	-0.525	0.783		-3.915	-0.040	-3.289	-0.082	-0.275
PTGMS- 51 x JRL- 97	1.417*	-0.108	-2.275	-0.096	-0.842		-18.519**	0.093*	1.027	-0.117	-4.150
PTGMS- 51 x JRL- 252	-1.750*	2.808*	1.808	-0.620	0.242		1.189	0.120**	1.207	-0.288*	-10.775*
PTGMS- 56 x Giza 177	0.183	-2.758*	-2.058	-0.426	-0.358		8.140*	0.124**	0.290	0.064	-11.817*
PTGMS- 56 x Giza 182	0.600	1.033	0.525	0.074	-0.025		-0.202	0.112*	0.201	0.057	3.517
PTGMS- 56 x JRL- 95	-0.317	4.492**	6.567**	0.478	0.517		4.798	-0.076	0.108	-0.106	3.558
PTGMS- 56 x JRL- 97	-0.317	-0.175	0.525	-0.176	0.392		11.944**	-0.064	2.153	0.065	11.017*
PTGMS- 56 x JRL- 252	-0.150	-2.592*	-5.558**	0.051	-0.525		-24.681**	-0.096*	-2.751	-0.080	-6.275
PTGMS- 62 x Giza 177	-0.883	-1.925	-6.025**	-0.133	0.275		-16.497**	-0.070	3.284	-0.166	4.117
PTGMS- 62 x Giza 182	-0.800	1.700	7.058**	-0.350	0.608		12.062**	-0.103*	0.718	0.111	9.450*
PTGMS- 62 x JRL- 95	0.283	-2.675*	-3.067*	-0.112	-2.017**		7.062*	0.100*	3.172	0.208	1.992
PTGMS- 62 x JRL- 97	-0.383	2.492*	3.558**	0.467	0.692		1.624	0.033	-6.477*	-0.211	-14.050**
PTGMS- 62 x JRL- 252	1.783*	0.408	-1.525	0.127	0.442		-4.251	0.040	-0.697	0.058	-1.508
PTGMS- 80 x Giza 177	3.117**	2.708*	0.775	-0.278	-0.158		-4.637	0.086*	0.755	-0.234	-2.983
PTGMS- 80 x Giza 182	-1.133	0.167	-3.975**	-0.128	-0.158		-20.112**	0.024	-6.304	-0.320*	-17.483**
PTGMS- 80 x JRL- 95	-1.383*	-0.042	-0.267	0.159	0.717		-7.945*	0.016	0.010	-0.020	-5.275
PTGMS- 80 x JRL- 97	-0.717	-2.208	-1.808	-0.195	-0.242		4.951	-0.062	3.298	0.264	7.183
PTGMS- 80 x JRL- 252	0.117	-0.625	5.275**	0.442	-0.158		27.743**	-0.064	2.241	0.310*	18.558**
LSD 5%	**1.370**	**2.244**	**2.474**	**0.657**	**0.885**		**5.848**	**0.081**	**4.821**	**0.268**	**8.411**
1%	**1.960**	**3.210**	**3.539**	**0.940**	**1.265**		**8.364**	**0.115**	**6.895**	**0.383**	**12.030**

Days to Heading (HDG), Plant Hieght(Ht), Tillers Plant^{-1} (Ti/P), Panicle Length (PnL), Primary Branches Panicle^{-1} (PB/Pn), Grain Yield Plant^{-1} (Yld/P), 100-Grain Weight (100-GW), Spikelet Fertility% (SpFrt%), Panicle weight (PnW), Filled Grains Panicle^{-1} (FG/Pn).
*** , ** Significant at 0.05 and 0.01 levels, respectively.**