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Genetic Variability, Correlation and Path Analysis of Floral, Yield and its Component Traits of Maintainer Lines of Rice (*Oryza sativa* L.)

M S Hossain[1*], N A Ivy[1], M S Raihan[1], E Kayesh[2], S Maniruzzaman[3]

ABSTRACT

Direct selection based on crop yields is paradox in breeding programmes because of its complex polygenically inherited character, which is influenced by its component traits. A field experiment was conducted to establish the extent of association between yield and yield components and other characters in maintainer lines of rice. Analysis of variance revealed that significant amount of genetic variability was present in the entire characters studied except grain length, grain width and flag leaf breadth. High heritability coupled with high genetic advance as percent of mean was observed for number of tillers per hill, number of panicles per plant, number of grains per panicle, 1000-grain weight (TGW), filled grains per panicle, flag leaf length, stigma breadth, filament length suggesting preponderance of additive gene action in the expression of these characters. The correlation coefficient between grain yield per plant and other quantitative characters attributing to yield showed that grain yield was significantly and positively associated with number of grains per panicle, TGW, spikelet fertility, filament length and pollen fertility at both genotypic and phenotypic levels. Path coefficient at genotypic level revealed that panicle length, number of effective tillers/plant, number of grains per panicle, TGW, filled grains per panicle, spikelet fertility, stigma length, stigma breadth, filament length and pollen fertility had direct positive effect on grain yield indicating importance of these parameters as the main contributors to yield. Thus, a genotype with higher extent of these traits could be selected as parents from existing genotypes for genetic improvement of yield in hybrid rice.

Key words: Rice, variability, heritability, correlation, path analysis.

INTRODUCTION

Rice is the most important staple food crop in the world which is used by more than half of the world population (Kohnaki *et al.* 2013). For growing population, the basic objective of the plant breeders always be towards yield improvement in staple food crops. It is anticipated that the world will have to produce 60% more rice by 2030 than that is produced in 1995 (Babu *et al.* 2012). Hence, an increase in the production of rice plays an important role in the food security and poverty alleviation.

It is known that yield of rice is complex quantitative trait and under pleiotropic gene control at the same time it is highly influenced by environment and contributed by many other traits. Furthermore, selection based on only yield may be misleading in some cases. Evidence on association of characters, direct and indirect effects added by each character towards yield will be more fruitful in aiding the selection process. A defined knowledge of the genotypes and scope of correlated response to selection for yield and yield attributes would be greatly helpful in planning a systematic breeding programme in situation of this kind. High scale of variability in a population provides the opportunity for selection to develop a variety having desirable characters.

The present investigation was undertaken in this context to elucidate information on variability, heritability, genetic advance, character associations and path of these parameters towards yield and

[1]Department of Genetics and Plant Breeding, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh. [2]Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh. [3]Plant Breeding Division, Bangladesh Rice Research Institute, Gazipur, Bangladesh.
*Corresponding author's E-mail: skmonir85@yahoo.com

to identify superior maintainer line in respect of various floral and yield contributing traits.

MATERIALS AND METHODS

Five maintainer lines were grown in a randomized complete block design with three replications at the experimental field of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur located at centre of Madhupur Tract (24°29 N latitude and 90°26 E longitude) having an altitude of 8.2m from the sea level (Anonymous, 1989) during *Aman,* 20018-19.

There are three blocks in the experimental fields. Seedlings of each line were raised in bed and 30-day-old seedlings were transplanted in the experimental plots. Transplanting was done with two to three seedlings per hill maintaining row to row spacing of 20 cm and plant to plant spacing of 15 cm. Proper soil fertility were maintained by applying urea-TSP-MoP-gypsum-$ZnSO_4$ @ 150:100:70:60:10 kg/ha respectively. Entire TSP, MoP, Gypsum and $ZnSO_4$ were applied during final land preparation. The urea was applied in three installments, at 15 days after transplanting (DAT), 30 and 45 DAT. Five sample plants were randomly selected from each plot excluding the border plants for recording traits *viz* Days to 50% flowering, days to maturity, flag leaf length (cm), flag leaf width (cm), plant height (cm), panicle length (cm), number of tillers per plant, number of panicles per plant, number of grains per panicle,1000 grain weight (g), filled grains per panicle, grain length (mm), grain width (mm), yield per hill (g), anther length (µm), anther breadth (µm), stigma length (µm), stigma breath (µm), filament length (µm), pollen sterility%, spikelet fertility%. Anther, stigma and filament length, breadth was measured with microscope using ocular micrometer (level 1) before anthesis. The data on quantitative characters were statistically evaluated on the basis of model designated by Cochran and Cox (1950) for Randomized Complete Block Design. In order to test the significance of treatments critical difference was calculated (Fisher and Yates, 1963). Phenotypic and genotypic coefficients of variation (PCV and GCV) were analyzed according to Burton (1952) and categorized according to Siva Subramanian and Menon (1973). Heritability in broad sense and genetic advance were calculated according to methods specified by Allard (1960) and categorized according to Johnson *et al.* (1955). Correlation coefficients were calculated for all quantitative character combinations at phenotypic, genotypic and environmental level by the formula set by Miller *et al.,* (1958). Path coefficient analysis proposed by Wright (1921) and explained by Dewey and Lu (1959) was used to analyze the direct and indirect impact of various traits to yield.

RESULTS AND DISCUSSION

Tables 1a and 1b furnish the analysis of variance studied for 21 characters. The analysis of variance revealed significant differences for all the characters (except grain length, grain breadth, flag leaf width) indicating the existence of sufficient variation among the genotypes for yield and yield component characters considered in the present investigation and therefore, there is an opportunity for effective selection.

GENETIC VARIABILITY

Tables 2a, 2b and 3 furnish the information on mean, range, PCV, GCV, heritability, and genetic advance in percent of mean for yield and yield component traits. A perusal of these results revealed maximum range of variability for number of panicle per plant followed by number of tiller per hill and yield (Table 3). Higher phenotypic coefficients of variation, compared to Genotypic coefficients of variation were noted for all the character studied in the present investigation,

Table 1a. Analysis of variance for maintainer lines.

Source of variation	d.f	50 % F	DM T	PH (cm)	PL (cm)	NT/H	NP/P	NG/P	GW (mm)	GL (mm)	Filled	Yield/hill (g)
Replication	2	0.0	0.00 0	8.867	0.569	0.600	2.467	2.467	0.056	4.433	5.267	0.936
Genotype	4	16. 5**	179. 1**	103.66 7**	6.148* *	94.267 **	84.833* *	4462.83 **	0.112 NS	1.846N S	2826.9 **	34.9**
Error	8	0.0	0.00 0	0.367	0.38	3.267	1.633	1.633	0.040	5.813	0.933	0.783

50% F = Days to 50% flowering, DMT = Days to maturity, PH = Plant height (cm), PL = Panicle length (cm), NT/H = Number of tillers per hill,, NP/P = Number of panicles per plant, NG/P = Number of grains per panicle, GL= Grain length (mm), GW = Grain width (mm), d.f= Degrees of freedom.

Table 1b. Analysis of variance for maintainer lines.

Source of variation	d.f	FLL (cm)	FLW (cm)	TGW (gm)	AL (µm)	AB (µm)	SL (µm)	SB (µm)	FL (µm)	PS (%)	SF (%)
Replication (B)	2	7.945	0.057	2.435	7.117	0.050	0.050	1.190	12.067	0.001	1.403
Genotype (B)	4	49.64 0**	0.147 NS	12.77**	3658. 40**	522.8 33**	189.54 2**	573.7 09**	73679.4 4**	5.40**	78.52* *
Error (B)	8	0.522	0.081	0.622	4.700	4.883	5.342	3.210	15.942	0.001	1.543

FLL = Flag leaf length (cm), FLW = Flag leaf width (cm), TGW = 1000 grain weight (g), A = Anther length (µm), AB = Anther breadth (µm), SL= Stigma length (µm), SB= Stigma breadth (µm), FL= Filament length (µm), PS= Pollen sterility%, SF= Spikelet fertility%, * = Significant at the 5% level, ** = Significant at the 1% level, d.f = Degrees of freedom.

Table 2a. Mean performance of 5 maintainer lines for 30 characters in rice (*Oryza sativa* L.).

Character	1	2	3	4	5	6	7	8	9
Maintainer line (B line)	50% F	DMT	PH	PL	NT/H	NP/P	NG/P	TGW	Filled grains/ panicle
Ghan46B	64.00 d	89.00 c	86.33 a	23.73 a	12.67 b	12.00 c	195.7 a	18.14 a	155.7 a
BRRI 1B	70.00 a	92.00 a	81.33 c	22.36 b	14.67 b	14.67 b	158.3 c	13.67 c	139.0 b
IR 68B	65.00 c	75.00 e	84.00 b	21.42 b	15.33 b	12.33 bc	132.0 d	14.66 bc	100.3 d
IR 62B	66.00 b	78.00 d	72.67 d	22.87 c	26.67 a	24.67 a	94.00 e	15.50 b	79.00 e
IR 58B	65.00 c	89.00 b	87.33 a	22.44 b	14.67 b	13.00 bc	168.3 b	18.23 a	128.3 c
Mean	66.53	85.26	82.33	21.96	16.80	15.33	149.66	16.03	120.46
CV	.47	.37	.73	2.80	10.75	8.33	0.85	4.91	.80
CD (5 %)	.59	.59	1.14	1.16	3.24	2.41	2.41	1.48	1.82
S.E	.18	.18	.34	.35	1.04	.73	.73	.45	.55

50% F = Days to 50% flowering, DMT = Days to maturity, PH= Plant height (cm), PL= Panicle length (cm), NT/H = Number of tillers per hill, NP/P = Number of panicles per plant, NG/P = Number of grains per panicle, TGW = 1000 grain weight (g). Mean values having common letters are not significantly different from each other.

Table 2b. Mean performance of 5 maintainer lines for 30 characters in rice (*Oryza sativa* L.).

Character	10	11	12	13	14	15	16	17	18
Maintainer line (B line)	FLL	AL (µm)	AB (µm)	SL (µm)	SB (µm)	FL (µm)	PS (%)	SF (%)	Yield/hill (gm)
Ghan46B	25.54 c	443.2 a	96.33 b	191.5 ab	84.19 a	667.2 b	98.00 a	79.56 c	34.98 a
BRRI 1B	20.94 d	407.0 c	69.67 d	273.7 c	83.67 a	453.7 d	97.00 b	87.79 a	30.80 c
IR 68B	24.06 b	417.0 b	98.50 ab	192.5 a	65.00 c	363.7 e	95.00 c	76.02 d	26.11 d
IR 62B	22.61 bc	397.7 d	82.33 c	192.0 ab	72.17 b	750.0 a	97.00 b	84.06 b	33.57 ab
IR 58B	35.19 a	407.0 b	100.7 a	187.8 b	51.17 d	526.8 c	95.00 c	76.24 d	32.28 bc
Mean	28.86	402.56	89.50	187.50	71.23	552.26	97.73	80.73	31.54
CV	2.50	.53	2.46	1.23	2.51	0.72	0.45	1.72	2.80
CD (%)	1.36	4.08	4.16	4.35	3.37	7.53	0.84	2.62	1.66
S.E	0.41	1.25	1.27	1.33	1.03	2.30	0.25	.80	.51

FLL = Flag leaf length (cm), AL = Anther length (µm), AB = Anther breadth (µm), SL = Stigma length (µm), SB= Stigma breadth (µm), FL= Filament length (µm), PS = Pollen sterility%, SF = Spikelet fertility% Mean values having common letters are not significantly different from each other.

indicating the influence of environment. Similar findings were stated by Mamta Singh et al. (2007). However, high (>20%) phenotypic co-efficient of variation for number of tillers per hill, number of panicles per plant, number of grains per panicle, filled grains/panicle, filament length and grain yield/hill in the present research was noted to be closely and essentially related with high genotypic co-efficient of variation for the trait, indicating the negligible influence of environment and existence of high genetic variability for the trait in the experimental material. Hence, selection on the basis of phenotype in these genotypes can be effective for improvement of grain yield. Similar results were described earlier by Mishra and Verma (2002) and Hasib et al. (2004). However, moderate (10-20%) genotypic and phenotypic coefficients of variation were recorded in the present study for flag leaf length, anther breadth, stigma breadth and TGW. These results are similar with the findings of Bornane et al. (2014) for TGW. In contrast, low (<10%) estimates of genotypic and phenotypic coefficients of variation were observed in the present study for days to 50% flowering, days to maturity, plant height, panicle length, anther length, stigma length, pollen fertility and spikelet fertility indicating low variability for these characters in the present experimental material and therefore, there is little scope for improvement of these traits. Similar findings were reported earlier by Satish *et al.* (2003) for plant height.

Heritability estimates in broad sense (h2b) were relatively higher (>60%) for almost all the traits studied. Iftekharuddaula *et al.*, (2001) stated similar result in hybrid rice. High heritability evaluations have been found to be helpful in making selection of superior

genotypes on the basis of phenotypic performance.

High heritability coupled with high genetic advance as percent meanwas recorded for number of tillers per hill, number of panicles per plant, number of grains per panicle, TGW, filled grains/panicle, flag leaf length, stigma breadth, filament length and grain yield per plant indicating that the high heritability observed is due to additive gene effects and selection may be effective for these characters. Similar findings were observed by Adilakshmi and Girijarani (2012) for TGW and Madhavilatha *et al.* (2005) for yield per plant. On contrary, high heritability coupled with moderate genetic advance in percent of mean was observed for plant height, panicle length, anther length indicating the role of both additive and non-additive gene effects for controlling the characters. The results are similar with the reports of Seyoum *et al.* (2012). Further, information on genetic variation along with heritability and genetic advance assessments has been informed to give a better idea about the efficiency of selection (Burton, 1952). In the present study, high GCV and PCV coupled with high heritability and high genetic advance in percent of mean were observed for number of tillers per hill, number of panicles per plant, number of grains per panicle, grain yield per plant indicating the preponderance of additive gene action and therefore, there is scope for improvement of the trait through selection. Similar results were given earlier by Mohana Krishna *et al.* (2009).

Table 3. Mean, range, genetic variability, heritability (broad sense) and genetic advance as percent of mean for yield and its component traits for five maintainer lines of rice.

Characters	Mean	Range	Coefficient of variation		Heritability	Genetic advance as percent of mean
			PCV(%)	GCV(%)		
Days to 50% flowering	66.53	64.66-70.66	3.60	3.57	98.26	7.30
Days to maturity	85.26	75.66-92.66	8.85	8.84	99.82	18.21
Plant height (cm)	82.33	72.33-87.66	7.16	7.12	98.94	14.60
Panicle length (cm)	21.96	19.87-23.33	6.90	6.31	83.49	11.88
Number of tillers/hill	21.96	12.66-26.66	34.50	32.78	90.27	64.16
Number of panicles /plant	15.33	12-24.66	35.34	34.34	94.43	68.75
Numberof grains/panicle	149.66	94- 195.66	25.77	25.76	99.89	53.04
1000 grain weight (g)	16.03	13.66-18.23	13.47	12.55	86.68	24.07
Filled grains/panicle	120.46	79-155.66	25.49	25.47	90.09	52.45
Flag leaf length (cm)	28.86	23.93-35.19	14.23	14.01	96.91	28.42
Anther length(µm)	402.56	348-443	8.68	8.66	99.61	17.82
Anther breath(µm)	89.50	69.66-100.6	14.88	14.68	97.24	29.82
Stigma length(µm)	187.50	173.66-192	4.35	4.19	91.99	8.25
Stigma breath (µm)	71.23	51.16-84.19	19.52	19.35	98.33	39.54
Filament length	552.26	363.66-750	28.38	28.37	99.93	58.43
Pollen sterility%	97.73	96-99	1.15	1.05	84.21	1.99
Spikelet sterility%	80.33	75.66- 88	6.63	6.40	93.26	12.74
Yield per plant (g)	31.54	26.11-34.98	31.05	30.68	93.53	31.30

CORRELATION COEFFICIENT

Tables 4a and 4b present the genotypic and phenotypic correlations for yield and yield components. These results exposed phenotypic and genotypic correlations to be of parallel direction and significance. However, genotypic correlations had found a higher extent compared to phenotypic correlations indicating the masking effect of environment. Similar results were stated by Madhavilatha *et al.* (2005). Further, grain yield per plant was observed to be positively and significantly associated with number of grains per panicle, TGW, spikelet fertility, filament length and pollen fertility indicating increase of grain yield with increase of these characters. Therefore, priority should be set to these traits, while making selection for yield improvement. The findings are in agreement with the finding of Manikaminnie *et al.* (2013) for reproductive tillers per hill. On the contrary, non-significant positive association was noticed for panicle length, number of panicles per plant, filled grains per panicle, anther length, stigma length and breadth. The findings are in agreement with the reports of Yadav *et al.* (2010).

PATH ANALYSIS

Path coefficient analysis (Tables 5a and 5b) revealed that panicle length, number of effective tillers/plant, number of grains per panicle, thousand grain weight, filled grains per panicle, spikelet fertility, stigma length, stigma breadth, filament length and pollen fertility % possessed the highest positive direct effect on grain yield and therefore direct selection based on these traits would be feasible. Negative direct effect of plant height and days to 50% flowering towards yield indicated short plant with short duration rice hybrids could be developed without sacrificing grain yield. Panicle length showed positive indirect effect with grain yield for most of the characters studied except for plant height, number panicle, filled grain.

Table 4a. Phenotypic (above diagonal) and genotypic (below diagonal) correlations for agronomical and floral characters in maintainer lines of rice (*Oryza sativa* L.).

Character	Days to 50% flowering	Days to maturity	Plant height	Panicle length	Number of tillers /hill	Number of panicles /tiller	Number of grains /panicle	TGW	Filled grains/ panicle	Spikelet fertility	Yield/ plant
Days to 50% flowering	-	.4108	-.2824	-.0714	.0072	.1422	-.0916	-.6610*	.1234	.8058**	-.1263
Days to maturity	.4203	--	.4620	.688**	-.5345*	-.3853	.7550**	.3000	.842**	.3188	.4892
Plant height	-.2863	.4649	-	.808**	-.907**	-.9447**	.8554**	.4899*	-.7289**	-.5949*	-.1418
Panicle length	-.0728	.7517**	.8628**	-	-.873**	-.8091**	.9434**	.4560	.9125**	-.1985	.2098
No. of tillers/hill	.0114	-.5643*	-.945**	-.922**	-	.9657**	-.8653**	-.2533	-.8156**	.3242	.1762
No. of panicles/tiller	.1423	-.3951	-.962**	-.837**	.9855**	-	-.8022**	-.2344	-.7122**	.4845	.3090
No. of grains/panicle	-.0922	.7560**	.858**	1.025**	-.907**	-.8228	-	.5176	.9682**	.1996	.2730*
1000 grain weight	-.7261*	.3256	.5184	.4968	-.2495	-.2751	.5502	-	.3639	.5468	.5535*
Filled grains/panicle	.1252	.8430**	.7347**	1.0094**	-.860**	-.7346	.9699**	.3959	-	.0481	.3263
Spikelet Fertility	.8356*	.3324	-.5989	-.1559	.3229	.4943	.1984	.5561	.0437	-	.3205*
Yield/plant	-.1211	.5029	-.1239	.2723	.1812	.3105	.2883	.6318*	.3336	.2981	-

TGW = 1000 grain weight

Table 4b. Phenotypic (above diagonal) and genotypic (below diagonal) correlations for agronomical and floral characters in maintainer lines of rice (*Oryza sativa* L.).

Character	Flag leaf length	Anther length	Anther breadth	Stigma length	Stigma breadth	Filament length	Pollen fertility	Yield/plant
Flag leaf length	-	-.7289**	.7493**	.4904	-.9071**	.0336	-.4674**	.0434
Anther length	-.7358**	-	-.1393	.1100	.8160**	.0882	.4776**	.0166
Anther breadth	.7635**	-.1376	-	.7532**	-.6075*	-.0800	-.3591	-.1078
Stigma length	.5070	.1249	.7607**	-	-.3584	.3436	-.0267	.0193
Stigma breadth	-.9256**	.8103**	-.6102*	-.3354	-	.2446	.7185**	.3056
Filament length	.0338	.0878	-.0792	.3589	.2469	-	.7836**	.8563**
Pollen fertility	-.4838**	.4975**	-.4080	-.0595	.7620**	.8137**	-	.7790**
Yield /plant	.0373	.0164	-.0873	.0773	.2951	.8872**	.8712**	-

Table 5a. Direct and indirect effects (phenotypic) of agronomical and floral characters on yield in maintainer lines of rice.

Character	Days to 50% flowering	Days to maturity	Plant height	Panicle length	Number of tillers /hill	Number of panicles /tiller	Number of grains /panicle	1000 grain weight	Filled grains/panicle	Spikelet fertility%
Days to 50% flowering	-1.0173	.3968	.2428	.0064	-.0061	.0532	-.3918	-.0148	-.4998	1.1097
Days to maturity	-.4276	.9440	-.3941	-.0657	.2988	-.1477	3.2119	.0066	-3.3645	.4414
Plant height	.2913	.4389	-.8478	-.0754	.5008	-.3596	3.6453	.0106	-2.9323	-.7954
Panicle length	.0740	.7096	-.7315	.0874	.4883	-.3128	4.3581	.0101	-4.0290	-.2070
Number of tillers/hill	-.0116	-.5327	.8019	.0806	-.5295	.3683	-3.854	-.0051	3.4343	.4288
Number of panicles/tiller	-.1447	-.3730	.8158	.0732	-.5218	.3737	-3.495	-.0056	2.9322	.6564
Number of grains/panicle	.0938	.7137	-.7274	-.0897	.4803	-.3075	4.2487	.0112	-3.8711	-.2635
1000 grain weight	.7387	.3074	-.4395	-.0434	.1321	-.1028	2.3377	.0204	-1.5802	-.7385
Filled grains/panicle	-.1274	.7958	-.6229	-.0883	.4556	-.2745	4.1207	.0081	-3.9913	.0580
Spikelet fertility	-.8501	.3138	.5074	.0136	-.1709	.1847	-.8529	-.0113	-.1745	1.3280
Yield/plant	-.1211	.5030	-.1238	.2726	.1810	.3103	.2885	.6319	.3338	.2981

Residue effect = 0.351

Table 5b. Direct and indirect effects (phenotypic) of agronomical and floral characters on yield in maintainer lines of rice.

Character	Flag leaf length	Anther length	Anther breadth	Stigma length	Stigma breadth	Filament length	Pollen fertility
Flag leaf length	.3746	.3216	.5529	-.3168	-1.0245	.0364	.0930
Anther length	-.2757	-.4370	-.0997	-.0781	.9079	.0946	-.0957
Anther breadth	.2860	.0601	.7241	-.4753	-.6754	-.0854	.0785
Stigma length	.1899	-.0546	.5508	-.6248	-.3823	.3868	.0115
Stigma breadth	-.3468	-.3585	-.4418	.2158	1.1069	.2661	-.1465
Filament length	0.0126	-.0384	-.0574	-.2243	.2733	1.0778	-.1565
Pollen fertility	-.1812	-.2174	-.2954	.0372	.8434	.8770	-.1923
Yield/ plant	.0373	.0164	-.0873	.0773	.2951	.8872	.8712

Residue effect = 0.1030

The residual effect for first ten character in Table 5a was 0.351 indicating that 65% of the variability in grain yield was contributed by ten characters studied in the path analysis. The remaining ten characters in Table 5b showed 0.1030, indicating 90% of the variability in grain yield was contributed by these characters. This result gives an impression that few other traits than those involved in the present experiment might also contribute to yield. Correlation and path coefficient reflected that panicle length, number of grains per panicle, thousand grain weight, filled grains/panicle, stigma breadth, filament length, pollen fertility% and spikelet fertility% were the most significant yield components in the studied maintainers of rice hybrids and selection based on these characters would help in exploiting yield potential rice hybrids.

CONCLUSION

Results of the present study on variability, heritability and genetic advance indicated an opportunity for upgrading of grain yield of maintainer lines through selection. The highest mean performance for yield in maintainer (B) lines was found in Ghan 46B followed by IR 62 B. For the development of rice hybrids with earliness and dwarfness IR 62B can be utilized. Most of the studied characters showed significant variation among the genotypes. Studies on character association and path co-efficients revealed the importance of number of reproductive tillers per hill, number of filled grains per panicle, 1000 grain weight, filament length, stigma breadth as selection criteria for effective yield improvement. The study also showed the need of balanced selection in the light of negative association of reproductive tillers per hill with filled grains per panicle and filled grains per panicle with 1000-grain weight in crop yield improvement programmes.

AUTHORS' CONTRIBUTION

MSH, NAI and MSR generated the idea; MSH, NAI, MSR and SM coordinated the experiment/research/project; MSH and NAI developed methodology; MSH, NSI, MSR, MEK and SM provided scientific insights; MSH and SM gathered data; NAI, and MAK carried out analysis and synthesis; MSH and NAI did the writings for all versions of the manuscript;MSH, NAI, MSR, MEK and SM performed critical review and editing; All authors read and approved the final manuscript.

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DECLARATION OF INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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