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Estimation of Genetic Variability, Correlation and Path analysis in short duration Rice Genotypes of Manipur

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ABSTRACT

High significant variations were observed for all the traits studied under present investigation. Considering parameters, high phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were observed for the number of effective tillers per plant, grain yield per plant, plant height followed by days to 50% flowering. Heritability in broad sense was higher in all of the characters studied under present investigation. High heritability coupled with high genetic advance as percent of mean was observed in plant height, days to 50% flowering, days to maturity, number of spikelets per panicle and number of grains per panicle, indicated that these characters under additive gene control and selection for improvement might be effective. Both at the phenotypic and genotypic level, grain yield per plant had significant and positive association with plant height, panicle length,number of filled grains per panicle and number of spikelets per panicle but had significant negative association with number of effective tillers per plant and 1000- grain weight. Number of spikelets per panicle had the maximum positive and direct effect followed by days to maturity, plant height, spikelet fertility and 1000- grain weight. Based on mean performance and various genetic parameters attributes, advance line namely, MC-34-1-10-6-1-26 was observed to be promising because it is of short duration, and yielded significantly higher than the short duration check RCM-8. Promising culture would be recommended for double cropping in the valley region of the state.

Keywords: Rice, GCV, PCV, heritability, genetic advance, correlation, path

INTRODUCTION

Rice (Oryza sativa L) is one of the important cereal crops of Manipur occupying maximum agricultural land. It is also an integral part of culture and tradition in Manipur. The state is enriched by tremendous amount of genetic variability of rice in form of local landraces and wild rice (Anonymous, 2015). Rice is grown in Manipur under different ecology like wetland rice, lowland (deep water), medium land, terraces and jhum lands (Kalita *et al.,* 2015). Development of appropriate rice genotypes for different rice ecology with high yield, stress tolerant, short to mid early duration and compatible with local taste preference is utmost need in order to achieve self-sustaining in rice production (Singh *et al.,* 2008). Valley region of the state has the high rice productivity and contribute nearly 81% of the total rice production (Anonymous, 2015). Pre-kharif rice is predominantly cultivated in valley district where adequate supplementary irrigation facilities are available. Developing of short duration rice cultivars is considered to be one of the most sustainable and effective strategies to achieve high rice productivity in state, because it promotes double cropping in lowland valley condition and equally suitable formoisture stress upland rainfed conditions for main kharif. Short duration cultures escape most of the diseases, insect pests and terminal drought and also serve as contingency variety (post flood).

Genetic parameters such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are useful in detecting the amount of variability present in the germplasm (Idris *et al.,* 2012). Genetic parameters of variability along with correlation and path coefficients are pre-requisites for improvement of any crop including rice for any agronomic and other quality trait by selection of superior genotypes. Yield component traits directly or indirectly increasing grain yield if the components are highly heritable and genetically independent or positively correlated with grain yield (Hasan *et al.,* 2013). Knowledge of inter-trait association between yield and its attributing characters are basic and foremost endeavor for superior plant selection. Partitioning of total correlation into direct and indirect effect by path analysis helps in making the selection more effective. Keeping in view the above facts, the present investigation was undertaken to know variability, correlation and path coefficient among yield and its contributing characters in nine pre-khairfrice genotypes under medium hill (730MSL) of Manipur.

MATERIALS AND METHODS

Field experiment was conducted at Lamphelpat research farm of ICAR RC Manipur Centre during pre-kharif season, 2011 (March-June), in a randomized complete block design with three replications. The experimental materials comprised of rice genotypes that include seven advance lines and two rice varieties (RC Maniphou-5, Ginaphou). Advanced lines were

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generated by pedigree method of breeding of a cross of Leimaphou (KD-2-6-3) x Akhanphou.The test plot consisted of 6 rows of 8m length with row to row and plant to plant spacing of 20cm and 15 cm,respectively. The recommended agronomical practices and plant protection measures were followed to ensure a normal crop. Observation were recorded on ten randomly selected plants in each entry and replication of ten quantitative traits viz., plant height, days to 50% flowering, days to maturity, number of effective tillers per plant, panicle size (cm), number of spikelets per panicle, number of filled grains per panicle, spikelet fertility (%) and grain yield per plant (g). The mean data were analyzed in RBD to determine statistical significance (Panse and Shukhatme, 1969) and extent of genetic and phenotypic coefficient of variation for yield and yield components were estimated as per Singh and Chaudhary (1979). The broad sense heritability and genetic advance in percent of mean were calculated as suggested by Jonson *et al.* (1955). The Estimates of phenotypic (rp) and genotypic (rg) correlation coefficients were estimated by the formula suggested by Miller *et al.,* (1958).Path coefficient analysis was estimated according to the method suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSIONS

Analysis of variance of the data reveled high significant differences among genotypes for all the characters studied. This suggests that the genotypes selected were genetically variable and have considerable amount of variability among them. The mean performance of nine genotypes of rice (7 advanced lines and 2 varieties) for ten quantitative characters has been depicted in Table 1. A perusal on mean performance of genotypes revealed highest yielding genotype was MC-34-1-9-30-2-3 (21.30 g) followed by Ginaphou (20.41 g), MC-34-2-15-6-15-1 (19.22 g), MC-34-7-1-3-46-41(18.82 g) and MC-34-1-10-6-1-26 (17.10 g). Advance line, MC-34-1-10-6-1-26 was observed to be promising culture for earlykharif cultivation because it is of short duration (days to 50% flowering- 63.67), bold seed (33.25 g) andgives reasonable yield (17.10 g/plant) under normal agronomic practices in pre-kharifseason.

The estimates of genetic parameters, viz., genotypic and phenotypic coefficient of variation, heritability in broad sense and genetic advance as percent of mean are presented in Table In general estimate of phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV),but the difference is quite narrow indicating little environment influence for the traits under investigations. Similar result was also reported by Kumar *et al.* (2016) in advanced lines of Kalanamak aromatic rice. Across the genotypes, average plant height ranged from 82.17-121.08 cm with overall mean of 102.22 cm. Moderate estimate of PCV (15.76%) and GCV (15.51%) were observed coupled with high heritability (96.79%) and genetic advance (31.43%). Similar finding was reported by Rukmini *et al.* (2016).

Days to 50% flowering range was varied from 63.67 to 99.33 days with average of 83.30 days. The estimate of PCV (15.97%) and GCV (15.75%) was moderate and associated with high heritability (97.27%) and genetic advance (32.01%). Day to maturity ranged from 94.00 to 126.67 days with average of 111.48 days. The estimate of PCV (10.20%), GCV (10.07%), and genetic advance (20.47%) were moderate coupled with high heritability (97.41%). These results were in consonance with the findings of Tuwar *et al.* (2013).Number of effective tillers per plant ranged from 4.08 to 8.50 with a mean of 5.96. High PCV (22.79%), GCV (21.39%), heritability (88.12%) and genetic advance (41.36%) was associated with the trait. Similar finding was also reported by Umesh *et al.* (2015). Panicle length ranged from 18.58 to 23.65 cm with mean of 21.04 cm. The estimate of PCV (8.64%) and GCV (8.20%) were low coupled with high heritability (90.14%) and moderate genetic advance (16.04%). The number of spikelets per panicle range was recorded from 109.17 to 157.08 with mean of 128.30. The trait had moderate estimates of PCV (12.36%), GCV (11.61%) and genetic advance (22.47%) coupled with high heritability. The number of filled grains per panicle had overall mean of 104.88 and ranged from 86.75 to 123.92. The estimates of PCV, GCV and genetic advance were moderate coupled with high heritability. These findings are in agreement with the finding by Das (2015).Heritability in broad sense was higher in all of the characters studied under present investigation. High heritability coupled with high genetic advance as percent of mean was observed in plant height (96.78, 32.13 %), days to 50% flowering (97.27, 26.67 %), days to maturity (97.40, 22.72 %) number of spikelets per panicle (88.26, 28.81%) and for number of grains per panicle (89.01, 24.06 %), indicating the role of additive gene expression of these traits and have better scope for improvement of these traits through direct selection. Similar with our present finding, Tiwari *et al.* (2014) recorded high heritability along with moderate to high genetic advance in plant height, number of spikelets per panicle, days to maturity and days to 50% flowering while assessing the genetic parameters of rice.

Correlation

Grain yield is a complex trait and depend on several inter-dependable component traits. Direct selection for grain yield trait may not be much effective and therefore other correlated yield component traits should be taken in to consideration. Inter-trait association analysis among grain yield and yield contributing traits (Table 3) reveled that in most of the cases value of genotypic correlation coefficients were higher than phenotypic correlation coefficients and this indicates the suppressive effect of environment modified the phenotypic expression of the character (Ganapati *et al.,* 2014).This is possibly due to the linkage or modifying effect of the gene and environment in genetic association between characters (Swain and Reddy, 2006).

Both at the phenotypic and genotypic level, grain yield per plant had significant and positive association with plant height (0.848, 0.897), panicle length (0.752, 0.791), number of filled grains per panicle (0.612, 0.656) and number of spikelets per panicle (0.601, 0.646) but had significant negative significant association with number of effective tillers per plant (-0.552, -0.610) and 1000- grain weight (-0.479, -0.506). The positive association reflected that grain yield and aforesaid traits could be improved simultaneously (Jaisudha and Sharma, 2010; Manikaya and Reddy, 2011 and Seyoum *et al.,* 2012). Patel *et al.,* (2014) reported positive association of

grain yield per plant with plant height, panicle length, number of grains per panicle however negative association for 1000-grain weight and number of tillers per plant.

Agreement with our finding, Mustafa and Elsheikh (2007) also found negative association of grain yield per plant with number of tillers per plant. Bhuvaneswari *et al.,* (2015) reported positive association of grain yield per plant with productive tillers per plant, filled spikelets, spikelet fertility and 1000 grains weight in F_2 population of black rice. Plant height had significant and positive correlation with days to 50% flowering (0.913, 0.945) and days to maturity (0.893, 0.932). On the other hand, it had negative association with 1000- grain weight (-0.784, -0.825). Days to 50% flowering had significant and positive correlation withdays to maturity (0.967, 0.984) and panicle length (0.787, 0.868) however, exhibited negative association with number of effective tillers per plant (-0.583, -0.631) and 1000- grain weight (-0.794, -0.818).Similarly, negative correlation of days to 50% flowering with 1000-grain weight was reported by Dhanraj *et al.* (1989) and Ratna *et al.* (2015). Days to maturity showed positive association with panicle length (0.720, 0.767) however it had negative association with 1000-grain weight (-0.833, -0.847). Panicle length showed significant and positive correlation with number of filled grain per panicle and had negative significant association with 1000-grain weight (-0.542, -0.578). From, the present finding it is obvious that longer panicle had large number of filled grains per panicle and it significantly contribute for high grain yield per plant. Number of spikelets per plant was significantly and positively associated with number of filled grains per panicle (0.920, 0.931) and grain yield per plant. Similar report was also observed by Kumar *et al.* (2016) Ranawake *et al.* (2014) and Rahman *et al.* (2014).

Path analysis

An estimate of simple correlation does not provide the true contribution of the characters towards the yield and this simple correlation could be partitioned into direct and indirect effects through path coefficient analysis. Path analysis allows separating the direct effect and their indirect effects through other attributes by apportioning the correlations (Wright, 1921) for better interpretation of cause and effect. Path coefficient analysis shown in Table 4, revealed the results of direct and indirect effects of various grain yield component trait on grain yield per plant. At phenotypic level, number of spikelets per panicle (2.334), days to maturity (0.996) had maximum positive direct effect followed by plant height (0.915), spikelet fertility (0.712) and 1000- grain weight (0.549).In contrary to phenotypic effect, plant height (-0.697) had negative indirect effect on grain yield per plant at genotypic level. High direct effect of filled spikelets/panicle on single plant yield was reported by Eidikohnaki *et al.,* (2013), Kiani and Nematzadeh (2012), Seyoum *et al.* (2012), Bagheric *et al.* (2011), Bhadruet al. (2011) Chandra et al. (2009) and Ratna *et al.* (2015).

Table 1: Mean of Short duration genotypes for different yield and yield attributing traits

Genotypes	Plant Height (cm)	Days to 50% flowering	Days to maturity	No. of effective tillers per plant	Panicle length (cm)	Number of spikelet's per panicle	Number of filled grains per panicle	Spikelet fertility (%)	1000-Grain weight (g)	Grain yield per plant (g)
MC-34-1-26-18-8-10	108.17	87.00	117.67	5.89	22.113	134.83	120.00	88.98	26.26	18.23
MC-34-1-31-19-4-8	83.00	75.33	103.67	5.557	20.32	109.17	86.75	79.42	27.92	12.22
MC-34-2-15-6-15-1	114.33	93.67	120.33	6.007	21.57	132.08	108.25	81.94	23.03	19.22
MC-34-7-1-3-46-41	116.58	94.67	119.67	4.347	23.12	109.67	94.08	85.84	25.39	18.82
MC-34-1-9-30-2-3	121.08	94.33	117.33	4.077	23.65	157.08	123.92	78.91	22.82	21.30
MC-34-1-10-6-1-26	85.17	63.67	94.00	6.667	19.23	136.92	113.50	82.92	33.25	17.11
MC-34-1-10-32-2-2	82.17	70.00	98.67	6.500	19.53	127.08	102.33	80.56	30.76	12.53
RCM-8	94.42	71.67	105.33	8.500	18.58	115.50	92.75	80.36	24.27	12.75
Ginaphou	115.08	99.33	126.67	6.083	21.29	132.33	102.33	77.32	23.65	20.41

All these reports are in conformity of the present findings. 1000-grain weight had positive direct effect but had significant negative association with grain yield per plant. The direct effect of 1000-grain weight seems to be neutralized by its considerable negative indirect effect via number of spikelets per panicle (-0.300, -2.082), days to maturity (-0.830, -1.403) and panicle length (-0.035, -0.664). Number of effective tillers per plant had positive direct effect on grain yield per plant at genotypic level only. Days to 50% flowering and number of filled grains per panicle were positively correlated with grain yield per plant but its direct effect on grain yield per plant was negative. It indicated that these characters influenced grains yield per plant by its indirect positive effects through days to maturity, and number of total spikelets per panicle.

Similarly, negative direct effect of days to 50% flowering on grain yield per plant was reported by Mehetre *et al.* (2003) and Sarker *et al.* (2014).Plant height had positive indirect effect on grain yield via. number of spikelets per panicle (0.821, 6.631), day to maturity (0.889, 1.542) and panicle length (0.052, 0.992) resulted in highly significant association with grain yield per plant. Similar report was reported by Sarma and Sharma

Table 2: Phenotypic and genotypic coefficient of variation, heritability and genetic advance (as % of mean) among Short duration genotypes for yield and yield attributing traits

Characters	Mean	Range	PCV(%)	GCV(%)	Heritability in broad sense (%)	Genetic advance (as % of mean)
Plant Height (cm)	102.22	82.17 -121.08	15.76	15.51	96.79	31.43
Days to 50% flowering	83.30	63.67 -99.33	15.97	15.75	97.27	32.01
Days to maturity	111.48	94.00 -126.67	10.20	10.07	97.41	20.47
No. of effective tillers per plant	5.96	4.08 -8.50	22.79	21.39	88.12	41.36
Panicle length (cm)	21.04	18.58 -23.65	8.64	8.20	90.14	16.04
Number of Spikelets per panicle	128.30	109.17 - 157.08	12.36	11.61	88.26	22.47
Number of filled grains per panicle	104.88	86.75 -123.92	12.54	11.83	89.01	22.99
Spikelet fertility (%)	81.807	77.32 -88.98	4.92	4.23	73.86	7.48
1000 -Grain weight (g)	26.37	22.82 -33.25	13.94	13.70	96.57	27.73
Grain yield per plant (g)	16.95	12.22 -21.30	21.68	20.54	89.79	40.10

Table 3: Estimates of phenotypic and genotypic correlation coefficient for yield and yield attributing traits

characters		Plant height	Days to 50% Flower	Days to maturity	No. of effective tillers per plant	Panicle length	No. of spkikelets per panicle	No. of filled grains per panicle	Spikelets fertility (%)	1000-grain weight (g)	Grain yield per plant (g)
Plant height	P	1.000	0.913**	0.893**	-0.517**	0.808**	0.352	0.366	0.107	-0.784**	0.848**
	G	1.000	0.945**	0.932**	-0.573**	0.863**	0.411*	0.422*	0.119	-0.825**	0.897**
Days to 50% Flowering	P		1.000	0.967**	-0.583**	0.787**	0.237	0.213	-0.006	-0.794**	0.739**
	G		1.000	0.984**	-0.631**	0.868**	0.239	0.217	0.006	-0.818**	0.816**
Days to maturity	P			1.000	-0.445*	0.720**	0.187	0.184	0.031	-0.833**	0.716**
	G			1.000	-0.469	0.767**	0.173	0.178	0.067	-0.847**	0.759**
No. of effective tillers per plant	P				1.000	-0.846**	-0.292	-0.309	-0.106	0.223	-0.552**
	G				1.000	-0.917**	0.262	-0.282	-0.136	0.249	-0.610**
Panicle length	P					1.000	0.334	0.386*	0.198	-0.542**	0.752**
	G					1.000	0.381*	0.448*	0.276	-0.578**	0.791**
No. of spkikelets per panicle	P						1.000	0.920**	-0.140	-0.129	0.601**
	G						1.000	0.931**	-0.109	-0.129	0.646**
No. of filled grains per panicle	P							1.000	0.256	-0.043	0.612**
	G							1.000	0.259	-0.049	0.656**
Spikelets fertility (%)	P								1.000	0.182	0.105
	G								1.000	0.175	0.122
1000-grain weight	P									1.000	-0.479**
	G									1.000	-0.506**

(*: Significant at 5% level of significance, **: Signficant at 1% level of significance)

(2009). At the both phenotypic and genotypic level, days to maturity had positive indirect effect via, number of spikelets per panicle (0.436, 2.793), while it had positive indirect effect via plant height (0.817) at the phenotypic level only. Days to maturity had inserted maximum negative indirect effect on grain yield per plant via day to 50% flowering (-0.790, -0.504), 1000-grain weight (-0.457, -0.556) and number of filled grains per panicle (-0.384, -2.851). Similarly, Rai *et al.* (2015) had also observed negative indirect effect on grain yield per plant via number of filled grains per panicle and 1000-grain weight in F4 generation of rice.

Number of effective tillers per plant exerted positive indirect effect on grain yield per plant via number of filled grain per panicle (0.644, 4.508), days to 50% flowering (0.476, 0.323), and it showed negative indirect effect via days to maturity (-0.443, -0.777), number of spikelets per panicle (-0.681, -4.233) and spikelet fertility percentage (-0.076, -0.773) and had negative association with grain yield per plant.This result is in

Table 4: Phenotypic (P) and genotypic (G) path coefficient among various yield and yield component traits

Character		Plant height (cm)	Days to 50% flowering	Days to maturity	No. of effective tillers/ plant	Panicle length (cm)	No. of filled grains/ panicle	No. of spikelet's/ panicle	Spikelet's fertility (%)	1000-grain weight (g)	Correlation with yield
Plant height (cm)	P	0.915	-0.746	0.889	0.035	0.052	0.821	-0.763	0.076	-0.431	0.848**
	G	-0.697	-0.484	1.542	-0.478	0.992	6.631	-6.742	0.675	-0.541	0.897**
Days to 50% flowering	P	0.835	-0.817	0.963	0.039	0.050	0.552	-0.443	-0.004	-0.436	0.739**
	G	-0.660	-0.512	1.629	-0.526	0.998	3.856	-3.467	0.033	-0.536	0.816**
Days to maturity	P	0.817	-0.790	0.996	0.030	0.046	0.436	-0.384	0.022	-0.457	0.716**
	G	-0.649	-0.504	1.656	-0.391	0.882	2.793	-2.851	0.379	-0.556	0.759**
No. of effective tillers/ Plant	P	-0.473	0.476	-0.443	-0.067	-0.054	-0.681	0.644	-0.076	0.122	-0.552**
	G	0.399	0.323	-0.777	0.834	-1.054	-4.233	4.508	-0.773	0.163	-0.610**
Panicle length (cm)	P	0.739	-0.643	0.717	0.057	0.064	0.779	-0.805	0.141	-0.297	0.752**
	G	-0.602	-0.444	1.270	-0.765	1.150	6.156	-7.165	1.571	-0.379	0.791**
No. of spikelets/ panicle	P	0.322	-0.193	0.186	0.020	0.021	2.334	-1.918	-0.099	-0.070	0.601**
	G	-0.286	-0.123	0.286	-0.219	0.438	16.146	-14.892	-0.621	-0.084	0.646**
No. of filled grains/ panicle	P	0.335	-0.174	0.183	0.021	0.025	2.148	-2.084	0.182	-0.024	0.612**
	G	-0.294	-0.111	0.295	-0.235	0.515	15.036	-15.991	1.473	-0.032	0.656**
Spikelets fertility (%)	P	0.098	0.005	0.031	0.007	0.013	-0.327	-0.533	0.712	0.100	0.105
	G	-0.083	-0.003	0.110	-0.113	0.318	-1.764	-4.143	5.686	0.115	0.122
1000-grain weight (g)	P	-0.718	0.649	-0.830	-0.015	-0.035	-0.300	0.090	0.130	0.549	-0.479**
	G	0.575	0.419	-1.403	0.207	-0.664	-2.082	0.789	0.996	0.656	-0.506**

Residual P: 0.092, G: 0.081 (P: Phenotypic, G: Genotypic

conformity with finding of Mustafa and Elsheikh (2007). Panicle length had moderate positive direct effect (0.064, 1.150) on grain yield per plant but had highly significant correlation with grain yield per plant. It indicated that panicle length had maximum positive indirect effect on grain yield via other components character such as number of spikelets per panicle (0.779, 6.156) and days to maturity (0.717, 1.270). Chandra *et al.* (2009) reported panicle length had negative direct but had significant and positive correlation with yield. Number of spikelets per panicle had shown positive indirect effect on grain yield per plant via days to maturity (0.186, 0.285) and inserted maximum negative effect via., number of filled grains per panicle (-1.918, -14.892), days to 50% flowering (-0.193, -0.123) and 1000-grain weight (-0.070, -0.084).

In contrary with our result Yadav et al. (2015) reported number of spikelets per panicle had positive indirect effect on grain yield via days to 50% flowering and 1000-grain weight in kharif rice. Both at the phenotypic and genotypic level, number of filled grains per panicle had contributed maximum positive indirect effect on grain yield per plant via., number of spikelets per panicle (2.148, 15.036) and spikelet fertility % (0.182, 1.473) and days to maturity (0.183, 0.295) while it had negative indirect effect via, days to 50% flowering (-0.174, -0.111) and 1000-grain weight (-0.024, -0.032). Similar kind of result was reported by Sesang et al. (2013) in hybrid rice. Spikelet fertility (%) had inserted positive indirect effect via 1000-grain weight (0.100, 0.115) while it had negative indirect effect on grain yield per plant via. number of filled grain per panicle (-0.533, -4.143) and number of spikelets per panicle (-0.327, -1.764). Similarly, positive indirect effect of spikelet fertility on grain yield per plant via 1000-grain weight was also reported by Suresh *et al.* (2014).

CONCLUSION

The present study showed the existence of a considerable level of genticvarialbity in short duration rice genotypes. High,phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were observed for the number of effective tillers per plant, grain yield per plant, plant height followed by days to 50% flowering.

High heritability along with high genetic advance as percent of mean was observed in plant height, days to 50% flowering, days to maturity, number of spikelets per panicle and number of grains per panicle. Correlation analysis revealed that grain yield per plant had a positive and siginifiant association with plant height, panicle length, number of filled grains per panicle, and number of spikelets per panicle. Path analysis indicated thatnumber of spikelets per panicle had the maximum positive and direct effect followed by days to maturity, plant height, spikelet fertility and 1000- grain weight.Selection of aforementioned tratis based on our results could be exploited in further breedin programme for developing promising short duration rice varieties.

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