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Yield component analysis in hybrid rice varieties under rainfed conditions of Manipur valley

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ABSTRACT

Comparative performance, character association and contribution of component characters towards grain yield were studied in hybrid rice (EX. HY.1, EX. HY. 2 and PA 6201) vis-a vis inbred (Leimaphou, Sanaphou and Tamphaphou) rice varieties under rainfed conditions of Manipur Valley. Hybrid rice recorded significantly higher yield by 52.14% along with 20% increase in ear bearing tillers hill^{-1}. The correlation and path analysis for hybrid and inbred rice revealed that ear bearing tillers hill^{-1}, grains panicle^{-1}and 1000 grain weight were the most important component traits for grain yield improvement in both hybrid and inbred rice varieties. However, the magnitude of contribution of these three components toward grain yield in hybrid were in the order of ear bearing tillers > grain weight > grains panicle^{-1} while their contribution in the inbred were in order of grain weight > ear bearing tillers > grains panicle^{-1}. Thus, selected lines possessing higher number of productive tillers, high grain weight and maximum number of filled grains panicle^{-1} would be ideal for developing high yielding rice varieties.

***Key words*:** *hybrid rice, performance, path analysis, rain fed, Manipur*

Rice based agriculture is the largest source of livelihood of majority of rural mass in Manipur and is the mainstay of the state economy. Among the wet season crops, rice alone occupies about 195 thousand hectares which is about 90 per cent of the total cropped area of the state with an annual production of about 382 metric tonnes under rain fed transplanted condition. Recent development of hybrid rice technology is one of the innovative approaches by which improved plant type combined with higher physiological efficiency resulted in higher production and productivity. The lack of identification and development of hybrid rice production technology particularly in rain fed ecosystem which suffers from uncertain weather conditions and periodic droughts, resulting in low and unstable yields as compared to irrigated rice ecosystem is the key impediment for slow pace of adoption. The Chinese hybrid rice experience has shown that the yield potential of hybrid rice can only be achieved, if each eco-region develops its own hybrids or screens hybrids developed in other regions to meet specific local conditions (Justin *et al*. 1994). As the yield potential of a rice cultivar growing in an environment would be expressed according to the adaptability to the ecological conditions therefore, breeding strategy for maximizing yield potential should base on ecological resources. In view of the above, the present investigation was undertaken to study the comparative performance, character association and contribution of component characters towards grain yield in hybrid rice vis-a vis inbred rice varieties and to determine the major yield components for development of modern rice varieties for rainfed transplanted condition of Manipur valley under north eastern hill region.

MATERIALS AND METHODS

The experimental materials comprising of three hybrids (EX. HY.1, EX. HY. 2 and PA 6201) developed by private sector and three commercial inbred varieties (Leimaphou, Sanaphou and Tamphaphou) were grown in a randomized complete block design with four replications during wet season, 2004-2005 and 2005-2006 at the experimental field of Central Agricultural University, Imphal located at an altitude of 780 m above

MSL. The soil type of experimental field is deep clay with a pH of 5.5. Twenty five days old single seedlings hill^{-1} for hybrid rice and 2-3 seedlings hill^{-1} for inbred rice were transplanted in a plot size of 3.4 x 3.3 m at 20 x 15 cm spacing. The recommended package of practices was followed to raise a good crop. Except for days to 50% flowering and days to maturity, which were recorded on plot basis, other characters *i.e.* plant height, number of ear bearing tillers hill^{-1}, panicle length, number of grains panicle^{-1}, 1000-grain weight and harvest index were recorded on the basis of ten randomly selected plants from the central rows of each plot. The total yield was recorded from all the plants of central rows and later converted to yield in 5 m^2. The mean data of two years was subjected to analysis of variance (Gomez and Gomez, 1987) followed by correlation and path coefficient analysis as per method explained by Singh and Chaudhary (1985). The't' test was used for comparison of the mean performance of hybrid and inbred varieties.

RESULTS AND DISCUSSION

The average significant percent increase or decrease of hybrid over inbred rice was recorded for all the characters under study. More than 20% increase in the performance of hybrid over inbred was recorded for grain yield (52.14), ear bearing tillers (21.58), panicle weight (44.16), grain panicle^{-1} (21.72) and harvest index (32.43) (Table 1). The potential of more than 20 % higher yield from rice hybrids than inbred varieties was also reported earlier (Nehru *et al*., 1999 and Janaiah, 2000).

Plant height is the agronomic character that reflects the inherent quality of early vigour and to a great extent, the lodging or non lodging habit of the genotype. All the hybrid and inbred rice varieties used in the present study had the average plant height of 91.94 cm and 86.84 cm, respectively showing stiff straw and non lodging habit for higher yield. The hybrid showed higher plant height of 5.87% over the inbred. Among the rice varieties, particularly photo insensitive high yielding types, the highest yield potential was expected in the varieties of 130 to 140 days durations (Anonymous, 1972). The choice of late maturing or photo sensitive varieties were mostly guided by the prevailing ecosystem for the convenience of harvest while the choice of early maturing varieties were dependent upon the precariousness of water resources or cropping system adopted. In the present study, comparing hybrid and inbred rice, days to 50% flowering and days to maturity were higher in inbred rice than hybrid rice.

In the present investigation, the genotypic correlations were, in general higher than the phenotypic correlation for both hybrid and inbred rice (Table 2) and thus suggested that the observed relationships among the characters were due to genetic factors. The characters which showed highly significant positive correlation with grain yield for hybrid and inbred rice were ear bearing tillers, grains panicle^{-1}, 1000-grain weight, panicle weight and harvest index. These findings were in conformity with those of Geetha (1993), Chauhan (1996) and Vanniarajan *et al*. (1996).The correlation among yield attributes revealed high positive association for ear bearing tillers with grains panicle^{-1} in hybrid rice. The similar results were also obtained by Meenakshi *et al*. (1999). High positive correlations of ear bearing tillers with panicle weight and harvest index, 1000-grain weight with panicle weight and panicle

Table 1. Mean performance of hybrids over inbred rice variety for different traits

Traits	Mean performance of hybrids	Mean performance of inbreds	Average % increase/decrease over inbreds
Days to 50% flowering	90.33	102.87	(-) 12.19*
Days to maturity	123.08	132.37	(-) 7.02*
Plant height (cm)	91.94	86.64	5.87*
No. of ear bearing tillers hill^{-1}	14.76	12.14	21.48*
Panicle weight (g)	7.54	5.23	44.16*
No. of grains panicle^{-1}	110.45	90.74	21.72*
1000-grain weight (g)	25.65	25.47	0.70*
Harvest index	0.49	0.37	32.43*
Yield (kg 5 m^{-2})	4.26	2.80	52.14*

* Significant at P 0.05 level

Table 2. Genotypic (G) and phenotypic (P) correlation coefficients among different traits in hybrid and inbred (in parenthesis) rice

Traits		Days to maturity	Plant height	Ear bearing tillers hill^{-1}	Grains panicle^{-1}	1000-grain weight	Panicle weight	Harvest index	Grain yield (kg 5 m^{-2})
Days to 50% flowering	G	0.97**(0.98**)	0.74**(0.99**)	0.29(0.82**)	0.02(0.12)	-0.99**(-0.59**)	-0.70**(0.87**)	-0.24(0.28)	-0.25(-0.07)
	P	0.97**(0.98**)	0.71**(0.97**)	0.28(0.75**)	0.01(0.01)	-0.95**(-0.58*)	-0.64**(0.78**)	-0.22(0.27)	-0.24(-0.03)
Days to maturity	G		0.78**(0.98**)	0.01(0.89**)	-0.04(-0.55)	-0.99**(-0.54)	-0.73**(0.82**)	-0.29(0.28)	-0.28(0.04)
	P		0.75**(0.96**)	0.02(0.74**)	-0.03(-0.51)	-0.96**(-0.50)	-0.71**(0.73**)	-0.29(0.26)	-0.27(0.01)
Plant height	G			-0.68**(0.77**)	-0.67*(-0.81**)	-0.83**(-0.69*)	-0.98**(0.85**)	-0.84**(0.20)	-0.83**(-0.17)
	P			-0.50(0.62*)	-0.64*(-0.47)	-0.80**(-0.67*)	-0.97**(0.71**)	-0.79**(0.11)	-0.79**(-0.15)
Ear bearing tillers hill^{-1}	G				0.83**(0.63*)	0.10(0.01)	0.75**(0.99**)	0.88**(0.75**)	0.99**(0.58*)
	P				0.72**(0.57*)	0.02(0.01)	0.57*(0.77**)	0.80**(0.62*)	0.88**(0.57*)
Grains panicle^{-1}	G					0.14(0.67*)	0.72**(-0.61*)	0.95**(0.75**)	0.99**(0.67*)
	P					0.13(0.60*)	0.70**(-0.33)	0.89**(0.62*)	0.90**(0.57*)
1000-grain weight	G						0.80**(-0.44)	0.39(0.46)	0.75**(0.84**)
	P						0.73**(-0.33)	0.35(0.30)	0.71**(0.78**)
Panicle weight	G							0.87**(0.37)	0.87**(0.59*)
	P							0.84**(0.32)	0.82**(0.57*)
Harvest index	G								0.98**(0.62*)
	P								0.97**(0.57*)

* and ** significant at P 0.05 and 0.01 levels, respectively G- Genotypic P- Phenotypic

weight with harvest index were also observed. In inbred rice, high positive correlations were observed for ear bearing tillers with grains panicle^{-1}, panicle weight and harvest index. Similarly, high positive correlations were observed for grains panicle^{-1} with 1000-grain weight and harvest index. Such correlations between the yield attributing characters suggested the possibilities of selection through correlated response.

Among the yield components for hybrid rice, which showed high positive direct effect at genotypic level towards grain yield were ear bearing tillers, 1000 grain weight and grains panicle^{-1} in order of magnitude (Table 3). The positive direct contribution of these three characters to grain yield were also reported by Ram (1992), Surek and Beser (2003), but they observed that the effect of the number of filled grain panicle^{-1} was higher than that of the others. The panicle weight and harvest index had also positive direct effects towards grain yield, but their magnitude were comparatively smaller than that of the above three components. The high positive correlations of panicle weight and harvest index with grain yield might be attributed to their high indirect effect on grain yield via ear bearing tillers, grains panicle^{-1} and 1000-grain weight.

For inbred rice, among the yield components, 1000-grain weight, ear bearing tillers, and grains panicle^{-1} in order of magnitude, had high values of positive direct effect towards grain yield. Although panicle weight had a positive direct effect towards grain yield, its magnitude was comparatively smaller than that of the above components. However, highly significant positive correlation of panicle weight with grain yield was due to high positive indirect effect via 1000-grain weight, grains panicle^{-1} and ear bearing tillers. Highly positive correlation of harvest index with grain yield was attributed mainly through the indirect effect via 1000-grain weight, grains panicle^{-1} and ear bearing tillers.

The present study indicated that hybrids out-yielded significantly in comparison to inbreds and suggested that development of hybrids would be adaptable and profitable under rainfed transplanted condition of valley areas of Manipur. The correlation and path analysis for hybrid and inbred rice revealed that ear bearing tillers, grains panicle^{-1}and 1000 grain weight were the most important component traits for grain yield improvement in both hybrid and inbred rice cultivars. However, the magnitude of contribution of

Table 3. Path coefficients analysis showing direct (bold) and indirect effect at genotypic level in hybrid (H) and inbred (I) rice

Traits		Days to 50% flowering	Days to maturity	Plant height	Ear bearing tillers hill^{-1}	Grains panicle^{-1}	1000-grain weight	Panicle weight	Harvest index	Genotypic correlation with Grain yield
Days to 50% flowering	HI	0.30 -0.67	-0.39 0.09	-0.20 0.52	0.05 0.56	0.00 -0.19	-0.48 -0.42	-0.09 0.09	-0.01 -0.00	-0.25 -0.07
Days to maturity	HI	0.51 -0.67	-0.39 0.09	0.21 0.51	0.00 0.61	-0.01 -0.18	-0.49 -0.38	-0.10 0.08	-0.01 -0.01	-0.28 0.04
Plant height	HI	0.38 -0.67	-0.30 0.09	0.27 0.22	-0.34 0.52	-0.24 -0.21	-0.41 -0.49	-0.14 0.08	-0.04 -0.00	-0.83** -0.17
Ear bearing tillers hill^{-1}	HI	0.05 -0.56	-0.00 0.08	-0.19 0.40	0.50 0.68	0.41 -0.07	0.05 -0.00	0.10 0.07	0.05 -0.02	0.99** 0.58*
Grains panicle^{-1}	HI	0.00 0.97	0.01 -0.14	-0.18 -0.94	0.57 -0.43	0.36 0.32	0.07 0.19	0.10 -0.12	0.05 0.05	0.99** 0.67*
1000-grain weight	HI	-0.52 0.46	0.39 -0.05	-0.23 -0.36	0.05 -0.00	0.05 0.20	0.48 0.71	0.11 -0.03	0.02 -0.02	0.75** 0.84**
Panicle weight	HI	-0.35 -0.72	0.18 0.10	-0.27 -0.19	0.48 0.31	0.39 0.55	0.26 0.67	0.14 0.07	0.05 -0.01	0.87** 0.59*
Harvest index	HI	-0.12 0.84	0.11 0.32	-0.23 0.14	0.52 0.37	0.35 0.42	0.29 0.60	0.12 -0.78	0.05 -0.00	0.98** 0.62*

these three components toward grain yield in hybrid were in order of ear bearing tillers>grain weight > grains panicle^{-1} while in the inbreds, they were in order of grain weight>effective tillers>grains panicle^{-1}. Thus, selected lines possessing higher number of productive tillers, high grain weight and maximum number of filled grains per panicle would be ideal for breeding of new type of high yielding rice varieties.

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