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Comparison of Direct and Indirect Effects of Yield Contributing and Physiological Characters Between Hybrids and Varieties of Rice

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ABSTRACT

A comparison of yield contributing characters between 10 hybrids and 10 varieties of rice indicates that the characters *viz.,* number of filled grains panicle^{-1}, biological yield plant^{-1}, harvest index, panicle length and number of productive tillers plant^{-1} are directly contributing to the yield in hybrids because of their positive direct effect coupled with positive significant correlation with grain yield plant^{-1}. Whereas in varieties biological yield plant^{-1}, plant height, 1000 grain weight and leaf area plant^{-1} are yield contributing characters due to their positive direct effect coupled with positive significant correlation with grain yield plant^{-1}.

Key words : Hybrids, Path Coefficient Analysis, Rice, Varieties

In rice, development of hybrids is one of the innovative approaches to increase the yield potential. Performance of hybrids was found to be superior over cultivars (Murthy *et al.,* 1992). An attempt was made to compare the direct and indirect effects of certain quantitative and physiological characters in hybrids and varieties of rice with an objective to select for these traits to improve yield potential of rice.

MATERIAL AND METHODS

Ten hybrids MTUHR 2034, MTUHR 2040, MTUHR 2041, MTUHR 2045, MTUHR 2048, APHR 2, DRRH 1, Proagro 6201. PHB 71, NSD 2 and ten varieties of rice MTU 1010, IR 64, MTU 1001,MTU 9992, MTU 2400, MTU 3626, MTU 7014, BPT 1235, MTU 1003,JGL 1798 were raised in randomized block design replicated thrice during *rabi* season of 1999-2000 at Agriculture College farm, Bapatla.

Thirty days old seedlings were planted in main field with inter- and intra-row spacing of 20 cm and 15cm. Standard cultural practices were adopted to raise the crop and observations were recorded on quantitative characters *viz.,* plant height, number of productive tillers plant^{-1}, panicle length, number of spikelets panicle^{-1}, number of filled grains panicle^{-1}, spikelet sterility percentage, biological yield plant^{-1}, 1000 grain weight and grain yield plant^{-1} and physiological traits *viz.,* leaf area plant^{-1}, net assimilation rate, crop growth rate and harvest index. The data were subjected to path coefficient analysis as per Dewey and Lu (1959).

RESULTS AND DISCUSSION

The results of correlation coefficients and path coefficient analysis at phenotypic and genotypic-levels among hybrids and varieties are furnished in Tables 1, 2, 3 and 4, respectively. Among hybrids maximum direct effect on grain yield plant^{-1} was contributed by number of filled grains panicle^{-1} followed by biological yield plant^{-1}, harvest index, panicle length and number of productive tillers plant^{-1} resulting in positive significant correlation with grain yield. Hence, direct selection of these traits would bring the yield improvement in hybrids (Murthy *et al.,* 1992, Ganesan *et al.,* 1998 and Selvarani and Rangasamy, 1998).

In varieties biological yield plant^{-1} had positive direct contribution on grain yield plant^{-1} followed by plant height, 1000 grain weight and leaf area plant^{-1} coupled with positive significant correlation with grain yield plant^{-1}. Hence, direct selection of these traits would be effective for yield improvement (Murthy and Venkatesh Babu, 1992; Wilfred Manuel and Rangaswamy, 1993 and Rather *et al.,* 1997).

Even though the traits number of spikelets panicle^{-1} and harvest index exhibited positive direct effects it ultimately resulted in positive non-significant correlation with grain yield plant^{-1} which might be reason for low yields of varieties compared to hybrids. In case of hybrids number of filled grains panicle^{-1} had major contribution to grain yield whereas in varieties it had negative direct effect coupled with positive non-significant correlation with grain yield leading to low yields.

Table 1. Estimates of phenotypic (P) and genotypic (G)correlation coefficients between yield and quantitative and physiological characters of 10 rice hybrids

Characters		No. of productive tillers plant^{-1}	Panicle length	Number of spikelet panicles^{-1}	Number of filled grains panicle^{-1}	Spikelet sterility %	Biological yield plant^{-1}	1000 grain weight	Leaf area plant^{-1}	Net assimilation rate	Crop growth rate	Harvest Index	Grain yield plant^{-1}
Plant height	P	0.49	0.71**	0.81**	0.82**	0.29	0.64*	-0.04	0.56*	0.27	0.28	0.51	0.60*
	G	(0.54)	(0.72)	(0.82)	(0.83)	(0.30)	(0.65)	(-0.04)	(0.60)	(0.28)	(0.28)	(0.53)	(0.61)
Number of productive	P		0.59*	0.23	0.37	-0.34	0.71**	0.57	0.14	-0.22	-0.34	0.74**	0.75**
tillers plant^{-1}	G		(0.68)	(0.26)	(0.40)	(-0.36)	(0.78)	(0.64)	(0.17)	(-0.27)	(-0.37)	(0.83)	(0.83)
Panicle length	P			0.71**	0.73**	0.23	0.56*	0.27	0.51	0.38	0.38	0.60*	0.57*
	G			(0.72)	(0.75)	(0.24)	(0.57)	(0.28)	(0.53)	(0.39)	(0.39)	(0.61)	(0.58)
Number of spikelets	P				0.97**	0.51	0.4981	-0.25	0.51	0.61*	0.66*	0.30	0.43
panicle^{-1}	G				(0.97)	(0.51)	(0.50)	(-0.25)	(0.53)	(0.61)	(0.66)	(0.32)	(0.44)
Number of filled	P					0.28	0.63*	-0.18	0.47	0.53	0.53	0.49	0.59*
grains panicle^{-1}	G					(0.28)	(0.63)	(-0.18)	(0.49)	(0.53)	(0.54)	(0.50)	(0.59)
Spikelet sterility	P						-0.19	-0.29	0.41	0.57*	0.70**	-0.43	-0.31
percentage	G						(-0.19)	(-0.29)	(0.43)	(0.58)	(0.70)	(-0.43)	(-0.31)
Biological yield	P							0.40	0.51	0.07	-0.88	0.82**	0.97**
plant^{-1}	G							(0.40)	(0.53)	(0.07)	(-0.09)	(0.85)	(0.98)
1000 grain weight	P								0.23	-0.42	-0.55*	0.40	0.41
	G								(0.24)	(-0.42)	(-0.55)	(0.41)	(0.41)
Leaf area plant^{-1}	P									0.30	0.31	0.39	0.47
	G									(0.32)	(0.31)	(0.43)	(0.49)
Net assimilation rate	P										0.92**	-0.00	0.01
	G										(0.93)	(-0.01)	(0.01)
Crop growth rate	P											-0.15	-0.14
	G											(-0.15)	(-0.141)
Harvest index	P												0.92**
	G												(0.93)

Figures in parentheses indicate genotypic correlation coefficients
* = Significance at 5% level, ** = Significance at 1% level

Table 2. Estimates of phenotypic (P) and genotypic (G)correlation coefficients between yield and quantitative and physiological characters of 10 rice varieties.

Characters		No. of productive tillers plant^{-1}	Panicle length	Number of spikelet panicles^{-1}	Number of filled grains panicle^{-1}	Spikelet sterility %	Biological yield plant^{-1}	1000 grain weight	Leaf area plant^{-1}	Net assimilation rate	Crop growth rate	Harvest Index	Grain yield plant^{-1}
Plant height	P	0.66**	0.67**	0.30	0.23	0.67**	0.79**	0.64*	0.81**	-0.19	0.11	-0.12	0.62*
	G	(0.74)	(0.67)	(0.30)	(0.24)	(0.70)	(0.86)	(0.65)	(0.82)	(-0.19)	(0.12)	(-0.43)	(0.64)
Number of productive	P		0.77**	0.01	-0.02	0.35	0.84**	0.55	0.68**	-0.54	-0.14	-0.07	0.87**
tillers plant^{-1}	G		(0.86)	(0.01)	(-0.02)	(0.44)	(0.94)	(0.62)	(0.78)	(-0.59)	(-0.17)	(-0.08)	(0.97)
Panicle length	P			0.23	0.20	0.39	0.76**	0.64*	0.64*	-0.57	-0.14	-0.09	0.84**
	G			(0.24)	(0.20)	(0.43)	(0.83)	(0.66)	(0.65)	(-0.58)	(-0.13)	(-0.10)	(0.86)
Number of spikelets	P				0.99**	0.42	0.06	-0.06	0.16	-0.26	-0.27	-0.16	0.05
panicle^{-1}	G				(0.99)	(0.42)	(0.07)	(-0.06)	(0.16)	(-0.27)	(-0.27)	(-0.16)	(0.05)
Number of filled	P					0.33	0.29	-0.08	0.11	-0.25	-0.28	-0.14	0.03
grains panicle^{-1}	G					(0.34)	(0.32)	(-0.08)	(0.11)	(-0.25)	(-0.28)	(-0.14)	(0.03)
Spikelet sterility	P						0.38	0.15	0.55	-0.38	-0.13	-0.27	0.26
percentage	G						(0.41)	(0.15)	(0.57)	(-0.38)	(-0.14)	(-0.28)	(0.26)
Biological yield	P							0.69**	0.70**	-0.42	0.11	-0.36	0.84**
plant^{-1}	G							(0.72)	(0.74)	(-0.45)	(0.11)	(-0.42)	(0.86)
1000 grain weight	P								0.76**	-0.23	0.03	-0.14	0.69**
	G								(0.77)	(-0.23)	(0.03)	(-0.14)	(0.69)
Leaf area plant^{-1}	P									-0.32	-0.09	-0.02	0.78**
	G									(-0.34)	(-0.09)	(0.03)	(0.79)
Net assimilation rate	P										0.56*	-0.00	-0.56*
	G										(0.57)	(-0.00)	(-0.56)
Crop growth rate	P											-0.44	-0.15
	G											(-0.45)	(-0.15)
Harvest index	P												0.10
	G												(0.08)

Figures in parentheses indicates genotypic correlation coefficients
* = Significance at 5% level , ** = Significance at 1% level.

Table 3. Genotypic direct and indirect effects of quantitative and physiological characters on grain yield plant^{-1} of 10 rice hybrids.

	Plant height	No. of productive tillers plant^{-1}	Panicle length	Number of spikelet panicles^{-1}	Number of filled grains panicle^{-1}	Spikelet sterility %	Biological yield plant^{-1}	1000 grain weight	Leaf area plant^{-1}	Net assimila-tion rate	Crop growth rate	Harvest Index	Genotypic correlation with grain yield plant^{-1}
Plant height	**-0.0793**	0.0149	0.0686	-0.9941	1.0246	0.0778	0.4376	0.0028	-0.0555	-0.0463	-0.0235	0.1166	0.6133*
Number of productive tillers plant^{-1}	-0.0432	**0.0275**	0.0641	-0.3120	0.5002	-0.0927	0.5292	-0.0380	-0.0163	0.0449	0.0314	0.1822	0.8320**
Panicle length	-0.0574	(0.0186	**0.0948**	-0.8791	0.9244	0.0621	0.3833	-0.0166	-0.0492	-0.0636	-0.0330	0.1356	0.5778*
Number of spikelets panicle^{-1}	-0.0649	0.0070	0.0685	**-1.2159**	1.2002	0.1330	0.3359	0.0149	-0.0497	-0.1017	-0.0555	0.0720	0.4372
Number of filled grains panicle^{-1}	-0.0655	0.0111	0.0706	-1.1769	**1.2400**	0.0736	0.4265	0.0108	-0.0456	-0.0876	-0.0451	0.1104	0.5997*
Spikelet sterility percentage	-0.0238	-0.0098	0.0227	-0.6241	0.3521	**0.2592**	-0.1291	0.0173	-0.0398	-0.0948	0.0588	-0.0948	-0.3115
Biological yield plant^{-1}	-0.0517	0.0216	0.0541	-0.6080	0.7873	-0.0498	**0.6717**	-0.0239	-0.0491	-0.0126	0.0075	0.1868	0.9825 **
1000 grain weight	0.0037	0.0176	0.0265	-0.3070	-0.2255	-0.0756	0.2707	**-0.0592**	-0.0225	0.0698	0.0460	0.0916	0.4167
Leaf area plant^{-1}	-0.0477	0.0048	0.0505	-0.6548	0.6121	0.1118	0.3570	-0.0144	**-0.0923**	-0.0534	-0.0262	0.0966	0.4883
Net assimilation rate	-0.0223	-0.0075	0.0366	-0.7703	0.6606	0.1495	0.0514	0.0251	-0.0300	**-0.1645**	-0.0778	-0.0024	0.0150
Crop growth rate	-0.0224	-0.0104	0.0376	-0.8113	0.6720	0.1833	0.0605	0.0328	-0.0291	-0.1539	**-0.0832**	-0.0339	-0.1461
Harvest index	-0.0421	0.0228	0.0585	-0.3882	-0.3882	-0.1119	0.5710	-0.0247	-0.0406	0.0018	0.0128	**0.2198**	0.9295**

* = Significance at 5% level, ** = Significance at 1% level, Residual effect:0.1315, Underlined and bold values are direct effects

Table 4. Genotypic direct and indirect effects of quantitative and physiological characters on grain yield plant^{-1} of 10 rice varieties.

	Plant height	No. of productive tillers plant^{-1}	Panicle length	Number of spikelet panicles^{-1}	Number of filled grains panicle^{-1}	Spikelet sterility %	Biological yield plant^{-1}	1000 grain weight	Leaf area plant^{-1}	Net assimila-tion rate	Crop growth rate	Harvest Index	Genotypic correlation with grain yield plant^{-1}
Plant height	**0.4072**	-0.0273	-0.0985	1.4707	-1.1992	-0.5318	0.2974	0.1856	0.1006	0.0566	-0.0031	-0.0859	0.6443*
Number of productive tillers plant^{-1}	0.3029	**-0.0367**	0.0641	0.0833	0.1371	-0.3350	0.3267	0.1772	0.0950	0.1712	0.0043	-0.0180	0.9786**
Panicle length	0.2752	-0.0317	**-0.0125**	1.1429	-1.0192	-0.3266	0.2887	0.1886	0.0800	0.1689	0.0032	-0.0201	0.8693**
Number of spikelets panicle^{-1}	0.1240	-0.0006	-0.0345	**4.8294**	-4.9537	-0.3232	0.0250	-0.0197	0.0196	0.0779	0.0068	-0.0335	0.0592
Number of filled grains panicle^{-1}	0.0982	0.0010	-0.0299	4.8106	**-4.9730**	-0.2635	0.0110	-0.0245	0.0134	0.0740	0.0069	-0.0290	0.0343
Spikelet sterility percentage	0.2863	-0.0162	-0.0630	2.0639	-1.7327	**-0.7563**	0.1424	0.0443	0.0697	0.1123	0.0035	-0.0578	0.2650
Biological yield plant^{-1}	0.3516	-0.0348	-0.1222	0.3506	-0.1590	-0.3127	**0.3444**	0.2070	0.0908	0.1303	-0.0027	-0.0847	0.8658**
1000 grain weight	0.2651	-0.0228	-0.0964	-0.3344	0.4667	-0.1174	0.2500	**0.2852**	0.0940	0.0679	-0.0008	-0.0296	0.6947**
Leaf area plant^{-1}	0.3376	-0.0287	-0.0287	0.7812	-0.5474	-0.4341	0.2577	0.2208	**0.1214**	0.0984	0.0023	0.0070	0.7963**
Net assimilation rate	0.0800	0.0218	0.0854	-1.3065	1.2778	0.2949	-0.1557	-0.0672	-0.0415	**-0.2880**	-0.0140	0.0008	-0.5660*
Crop growth rate	0.2070	0.0065	0.0192	-1.3478	1.4183	0.1077	0.0388	0.0098	-0.0114	-0.1666	**-0.0242**	-0.0904	-0.1519
Harvest index	-0.1751	0.0033	0.0033	-0.8106	0.7206	0.2186	-0.1459	-0.0423	0.0043	-0.0012	0.0110	**0.1998**	0.0874

* = Significance at 5% level, ** = Significance at 1% level, Residual effect:0.1084, Underlined and bold values are direct effects

It can be concluded that number of filled grains panicle^{-1}, biological yield plant^{-1}, panicle length and number of productive tillers plant^{-1} are the major yield contributing characters leading to increased yields in hybrids compared to varieties in which biological yield plant^{-1}, plant height, 1000 grain weight and leaf area plant^{-1} are the yield contributing characters directly.

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