

## ESTIMATION OF ASSOCIATION AMONG THE YIELD AND YIELD ATTRIBUTING TRAITS IN THE SEGREGATING POPULATION OF RICE

### ABSTRACT

Indirect selection, using correlation coefficients, linear regression coefficients, and path analysis, uses a variety of yield determinants that are more heritable than yield itself and less influenced by genetic and environmental factors and therefore are stable. Therefore, Selection indirect selection based on the characters selected in the indirect selection makes the selection process more efficient, especially in the early generations selection process. Correlation coefficient analysis and the use of path coefficients are particularly important for economical and complex traits such as yield, where direct selection is less effective. Thus the present experiment was undertaken to exploit-decipher the character association between the characters in a segregating population ( $F_2$ ) population obtained from a cross between Naveen x IR 64 Drt1, and from the study, it was evident that the characters like leaf breadth, leaf area, plant height, panicle length, number of primary branches, number of secondary branches, number of filled grains, grain length and test weight were observed to have had the maximum association with yield among the characters under the study. Correlation coefficient and path coefficient analysis, revealed that the characters like-viz., number of filled grains per plant followed by grain breadth, like total number of grains, number of secondary branches, plant height, number of panicle, leaf breadth, flag leaf area, 1000 seed weight, panicle length and number of primary branches had highly significant and positive correlation with yield and positive direct effect on yield. Thus, emphasis may be given to these traits can be used to build selection criteria for the effective selection of promising lines under study. As these studies provide complete information for the response and effectiveness of the selection.

Keywords: Character association, correlation studies, path analysis, rice, segregating population,  $F_2$  generation

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### 1. INTRODUCTION

Rice has been cultivated as a major crop for over 7000 years and now feeds more than half of the world's population [cite reference]. It belongs to the monocot family Poaceae. Rice and many other food plants are monocotyledons; these plants are clearly important. Cultivated rice is made up comprises of two species: *Oryza sativa* and *Oryza glaberrima*, however, major emphasis we shall focus has been given on *O. sativa* because it is the rice grown in the majority of rice-growing countries. Except for Antarctica, rice

is now planted and harvested ~~on in~~ every continent ~~and~~. Rice is still a staple diet for the vast majority of the world's population. Rice provides nutritional ~~us~~ value to more than two-thirds of the world's population. The wide range of genetic variability in segregating populations, which is determined by the quantity of genetic variation among genotypes, provides more opportunities for selection. Many countries are currently facing the second generation problem of growing more rice at a lower cost in a deteriorating environment. Efforts ~~will beare being~~ made using a systematic research strategy to maximize yield potential through direct and indirect selection (1). ~~SegregatingSegregating~~ population the availability of genetic variety and the use of appropriate selection strategies form the foundation of any crop development strategy. ~~(2)~~. The wide range of variability presented by the ~~segregatingsegregating~~ population provides the most suitable platform for wider opportunities for effective selection. And because the F<sub>2</sub> generation is a segregating population, it is particularly important for ~~enhancing plant kinds by enforcing further selection improvement~~ improvement of particular trait(s) through selection. For this, ~~C~~ correlation studies provide knowledge on contribution of various traits on yield ~~(5)~~. ~~But~~ However, correlation does not provide the relation among cause and effect. Hence, the direct and indirect contribution of traits towards yield is predicted by path coefficient analysis (9, 8). The present investigation was ~~done carried out~~ to assess the genetic variability and study the association between traits to determine the selection criteria for enhancing the effectiveness of the selection.

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**Comment [SP2]:** You might have studied genetic variability also. It is unnecessary to write if you are not including this in the manuscript.

## 2. MATERIALS AND METHODOLOGIES

The study was conducted on the F<sub>2</sub> population developed from the cross between Naveen x IR 64 Drt1. The segregating population obtained were raised as single plant progenies and evaluated at rice research field, under the Department of Genetics and Plant Breeding, Birsra Agricultural University, Kanke, Ranchi, Jharkhand. During the *kharif* season 2021-22, the F<sub>2</sub> seeds obtained from the previous season were raised in single lines in and were also evaluated for various yield and yield attributing traits for further selection for superior segregants. The characters like ~~Days-days~~ to first flowering, days to maturity were observed for per plot ~~bases-basis~~ and characters like number of tillers, leaf length, leaf breadth, leaf area, plant height, number of panicles, panicle length, number of primary branches, number of secondary branches, number of filled grains, number of chaffy seeds, total number of grains, grain length, grain breadth, LBR ratio, biomass, test weight and grain yield per plant were taken on individual plant ~~basesbasis~~. The data recorded were subjected to correlation coefficient and path coefficient analysis using the software GRAPES (developed by the Department of Agricultural Statistics, College of Agriculture, Vellayani is based on R software) [ Must cite the authors here ]

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**Comment [SP3]:** Since each F<sub>2</sub> plant has a different genotype, estimation of these traits on per plot basis sounds very much unscientific. The authors must clarify this in the manuscript that why such observation was taken on per plot basis.

**Comment [SP4]:** The authors must mention details about:

1. Date of sowing
2. Spacing
3. Transplanting method
4. Date of harvest
5. Fertilizer dosage applied
6. Weeding and interculture methods followed
7. Plant protection measures taken (if any)
8. Methods with proper citation and name of the instruments used for estimation of all the parameters under study.

## 3. RESULT AND DISCUSSION

Indirect selection, using correlation coefficients, linear regression coefficients, and path analysis, uses a variety of yield determinants that are more heritable than yield itself and less influenced by genetic and environmental factors and therefore stable. Therefore, ~~Selectionselection~~ based on the characters selected in the indirect selection makes

theselectionmoreefficient,especiallyintheearlygenerationselectionprocess.

Correlationcoefficientanalysisandtheuseofpathcoefficientsareparticularlyimportantforeconomicalandcompl  
extraitssuchasyield,wheredirectselectionislesseffective.From the ~~table-Table~~ Table 1, it was evident that the  
characters like leaf breadth, leaf area, plant height, panicle length, number of primary branches of?,  
number of secondary branches of?, number of filled grains, grain length and test weight were observed to  
have the maximum association among the characters under the study. ~~And~~ the characters like leaf  
breadth (0.31\*\*), leaf area (0.29\*\*), plant height (0.42\*\*), number of panicle (0.16\*\*), panicle length  
(0.37\*\*), number of primary branches (0.26\*\*), number of secondary branches (0.55\*\*), number of filled  
grains(0.82\*\*), total number of grains(0.31\*\*) and grain breadth(0.28\*\*) were found to be significantly and  
positively correlated with yield per plant. Whereas for characters like days to flowering (-0.13\*), days to  
maturity (-0.13\*), grainlength (-0.23\*), LBR ratio (-0.31\*\*) and test weight (-0.16\*\*) were found to be have  
negative significant?association with the yield per plant. The association between the characters having  
positive correlation coefficient suggests the increment in both characters will be in the same direction, that  
is increase in one character will directly cause and increase in the other character, thus selection based  
on characters having positive association with the yield will ~~be selective and moderate selection will~~  
provide with the better gains. On the other hand, the characters having negative association, here the  
increase in one character will cause in decrease of the other character, thus the progress between the  
characters are in opposite direction. The selection based on these characters will not effective (10, 3,7).

What if negative selection is done for those traits?

Foraneffectiveandsuccessfulimprovementprogram,the correlationcoefficientanalysisresultsandinformationd  
onotprovidecompleteinformationabouttheoverallcontributionofindividualtraitstoyield,andthus therelationship  
betweenthe traitsunderstudy.Itisimportanttorecognizethegeneticbasis.Evenunfavorableattributes,yield-  
influencingresponsesinonetrainchoosinganothertrait,andtheirunderlyingcausesallcombinetocontributetolo  
ng-termimprovement.(9, 15).Thus, to measure the response and efficacy of selection,  
pathanalysisiscalculatedandthepathanalysiscoefficientsareusedtomapthe completeinformationabouteach  
omponent'scontributiontotheyield.Significantcorrelationsaredividedintodirectandindirecteffectsofingredient  
sonyield (12,17). Thus in the present study, from the Table 2, containing partitioning of correlation matrix  
into direct and indirect effect for the Naveen x IR 64 Drt1 via path coefficient analysis, it is evident that the  
characters having the highest positive direct effect on yield were number of filled grains per plant (0.648)  
followed by length breadth ratio (0.404) and grain breadth (0.333), and characters like total number of  
spikelet (0.073), number of secondary branches (0.069), plant height (0.055), number of panicle (0.051),  
leaf breadth (0.039), flag leaf area (0.037), 1000 seed weight (0.029), days to maturity (0.024), panicle  
length (0.014) and number of primary branches (0.008) were also found to be positive direct effect on  
yield, whereas among the characters being correlated with the yield, the character grain length (-0.199)  
and days to first flowering (-0.079) were observed to have high negative direct effect on the yield. The

residual effect was observed to be 0.29. What do you mean by residual effect? What is the implication of this value in breeding?

For the observations where the correlation coefficient is positive, but on the other hand the character's direct effect is negative, then in such cases the positive indirect effects are the main attributes of the desired positive correlation and thus the selection based on these positive indirect effects to reduce the undesirable impacts of the negative effects will be effective for selection (11,6). And for the positive direct effects in case of negative correlation a restricted selection has to be adopted for effected selection. The similar findings were observed for the days to maturity under the present study (13,14 12).

Where is the discussion portion? Same thing is written again and again!

UNDER PEER REVIEW

**Table 1: Association study among different yield and yield attributing traits for cross 1 Naveen x IR 64 Drt1**

	DF	DM	NT	LL (cm)	LB (cm)	FLA (cm <sup>2</sup> )	PH (cm)	NP	PL (cm)	PB	SB	FG	CS	TNG	GL (mm)	GB (mm)	LB R	BIO (gm)	<sup>1000</sup> SW (gm)	TGW (gm)
DF	1	0.96**	-0.01	-0.01	-0.18**	-0.12*	-0.26**	0.04	-0.08	0.02	-0.03	-0.08	-0.05	-0.09	0.12*	-0.02	0.09	0.07	0.14*	-0.13*
DM		1	0.01	-0.01	-0.20**	-0.13*	-0.26**	0.07	-0.08	0.02	-0.05	-0.08	-0.06	-0.09	0.14*	-0.04	0.12*	0.11	0.16**	-0.13*
NT			1	0.06	-0.03	-0.01	0.11	0.71**	0.09	0.13*	0.07	-0.03	0.03	-0.02	0.03	0.06	0.00	0.41**	0.03	0.01
LL (cm)				1	0.09	0.59**	0.05	0.04	0.10	-0.01	0.08	0.09	0.08	0.11	-0.09	0.06	-0.11	0.01	0.04	0.07
LB (cm)					1	0.74**	0.45**	-0.07	0.21**	-0.01	0.22**	0.27**	0.03	0.28**	-0.20**	0.18**	-0.24**	-0.16**	-0.24**	0.31**
FLA (cm <sup>2</sup> )						1	0.34**	-0.01	0.20**	-0.01	0.20**	0.26**	0.07	0.27**	-0.17**	0.15*	-0.21**	-0.09	-0.12*	0.29**
PH (cm)							1	0.07	0.33**	0.07	0.37**	0.39**	-0.00	0.39**	-0.34**	0.29**	-0.39**	-0.03	-0.38**	0.42**
NP								1	0.17**	0.15*	0.15*	0.11	0.04	0.12*	0.02	0.04	0.00	0.49**	0.01	0.16**
PL (cm)									1	0.34**	0.42**	0.39**	0.11	0.42**	-0.22**	0.09	-0.20**	0.12*	-0.17**	0.37**
PB										1	0.35**	0.32**	0.19**	0.36**	-0.17**	0.00	-0.13*	0.08	-0.09	0.26**
SB											1	0.59**	0.29**	0.66**	-0.31**	0.17**	-0.31**	0.08	-0.18**	0.55**
FG												1	-0.05	0.97**	-0.32**	0.23**	-0.35**	0.02	-0.21**	0.82**
CS													1	0.21**	-0.09	0.02	-0.08	0.04	-0.10	0.04
TNG														1	-0.33**	0.23**	-0.36**	0.03	-0.23**	0.81**
GL (mm)															1	-0.19**	0.79**	0.28**	0.45**	-0.23**
GB (mm)																1	-0.75**	-0.07	-0.13*	0.28**
LB R																	1	0.23**	0.38**	-0.31**
BIO (gm)																		1	0.24**	0.08
<sup>1000</sup> SW (gm)																			1	-0.16**
TGW (gm)																				1

\*- significant @ 5%, \*\*- highly significant @1%, DF-days to first flowering, DM- days to maturity, NT- number of tillers, FLL- flag leaf length, FLB-flag leaf breadth, FLA-flag leaf area, PH-plant height, NP-number of panicles, PL-panicle length, NPB-number of primary branches of?, NSB-number of secondary branches of?, FG-number of filled grains, CS-number of chaffy grains, TNG-total number of grains, GL-grain length, GB-grain breadth, BIO-biomass, 10SW-10 seed weight, 1000sw-test weight, TGW- total grain weight.

**Table 2: Distribution of correlation coefficient into direct and indirect effects using path coefficient analysis**

	DF	DM	LB	FLA	PH	NP	PL	PB	SB	FG	TNG	GL (1)	GB(1)	LB R	1000 SW	r value
																Y/P
<b>DF</b>	<b>-0.079</b>	0.023	-0.007	-0.004	-0.014	0.002	-0.001	0.000	-0.002	-0.051	-0.005	-0.024	-0.008	0.039	0.004	<b>-0.13</b>
<b>DM</b>	-0.076	<b>0.024</b>	-0.008	-0.005	-0.014	0.003	-0.001	0.000	-0.003	-0.051	-0.006	-0.028	-0.013	0.049	0.005	<b>-0.13</b>
<b>LB</b>	0.015	-0.005	<b>0.039</b>	0.027	0.025	-0.003	0.003	0.000	0.015	0.177	0.021	0.040	0.061	-0.097	-0.007	<b>0.31</b>
<b>FLA</b>	0.009	-0.003	<b>0.029</b>	<b>0.037</b>	0.019	0.000	0.003	0.000	0.014	0.169	0.019	0.035	0.049	-0.083	-0.004	<b>0.29</b>
<b>PH</b>	0.020	-0.006	0.018	0.013	<b>0.055</b>	0.003	0.005	0.001	0.025	0.258	0.031	0.068	0.100	-0.161	-0.011	<b>0.42</b>
<b>NP</b>	-0.003	0.002	-0.003	0.000	0.004	<b>0.051</b>	0.002	0.001	0.010	0.073	0.009	-0.003	0.012	0.002	0.000	<b>0.16</b>
<b>PL</b>	0.007	-0.002	0.008	0.007	0.018	0.008	<b>0.014</b>	0.003	0.029	0.256	0.031	0.043	0.030	-0.082	-0.005	<b>0.37</b>
<b>PB</b>	-0.002	0.001	0.000	0.000	0.004	0.008	0.005	<b>0.008</b>	0.024	0.207	0.026	0.034	0.001	-0.052	-0.003	<b>0.26</b>
<b>SB</b>	0.002	-0.001	0.009	0.007	0.020	0.008	0.006	0.003	<b>0.069</b>	0.387	0.053	0.063	0.056	-0.127	-0.005	<b>0.55</b>
<b>FG</b>	0.006	-0.002	0.011	0.010	0.022	0.006	0.006	0.002	0.041	<b>0.648</b>	0.072	0.063	0.077	-0.141	-0.006	<b>0.81</b>
<b>TNG</b>	0.006	-0.002	0.011	0.010	0.023	0.007	0.006	0.003	0.050	0.639	<b>0.073</b>	0.067	0.078	-0.148	-0.006	<b>0.82</b>
<b>GL (1)</b>	-0.009	0.003	-0.008	-0.006	-0.019	0.001	-0.003	-0.001	<b>-0.022</b>	-0.205	-0.025	<b>-0.199</b>	-0.065	0.320	0.013	<b>-0.23</b>
<b>GB(1)</b>	0.002	-0.001	0.007	0.005	0.016	0.002	0.001	0.000	0.012	0.150	0.017	0.039	<b>0.333</b>	-0.302	-0.004	<b>0.28</b>
<b>LB R</b>	-0.008	0.003	-0.009	-0.008	-0.022	0.000	-0.003	-0.001	-0.022	-0.226	-0.027	-0.157	-0.249	<b>0.404</b>	0.011	<b>-0.31</b>
<b>1000 SW</b>	-0.011	0.004	-0.009	-0.005	-0.021	0.001	-0.002	-0.001	-0.012	-0.133	-0.016	-0.090	-0.042	0.152	<b>0.029</b>	<b>-0.16</b>

Residual effect: 0.299

\* r= correlation, DF-days to first flowering, DM- days to maturity, NP- number of tillers, FL- flag leaf length, FLB-flag leaf breadth, FLA-flag leaf area, PH- plant height, NPnumber of panicles, PL-panicle length, NPB-number of primary branches, NSB-number of secondary branches, FG-number of filled grains, CS-number of chaffy grains, TNG-total number of grains, GL-grain length, GB-grain breadth, BIO-biomass, 10SW-10 seed weight, 1000sw-test weight, TGW- total grain weight.

**Table 3: Selected Segregants having superior characteristics based on the selection criteria**

SL. NO.	PL NO	DF	DM	NT	LL	LB	FLA	PH	NP	PL	PB	SB	FG	TNG	GL	GB	LB R	BIO	TSW	Y/P
264	B1C9 297	112	151	5	30	1.8	54	92	4	25	10	27	162	172	4	1.4	2.85	12.27	23	6.19
271	B1C9 375	113	152	8	22	1.8	39.6	99	6	22	10	22	112	122	4.3	1.2	3.58	14.69	17	6.43
239	B1C8 159	112	151	10	19	1.6	30.4	74	8	21	9	19	101	106	3.8	1.4	2.71	15.46	14	7.4
252	B1C9 128	120	159	15	28	1.2	33.6	109	11	22	6	22	142	148	4	1.9	2.10	19.19	19	8.49
263	B1C9 282	113	152	6	8	1.2	9.6	107	4	19	8	21	115	120	3.9	1.4	2.78	15.46	12	5.15
262	B1C9 280	113	152	6	27	1.5	40.5	106	4	20	8	22	108	121	3.9	1.4	2.78	21.01	20	7.18
249	B1C9 26	119	158	6	25	1.2	30	98	18	27	11	40	172	183	3.6	1.2	3	17.72	13	7.64
255	B1C9 176	112	151	19	30	1.2	36	73	17	24	9	10	110	115	4.3	1.2	3.58	16.25	22	7.18
250	B1C9 76	122	161	16	28	1.2	33.6	66	12	25	12	29	25	49	4	1.4	2.85	18.78	30	3.46
245	B1C9 14	120	159	4	30	1.2	36	71	9	28	12	46	136	191	3.8	1.3	2.92	16.81	10	10.13
260	B1C9 254	112	151	9	32	1	32	88	7	23	10	34	95	135	4.8	1.3	3.69	23.54	17	4.91
267	B1C9 342	112	151	6	32	1.5	48	105	2	23	11	33	208	222	3.7	1.3	2.84	6.38	14	12.6
268	B1C9 350	113	152	7	24	1.5	36	90	7	21	10	30	195	205	3.8	1.2	3.16	14.16	12	8.79
219	B1C8 15	110	149	8	23	1	23	86	7	26	11	9	120	131	3.9	1.5	2.6	10.89	13	8.96
105	B1C1 169	116	155	6	30	0.9	27	67	6	20	10	19	82	88	4	1.3	3.07	18.29	70	2.75
185	B1C1 190	122	167	5	24	1	24	58	5	20	7	8	58	64	4.6	1.3	3.53	12.27	33	4.33
243	B1C8 246	112	151	9	22	1	22	78	8	21	8	29	127	133	3.9	1.4	2.78	12.65	10	9.44

DF-days to first flowering, DM- days to maturity, NT- number of tillers, FLL- flag leaf length, FLB-flag leaf breadth, FLA-flag leaf area, PH-plant height, NP- number of panicles, PL-panicle length, NPB-number of primary branches, NSB-number of secondary branches, FG-number of filled grains, CS-number of chaffy grains, TNG-total number of grains, GL-grain length, GB-grain breadth, BIO-biomass, 10SW-10 seed weight, 1000sw-test weight, TGW- total grain weight.

#### 4. CONCLUSION

On the basis of the study conducted ~~for via~~ correlation coefficient and path coefficient analysis, the characters like number of filled grains per plant followed by grain breadth, along with characters like total number of grains, number of secondary branches, plant height, number of panicles, leaf breadth, flag leaf area, 1000 seed weight, panicle length and number of primary branches can be used to ~~build formulate~~ selection criteria for the effective selection of promising lines under study. As these studies provide complete information for the response and effectiveness of the selection. ~~The selected segregants based on the created selection criteria are stated in the table 3.~~

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