Full Length Research Article

CARAS
© 2024, Centre for Advanced Research in Agricultural Sciences
Research Journal of Agricultural Sciences
Volume 15; Issue 06 (Nov–Dec 2024); pp 1295–1298

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

Regression and Path Analysis of Some Yield Attributing Traits in Aromatic Rice Landraces of North East India

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Received: 28 Jan 2024; Revised accepted: 28 Nov 2024

Abstract

Present study focusses on regression analysis based on correlation of traits and cause effect analysis in eight promising scented and aromatic landraces of rice collected from the Bagbari village of Kaliganj area of Karimganj district, South Assam. Remarkable variability was found among the trait's studies. Correlation analysis reflects the strength of the relationship of the characters like number of grains per panicle (r=0.823), 1000grain weight (0.704), leaf breadth (r=0.815), flag leaf angle (0.804), grain length (r=0.700) and grain yield (r=0.410) where they are highly correlated with positive value. Regression analysis revealed the importance of the traits like Leaf length leaf breadth, seedling height, panicle length, grain length/breadth ratio, grain length, number of primary branches per panicle and maturity in days influencing the grain yield remarkably. Important characters which showed highest direct positive effect on grain yield were grain breadth (10.939), leaf length (0.983), grain length/breadth ratio (8.861), grain length (r=0.700) number of primary branches per panicle (0.657) and seedling height (0.589). This study explored the direct selection of the above cited traits which might be selected for grain yield improvement due to their true relationship with the grain yield.

***Key words*:** Regression, Aromatic rice, Landrace, Direct and indirect effect, Path analysis, Grain yield

Rice (*Oryza sativa* L.) is the staple food for more than two billion people of the world [1] and South East Asia is the place of people who consume rice as their major food [2]. In the 21st century, there is an increase in the number of rice consumers due its many nutritive values, especially for the mass people [3]. Rice has evolved through different ways of adaptation and changed from local traditional cultivars, experienced by farmers, keeping them intact in the form of race, cultivating them as such and conserving them for future use [4-5]. Any crop improvement programme needs a suitable donor and traditional rice is the only option [6]. A challenging rice yield is desirable to every farmer and there is always a need of identification of yield attributing traits for rice yield improvement [7]. Challenges and efforts are being made to develop a promising variety with less time to maturity, fine grains and high-quality yield. Developing a promising rice variety that meets the criteria of shorter maturity time, fine grains, and high-quality yield is a complex but highly sought-after goal. This involves overcoming several challenges and leveraging innovative strategies. It is a struggle and challenge nowadays to provide quality rice to the nation. The extent and duration of variability and diversity in local rice landraces is unparallel which is helpful to mitigate the unlimited food supply, decrease the poverty level and develop a primary economic growth not only for the nation but also at global level [5]. Basically, any documentation and information about the traits and their nature of variability can be done by selection of parameters like genotype×environment interaction. It can be said that the environment plays a major role in expressing the variability of any trait and selection of any trait is more stable which allows us to use as an efficient selection criterion in breeding programme [8].

It has been stated that a character can be used as a selection criterion if there is a real relationship between the characters and the intended character [9]. Study of correlation and regression is important to know the relationship of traits which can be referred for any future crop improvement programme for making a selection. In a linear regression model, a regression analysis is used to analyze and determine the relationship of response variable and explanatory variable. The residual sum of squares gives the idea about the magnitude and percentage of variability in the response variable. The R^2 value confirms the successful linear relationship between the variables and hence the program. On the other hand, path analysis helps us to partition the correlation coefficients into direct and indirect effects for yield attributing traits on rice grain yield [10]. Assam is a place of locally cultivated germplasm of rice having diverse gene pool and is highly demandable in the market due to its high scent and aromatic features. Documentation, cultivation and conservation of these invaluable scented cultivars is now keenly essential. Keeping this in view, this study aims to understand the consideration of some yield attributing traits which are interrelated and have direct and indirect effect on grain yield and productivity of traditional aromatic rice landraces of South Assam. It is very much beneficial for a plant breeder to select the right characters

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Citation: Chakravorty A. 2024. Regression and path analysis of some yield attributing traits in aromatic rice landraces of North East India. *Res. Jr. Agril. Sci.* 15(6): 1295-1298.

which may bring good yield and indirectly help in selection of suitable cultivars in segregating population.

MATERIALS AND METHODS

Total eight aromatic rice landraces were collected from the gene bank of Krishi Vigyan Kendra, Akbarpur, Karimganj, Assam. The cultivars were also collected from farmers' field of Bagbari village, kaliganj area, under Karimganj district in 2018 and 2019. The experiment was done following randomized block design with three replications. (24˚86´N latitude and 92˚30´E longitude with an altitude of 9.75 meters above mean sea level). The soil reaction gives a slightly acidic pH of 6.0, with low soluble salts (EC of 0.15 dS m^{-1}), medium organic carbon content (0.57%), Total N (0.056%), medium in available P (25.28 kg ha^{-1}) and K (148.77 kg ha^{-1}). Each admission was transplanted (45 days old seedling) in a plot of $6m^2$ with a spacing of 20cm. between rows and 15cm. connecting plants in a row. An unsystematic sample of five competitive plants was used for observations on different character under study. Among eight elite rice races, three races viz., Biroin, Gandhi Biroin and Latma was highly aromatic.

The yield attributing traits taken for this study were Leaf length (Ch1), Leaf Breadth Ch2), seedling height (Ch3), flag leaf angle (Ch4), panicle length (Ch5), grain length (Ch6), grain breadth (Ch7), grain length/breadth ratio (Ch8), 1000 grain weight (Ch9), number of grains per panicle (Ch10), number of primary branches $panicle^{-1}$ (Ch11), sterile lemma length (Ch12), maturity in days (Ch13) and grain yield (Ch14). Calculation was done based on statistical procedures following variance and covariance was done following the formula of Singh and Chaudhury [11]. The replication-wise mean values of cultivars were subjected to statistical analysis using AGRISTAT software. Mean values of the cultivars were subjected to genotypic correlation co-efficient as per the method suggested by Falconer and Mackay [12]. Besides regression analysis was done taking grain yield as independent variable in each separate analysis where average of replications data and average of genotypes data were used. Path coefficient analysis as applied by Dewey and Lu [13], was utilized for the partition of the genotypic correlation coefficients into measures of direct and indirect effects.

RESULTS AND DISCUSSION

Results showed that there was a remarkable and positive correlation among the traits taken under study. The study of correlation analysis reflects the strength of the relationship of the characters like number of grains per panicle (r=0.823), 1000grain weight (0.704), leaf breadth (r=0.815), flag leaf angle (0.804), grain length (r=0.700) and grain yield (r=0.410) where they are highly correlated with positive value. These findings were also in accordance with the previous reports of Sinha *et al.* [14]. Similar findings were made by Ekka *et al*. [15] for grain length, grain breadth, kernel length and kernel breadth. Reddy [16], Acharya *et al*. [17], Prashanth *et al*. [18], Sawarkar and Senapati [19], Chakravorty and Ghosh [20] also observed significant positive correlation at both genotypic and phenotypic levels for 100 grain weight. The regression analysis was done following the results of correlation analysis. Linear equation showed good relationship between grain yield (Ch14) with other characters. Regression analysis reveals the importance of the traits like Leaf length leaf breadth, seedling height, panicle length, grain length/breadth ratio, grain length, number of primary branches per panicle and maturity in days influencing the grain yield remarkably. The high value of R^2 (adjusted) indicated that all the variables or traits taken for the study were able to describe all grain yield variation. So, to increase the grain yield/plant, the above parameters are to be taken in account to frame the hybridization programme (Table 1). A strong positive correlation among the studied traits, highlighting their significant influence on grain yield and underscoring the importance of incorporating these parameters in hybridization programs to enhance rice productivity.

Table 1 Linear regression of dependent variable with response variable

Response variable	S. No.	Dependent variable	Multiple of R	R-SQ	Adjusted R-SQ	F	DF
Ch14	1	Ch1	0.9997	0.9994	0.9995	258.19	2
	2	Ch2	0.9997	0.9993	0.9965	361.02	3
	3	Ch3	0.9997	0.9993	0.9975	539.63	4
	4	Ch4	0.9996	0.9993	0.9978	675.29	5
	5	Ch5	0.9996	0.9992	0.9980	846.47	6
	6	Ch6	0.9995	0.9991	0.9981	967.91	7
	7	Ch7	0.9991	0.9983	0.9968	667.22	8
	8	Ch8	0.9981	0.9962	0.9717	40.68	2
	9	Ch9	0.9983	0.9965	0.9825	71.32	3
	10	Ch10	0.9981	0.9962	0.9857	97.81	4
	11	Ch11	0.9981	0.9962	0.9885	130.24	5
	12	Ch12	0.9980	0.9960	0.9900	165.19	6
	13	Ch13	0.9975	0.9950	0.9893	174.26	7

Ch1=Leaf Length, Ch2=Leaf Breadth, Ch3=Seedling Height, Ch4=Flag Leaf Angle, Ch5=Panicle Length, Ch6=Grain Length, Ch7=Grain Breadth, Ch8=Grain Length /Breadth Ratio, Ch9=1000 Grain Weight, Gh10=No. of grains/panicle, Ch11=No. of Primary Branches/ panicle, Ch12=Sterile lemma length, Ch13: Maturity in days, Ch14=Grain Yield

Findings from the path analysis cited in (Table 2-3) revealed that highest direct positive effect of grain breadth (10.939) on grain yield was observed. It was followed by grain leaf length (0.983), grain length/breadth ratio (8.861), number of primary branches per panicle (0.657), seedling height (0.589) and leaf breadth (0.205). Chakravorty and Ghosh [21] found the direct relationship of number of primary branches per panicle with the grain yield. Besides, there was some direct negative effects of some traits viz., grain length (-9.161), 1000 grain weight (-0.950) were found on grain yield, maturity in days (-0.704) and sterile lemma length (-0.704). The residual value was found to be 0.27 which indicates that 99.73 percent of the variability in respect to grain yield could be contributed by thirteen characters studies in path analysis. Thus, it may be stated that the causal variables are proficient to elucidate the state of variation in response variable, i.e., grain yield. So, value

of traits stated in genotypic and phenotypic path could be considered and taken into account while framing the selection criteria in breeding programme on the basis of the above cited traits under experimentation and research.

Table 2 Path analysis (genotypic) showing the direct and indirect effects of 13 traits on grain yield (Ch14) in traditional aromatic rice cultivars

Traits	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12	Ch13
Ch1	**2.312**	0.729	-0.267	-0.377	-0.493	-16.105	-2.562	14.711	0.134	0.025	-0.415	1.037	0.677
Ch2	2.129	**0.791**	-0.737	-0.217	-0.068	-15.074	3.436	8.908	0.502	0.032	-0.588	0.716	0.515
Ch3	-0.367	-0.355	**1.641**	-0.168	-0.263	1.374	-10.452	6.160	0.890	0.059	0.857	0.514	0.327
Ch4	1.854	0.367	0.589	**-0.469**	-0.816	-9.249	-10.990	15.958	0.566	0.029	0.580	1.567	-0.103
Ch5	0.870	0.041	0.330	-0.292	**-1.309**	-15.433	3.785	9.641	1.773	-0.104	-0.416	0.511	0.387
Ch6	1.617	0.518	-0.098	-0.188	-0.878	**-23.021**	12.327	7.579	0.936	-0.061	-1.087	0.504	1.132
Ch7	-0.208	0.096	-0.603	0.181	-0.174	-9.978	**28.441**	-16.602	0.089	-0.149	-1.285	-0.058	-0.016
Ch8	1.445	0.299	0.429	-0.318	-0.536	-7.412	-20.058	**23.541**	0.871	0.098	0.493	0.342	0.739
Ch9	-0.150	0.192	-0.706	0.128	0.122	10.410	1.217	-9.908	**-2.070**	0.113	0.472	0.142	-0.519
Ch10	0.215	0.094	0.361	-0.050	0.506	5.190	-15.710	8.598	-0.871	**0.269**	1.380	0.461	0.921
Ch11	-0.491	-0.238	0.720	-0.139	0.279	12.818	-18.729	5.942	-0.500	0.190	**1.952**	0.124	-0.793
Ch12	-1.358	-0.321	-0.478	0.416	0.379	6.577	0.930	-4.557	-0.166	0.070	0.137	**-1.765**	-0.507
Ch13	-0.591	-0.154	-0.240	-0.018	0.191	9.841	0.173	-6.573	-0.406	-0.093	0.584	0.338	**-2.648**

Diagonal values indicate the direct effects (Residual Value-0.027)

Ch1=Leaf Length, Ch2=Leaf Breadth, Ch3=Seedling Height, Ch4=Flag Leaf Angle, Ch5=Panicle Length, Ch6=Grain Length, Ch7=Grain Breadth, Ch8=Grain Length /Breadth Ratio, Ch9=1000 Grain Weight, Ch10=No. of grains/panicle, Ch11=No. of Primary Branches/ panicle, Ch12=Sterile lemma length, Ch13: Maturity in days, Ch14=Grain Yield

Table 3 Path analysis (phenotypic) showing the direct and indirect effects of 13 traits on grain yield (Ch14) in traditional aromatic rice cultivars

Traits	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12	Ch13
Ch1	**0.893**	0.180	-0.096	-0.110	-0.073	-6.346	-0.984	5.470	0.058	0.061	-0.165	0.337	0.182
Ch2	0.783	**0.205**	-0.251	-0.057	-0.017	-5.735	1.387	3.145	-0.234	0.072	-0.248	0.195	0.127
Ch3	-0.145	-0.087	**0.589**	-0.048	-0.039	0.546	-4.001	2.301	0.407	0.145	0.334	0.166	0.101
Ch4	0.574	0.068	0.165	**-0.171**	-0.092	-2.849	-3.016	4.391	0.194	0.052	0.149	0.445	0.003
Ch5	0.328	0.017	0.116	-0.078	**-0.200**	-6.085	1.547	3.613	0.795	-0.250	-0.181	0.158	0.098
Ch6	0.619	0.128	-0.035	-0.053	-0.133	**-9.161**	4.721	2.877	0.432	-0.148	-0.418	0.161	0.294
Ch7	-0.080	0.026	-0.215	0.047	-0.027	-3.954	**10.939**	-6.241	-0.042	-0.362	-0.507	-0.023	-0.003
Ch8	0.552	0.073	0.153	-0.085	-0.081	-2.974	-7.705	**8.861**	0.402	0.238	0.199	0.112	0.189
Ch9	0.055	0.050	-0.252	0.035	0.167	4.164	0.486	3.753	**-0.950**	0.275	0.173	-0.050	-0.132
Ch10	0.084	0.022	0.130	-0.014	0.076	2.066	-6.025	-3.211	-0.398	**0.657**	0.539	-0.150	0.244
Ch11	-0.186	-0.064	0.249	-0.032	0.046	4.841	-7.003	2.229	-0.207	0.447	**0.791**	-0.044	-0.214
Ch12	-0.507	-0.067	-0.164	0.128	0.053	2.491	0.430	-1.677	-0.080	0.166	0.059	**-0.594**	0.124
Ch13	-0.231	-0.037	-0.085	0.001	0.028	3.823	0.043	-2.377	-0.178	-0.227	0.241	0.104	**-0.704**

Diagonal values indicate the direct effects (Residual Value-0.050)

Ch1=Leaf Length, Ch2=Leaf Breadth, Ch3=Seedling Height, Ch4=Flag Leaf Angle, Ch5=Panicle Length, Ch6=Grain Length, Ch7=Grain Breadth, Ch8=Grain Length /Breadth Ratio, Ch9=1000 Grain Weight, Ch10=No. of grains/panicle, Ch11=No. of Primary Branches/ panicle, Ch12=Sterile lemma length, Ch13: Maturity in days, Ch14=Grain Yield

CONCLUSION

So, in summary, it may be concluded that characters like number of grains per panicle (r=0.823), 1000grain weight (0.704), leaf breadth (r=0.815), flag leaf angle (0.804), grain length (r=0.700) and grain yield (r=0.410) are highly correlated with positive value among themselves and with the grain yield. The high value of R^2 (adjusted) indicated that all the variables or traits taken for the study were able to describe all grain yield variation. So, to increase the grain yield/plant, the above parameters are to be taken in account to frame the hybridization programme. Path analysis revealed the direct relationship of number of primary branches per panicle with the grain yield. The residual value was found to be 0.27 which indicates that 99.73 percent of the variability in respect to grain yield could be contributed by thirteen characters studies in path analysis. So, selection of traits based on this study would be useful for future breeding programme in rice.

Acknowledgement

The author acknowledges his debt of gratitude to the Principal, Sripat Singh College, SAJC and HoD, Department of Botany, K. U. for providing facilities to complete the work in the Department. Author is especially thankful to Prof. P. D. Ghosh, Dept. of Botany University of Kalyani, Dr. Amitava Ghosh, (Former Scientist, Chinchurah Rice Research Station and ZARS, Krishnagar) of IAS, Calcutta University and Prof. P. K. Sahu (BCKV) for all success of this project.

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