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Research Article

Assessing the genetic diversity and association of traits among the rice (*Oryza sativa* L.) landraces and varieties from Tamil Nadu

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Abstract
In this study, the genetic diversity among forty-two rice genotypes were evaluated for fifteen quantitative and eleven qualitative traits using D^2 statistics and DUS characterization. The genotypes were grouped into eight clusters of which the cluster VIII was the largest consisting of twelve genotypes. While, the clusters IV and VII were the smallest with a single genotype each. The maximum inter-cluster distance was observed between clusters I and II. Hence, the genotypes from these clusters could be used as parents for rice hybridization programmes in future. Among all traits, days to 50% flowering and apiculus colour were found to be the major contributing quantitative and qualitative traits towards genetic diversity. Beyond this, in this study Cluster II recorded the highest mean value for shoot length, plant height, flag leaf width, panicle length, number of seeds per panicle, 1000 grain weight and single plant yield. However, the cluster VII recorded the highest mean for seedling height, flag leaf length, grain length and grain width. Thus, the genotypes from these clusters which were Aanai Komban, Kichili samba and Karuppu kavuni could be used in improving the yield parameters in rice. Further, the correlation analysis for fifteen traits revealed a significant positive correlation of number of productive tillers, flag leaf length, flag leaf width, number of seeds per panicle, grain length and 1000 grain weight with single plant yield. Further the path analysis portrayed that the from these correlated traits, number of productive tillers, flag leaf width, number of seeds per panicle and grain length were observed to have a positive direct influence on yield. Thereby, it could be observed that these traits could be used as major indicators for selection of desirable genotypes for utilization in hybridization programme to develop elite rice genotypes.

Keywords: Genetic diversity, rice landraces, D^2 statistics, clustering by PCA, correlation and path analysis.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important staple food, consumed by both developed and developing countries. It contributes for almost 40 per cent of total food grain production and provides a livelihood for millions of rural populations (Amudha and Ariharasutharsan, 2021). Rice among all food crops is observed to contribute for about 45 per cent of Indian cereal production covering about one-fourth of the total cropped area which provides food to about half of the Indian population. This is a self-pollinated cereal crop in the order of Cyperales and is a part of the family Gramineae (synonym-Poaceae) (Chakma *et al.,* 2012). Rice is grown under a variety of environments such as irrigated, rainfed lowland, rainfed and flood-prone ecosystems. Thus, it is the only crop grown in the most

fragile ecosystems covering all agro-climatic zones from sea level to hilly areas (Hazman *et al.,* 2018). Thereby, future concerns on growing the rice genotypes under unfavourable circumstances necessitate more resilient types with higher yield potential which emphasizes the restoration of novel alleles from rice landraces (Kumari *et al.,* 2018).

Landraces are generally called as the native varieties. The heterozygosity in landraces aids in the adaptation to wide agro-ecological niches and also possesses the necessary qualitative and medicinal properties (Divya, 2020). The importance of landraces in agriculture could also be emphasised in future for improving existing varieties with desirable novel genes for nutrition and climate resilience. Thus, landraces could provide a significant gene pool for future breeding programmes and it also provides immense potential for wide variation (Umadevi *et al.,* 2019). Rich variability for complex quantitative traits among the traditional landraces is found to be unexplored. Thereby, identification of unique traditional rice genotypes with climate resilience and yield needs to be further explored (Divya, 2020; Kumbhar *et al.,* 2015).

Usage of agro-morphological markers in the characterization of rice has been reported by Chakravorty *et al.,* 2013. Study on genetic diversity among rice landraces by Kumari *et al.* (2018) identified flowering, plant height and panicle length to be the key contributors for analysing the variability and diversity. Similarly, higher genetic variations for rice genotypes with six clusters having a monogenotypic pattern of distribution further reveals the presence of extensive variation among the rice genotypes (Rashmi *et al*.2019). Recent studies on unravelling the genetic diversity among the landraces presented the existence of wider variability for single plant yield, grain length, 1000 grain weight, grain width and days to 50% flowering. Hence, it could be observed that the presence of variability among the diverse accessions in rice from varied agroclimatic conditions needs to be further explored for characterizing novel traits for utilization in future (Amudha *et al*.2021). In a view of these findings, the present study was conducted to assess the nature and magnitude of genetic divergence as well as the interrelationship of quantitative and qualitative traits present in the rice germplasm from Tamil Nadu for yield attributes and grain characteristics.

MATERIALS AND METHODS

The experiment was conducted with 42 rice landraces and varieties collected from different parts of Tamil Nadu (**Table 1**). They were evaluated at Karunya Institute of Technology and Sciences, Coimbatore during *kharif* 2022. The genotypes were raised in a Randomized Block Design (RBD) with three replications with a spacing of 20 x 20 cm by implementing the recommended packages of agricultural practices. Five plants were selected randomly from each replication and observations were recorded on 15 quantitative traits *viz.,* seedling height (cm), days to 50% flowering, plant height (cm), shoot length (cm), number of tillers (nos), number of productive tillers (nos), flag leaf length (cm), flag leaf width (cm), panicle length (cm), number of seeds per panicle (nos), grain length (mm), grain breadth (mm), 1000 grain weight (g), days to maturity, single plant yield (g) and 11 qualitative traits *viz.,* vegetative vigour, tillering ability, leaf blade pubescence, leaf blade colour, auricle colour, apiculus colour, panicle type, secondary branches of panicle, panicle curvature of main axis, panicle exsertion and seed colour. These 11 visually assessed morphological and agronomical traits were recorded using the National Test Guidelines for DUS test by the Indian Institute of Rice Research, Hyderabad. Observation on various characteristics was recorded during the determined growth phases of development using appropriate methods in compliance with the DUS test guidelines of the PPV & FR Act, 2001. (Rani *et al.,* 2004). D^2 statistics developed by Mahalanobis (1936) using hierarchical clustering on principal components method was used to analyse the collected data. Further, correlation among the morphological traits were analysed using the methodology developed by Johnson *et al.* (1995) and path coefficients were estimated using the methodology developed by Dewey and Lu (1959). The statistical analyses were carried out in R software version 4.2.2 from the packages of 'Biotools,' 'Agricolae,' and 'Metan'.

RESULTS AND DISCUSSION

The analysis of variance for 15 quantitative traits revealed significant difference among the 42 genotypes indicating the presence of variation among the genotypes for all the characters studied (**Table 2**). The 42 genotypes were grouped into eight clusters based on the D^2 distance. Among these eight clusters, cluster VIII comprised of 12 genotypes. Cluster I and cluster VI constituted of eight genotypes each, followed by which cluster III and V had five genotypes each respectively. Cluster II included two genotypes whereas, cluster IV and cluster VII had only one genotype each respectively (**Table 3**). These genotypes were thus grouped into clusters based on the per cent contribution of the traits. It was observed that the major contributing genotypic traits towards divergence were days to 50% flowering, number of seeds per panicle, number of tillers and 1000 grain weight. The qualitative traits with major contribution for divergence were found to be apiculus colour , panicle exertion, leaf blade colour and panicle curvature of main axis (**Table 4a & 4b**). Similar observations were reported for days to 50% flowering, plant height and number of seeds per panicle by Kumari *et al.* (2018), Rashmi *et al.* (2018) and Amudha *et al.* (2021).

The inter and intra cluster distances were very useful in assessing the diversity among and within the clusters of genotypes. Further, this helped in identifying suitable diverse genotypes for hybridization. In the present study,

Table 1. List of Genotypes and their place of collection

S. No.	Name of the Variety	Place of Collection
1	Aanai Komban	TNAU-AC & RI, Madurai
2	ADT (R) 45	Local farmer, Madurai
3	Amman Ponni	Local farmer, Salem
4	Arumpatham Kuruvai	State seed farm, Kanyakumari
5	ASD 16	Local farmer, Kanyakumari
6	Chinnar	TNAU-AC & RI, Madurai
7	CO 51	TNAU, Coimbatore
8	CO 52	TNAU, Coimbatore
9	CO 53	TNAU, Coimbatore
10	CO 54	TNAU, Coimbatore
11	CO 55	TNAU, Coimbatore
12	CR1009Sub 1	State seed farm, Kanyakumari
13	JGL	Local farmer, Madurai
14	Kalasar	Local farmer, Madurai
15	Karudan Samba	Local farmer, Salem
16	Karumkuruvai	TNAU-AC & RI, Madurai
17	Karuppu Kavuni	State seed farm, Kanyakumari
18	Keerai Samba	State seed farm, Kanyakumari
19	Kichadi Samba	TNAU-AC & RI, Madurai
20	Kollan Samba	State seed farm, Kanyakumari
21	Kothamalli Samba	TNAU-AC & RI, Madurai
22	Kottaram Samba	Local farmer, Kanyakumari
23	Kulipadichan	TNAU-AC & RI, Madurai
24	Kullakar	TNAU-AC & RI, Madurai
25	Kuttakar	Local farmer, Salem
26	Kuzhaiyadi Samba	Local farmer, Kovilpatti
27	Mapillai Samba	TNAU-AC & RI, Madurai
28	Milagu Samba	TNAU-AC & RI, Madurai
29	Navara	Local farmer, Salem
30	Norungan	TNAU-AC & RI, Madurai
31	Poongar	Local farmer, Salem
32	Rajae Samba	State seed farm, Kanyakumari
33	Rakthasali	Local farmer, Salem
34	Seeraga Samba	TNAU-AC & RI, Madurai
35	Sithiraikar	TNAU-AC & RI, Madurai
36	Sivapu Kavuni	TNAU-AC & RI, Madurai
37	Sornamasuri	TNAU-AC & RI, Madurai
38	Thanga Samba	State seed farm, Kanyakumari
39	Thooyamalli	Local farmer, Kovilpatti
40	TPS 3	Local farmer, Kanyakumari
41	TPS 5	Local farmer, Kanyakumari
42	Vellakar	Local farmer, Salem

Table 2. ANOVA for fifteen quantitative traits

S. No.	Traits	Mean sum of squares		
		Replication	Genotypes	Error
1	Seedling height	718.35	285.53**	12.94
2	Days to 50% flowering	35.39	657.87**	2.09
3	Shoot length	134.21	1310.97**	3.60
4	Plant height	725.40	1597.67**	4.98
5	Number of tillers	86.82	57.70**	0.42
6	Number of productive tillers	76.61	71.27**	0.45
7	Flag leaf length	699.12	220.37**	2.19
8	Flag leaf width	0.24	0.10**	0.01
9	Panicle length	235.67	44.61**	0.86
10	Number of seeds per panicle	57.37	1118.11**	6.08
11	Grain length	0.15	7.95**	0.06
12	Grain width	0.05	1.28**	0.03
13	1000 grain weight	2.39	166.13**	1.11
14	Days to maturity	35.39	576.25**	2.09
15	Single plant yield	24.76	131.93**	0.94

** Significant at 1% level,

Table 3. Distribution of forty-two genotypes among different clusters

Clusters	Number of genotypes	Name of genotypes
I	8	Kullakar, Seeraga Samba, Milagu Samba, Thanga Samba, Vellakar, Kuzhiyadichan, Thooyamalli, Rathashali
II	2	Aanai Komban, Kichili Samba
III	5	Norungan, Kuliyadichan, TPS 3, Keerai Samba, Kollan Samba
IV	1	Sivapu Kavuni
V	5	Sithiraikar, Karum Kuruvai, Mapillai Samba, Kothamalli Samba, Navara
VI	8	Chinnar, Sornamasuri, CR1009Sub1, CO 52, CO 55, Kalasar, Amman Ponni, Karudan Samba
VII	1	Karupu Kavuni
VIII	12	Arumpatham Kuruvai, TPS 5, ASD 16, CO 54, CO 53, CO 51, Rajae Samba, Kottaram Samba, JGL, ADT (R) 45, Poongar, Kuttakar

highest inter cluster distance was recorded between cluster I and cluster II. The cluster I comprised of the genotypes namely, Kullakar, Seeraga Samba, Milagu Samba, Thanga Samba, Vellakar, Kuzhiyadichan, Thooyamalli, Rathashali. The cluster II comprised of the genotypes such as, Aanai Komban and Kichadi Samba. Following this, the cluster IV and cluster VII showed the second highest inter cluster distance. In which the cluster IV comprised of the genotypes *viz.,* Sivapu Kavuni and the cluster VII comprised of the genotype Karuppu Kavuni respectively. Thus, the genotypes from these diverse clusters could be used in hybridization programmes for developing desirable segregants with the accumulation of favourable genes in the segregating generations. On contrary, the lowest inter cluster distance was observed between cluster III and cluster V. This indicated that the genotypes in these clusters were genetically similar (**Table 5**). The inter-cluster distances were higher than the intra-cluster distances, indicating that there was significant variability among the genotypes (Kumar *et al.,* 2014). Further, the intra-cluster distance was highest in cluster I and it comprised of eight genotypes followed by cluster VIII which had second highest intra-cluster distance and consisted of 12 genotypes (**Fig. 1**). The intra-cluster distance was observed to be as null in the cluster IV and cluster VII as they contained only one genotype each respectively (**Table 5**). Similar findings on the inter and intra cluster distances in rice were also reported by Sinha *et al.* (2013), Kumari *et al.* (2018) and Rashmi *et al.* (2018). The clusters with mono-genotypes were also reported by Rashmi *et al.* (2019) and Amudha *et al.* (2021).

Table 4a: Contribution of fifteen quantitative characters towards genetic divergence

Traits	% contribution
Days to 50% flowering	17.99
Number of seeds per panicle	14.72
Number of tillers	11.21
1000 grain weight	9.35
Panicle length	8.18
Single plant yield	6.89
Shoot length	6.89
Seedling height	6.19
Flag leaf width	5.84
Days to maturity	5.14
Flag leaf length	2.92
Plant height	1.64
Grain width	1.52
Number of productive tillers	0.93
Grain length	0.58

Table 4b. Contribution of eleven qualitative characters towards genetic divergence

Traits	% contribution
Apiculus colour	25.43
Panicle exsertion	14.84
Leaf blade colour	10.98
Panicle curvature of main axis	8.86
Seed colour	8.67
Vegetative vigour	7.89
Secondary branches of panicle	7.32
Tillering ability	6.94
Panicle type	4.05
Leaf blade pubescence	3.47
Auricle colour	1.54

Table 5. Average inter and intra cluster D^2 values among eight clusters

	C1	C2	C3	C4	C5	C6	C7	C8
C1	**5.03**	33.00	13.08	17.22	13.39	15.54	23.73	17.02
C2		**2.37**	14.33	22.19	15.31	19.94	5.98	23.94
C3			**3.61**	16.31	5.37	8.58	7.41	10.20
C4				**0.00**	20.75	9.67	27.37	21.54
C5					**1.77**	13.27	6.45	10.47
C6						**3.44**	18.10	13.62
C7							**0.00**	13.01
C8								**4.22**

The cluster mean revealed a wide range of variation for both quantitative and qualitative traits (**Table 6**). Cluster II performed better with highest mean for shoot length, plant height, flag leaf width, panicle length, number of seeds per panicle, 1000 grain weight and single plant yield. Therefore, the genotypes in cluster II (Aanai Komban and Kichadi Samba) would be useful for the improvement of photosynthetically efficient and high yielding rice varieties.

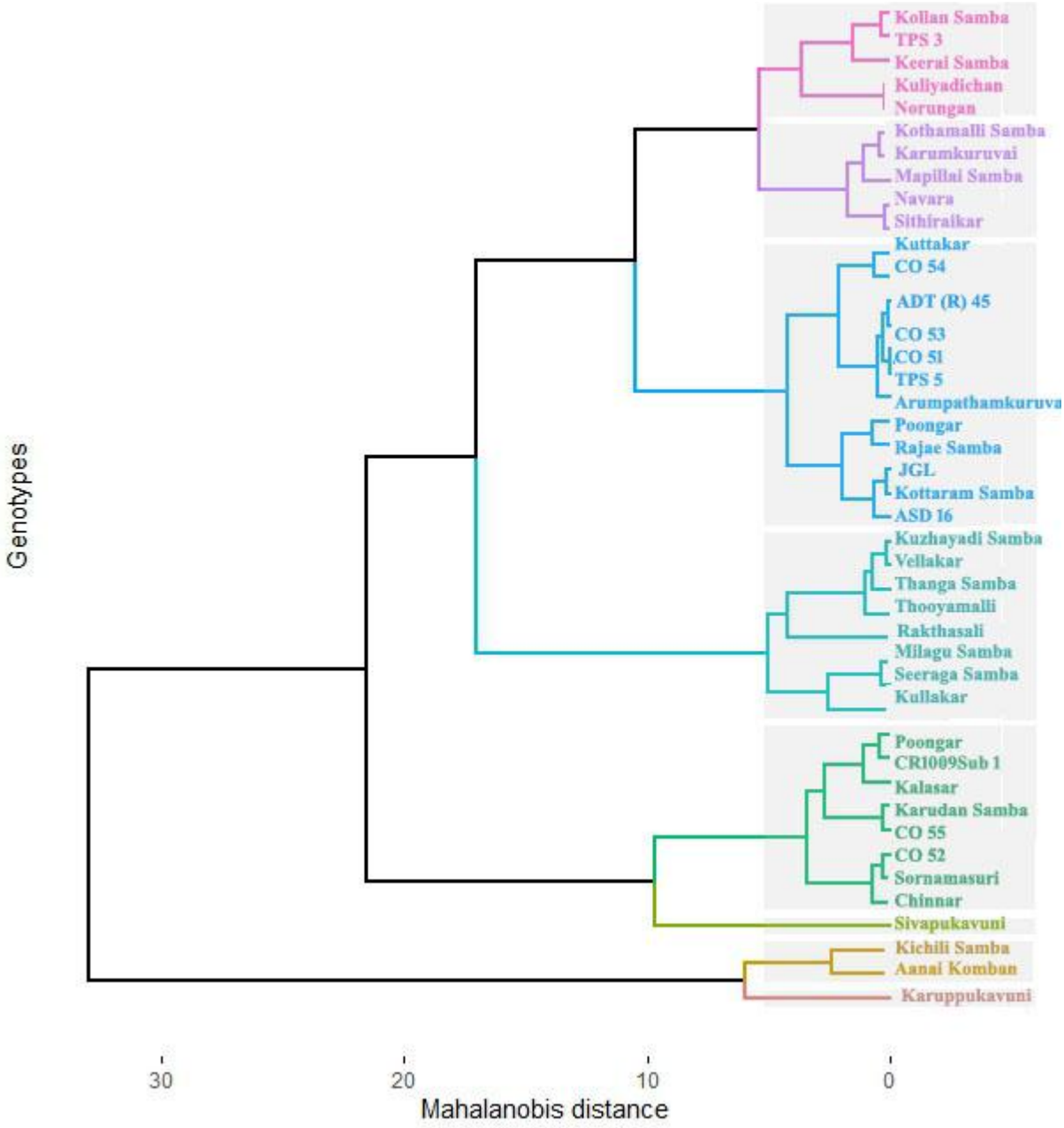

Fig. 1. Dendrogram based on Hierarchical clustering of Rice genotypes for Quantitative and Qualitative Traits

Followed by the above, cluster VII showed the highest mean for seedling height, flag leaf length, grain length and grain width. These traits were reported to be the major yield contributors in rice (Sinha *et al.,* 2013). Hence, the genotype in cluster VII namely Karuppu Kavuni could be used as a donor for enabling higher yield attributing traits into the desirable genotypes in future. Further, cluster III which had the genotypes namely, Norungan, Kuliyadichan, TPS 3, Keerai Samba and Kollan Samba were observed to encompass a desirable performance for number of productive tillers. Thereby, these genotypes could be useful for improving the tillering ability.

On contrary to the longer duration in landraces, the cluster VIII established the lowest mean value for days to 50% flowering and days to maturity. Thus, the genotypes from this cluster could be useful for the development of early maturing rice varieties in future. From this study it is evident that landraces bestow a lot of desirable features. Hence, according to the major breeding objectives, trait-specific lines could be chosen from various clusters from this study for future evaluation and selection in rice breeding programs (Amudha *et al.,* 2021). Similar results for the diversity in landraces were reported in rice by Muthuramu and Sakthivel (2018), Ranjith *et al.* (2018)

and Kavurikalpana *et al.* (2018). On comparison for all the yield related aspects, it could be concluded that the genotypes Aanai Komban and Kichadi Samba (Cluster II), Karuppu Kavuni (Cluster VII), Norungan, Kuliyadichan, TPS 3, Keerai Samba and Kollan Samba (Cluster III) from their respective clusters with highest inter cluster distance could be used as a parent for hybridization programme in future.

While clustering of genotypes for qualitative traits, the genotypes comprised under cluster II and cluster VII showed vigorous vegetative growth while the genotypes in cluster III showed good tillering ability **(Table 6**). The genotypes which showed pubescent leaf blade and dark green colour leaf blade were grouped into cluster IV and cluster VII. Among these clusters, the genotype from cluster VII showed brown coloured apiculus, slightly drooping curvature of panicle main axis and well exserted panicle from the collar of the flag leaf blade. However, the genotype from the cluster IV showed purple colour auricle and red coloured seed respectively. The genotypes grouped under cluster VII showed the absence of auricle while the genotypes under cluster IV exhibited a purple auricle. White colour apiculus was observed in the genotypes of cluster IV. The genotypes grouped under cluster II, VI and VIII showed compact mode for branching, angle of primary branches and spikelet density respectively. However, the secondary branches showed clustery arrangement for the genotypes comprised under cluster V. Further, panicle curvature of the main axis was upright and slightly drooping in the cluster IV and cluster VII. In cluster II, the panicle was observed to be as enclosed within the leaf, while in cluster VII, it was well exserted above the collar of the flag leaf blade. The genotypes comprised under cluster II and cluster VI exhibited light brown colour seed whereas the genotypes comprised under cluster IV exhibited red colour seed (**Table 6**).

The overall performance revealed that, the landraces were exhibiting a higher mean value for days to 50% flowering, plant height, number of tillers, flag leaf length, flag leaf width, panicle length, number of seeds per panicle, grain length, grain width, 1000 grain weight and days to

Table 6. Cluster mean values for twenty-six morphological traits

Traits	I	II	III	IV	V	VI	VII	VIII
Seedling height	41.73	44.20	43.04	31.57	46.99	38.38	50.37	44.81
Days to 50% flowering	102.75	112.33	105.47	111.33	109.53	97.71	108.67	77.78
Shoot length	98.60	136.30	89.23	71.90	100.11	67.68	106.10	79.80
Plant height	119.63	164.30	113.27	95.03	122.61	88.58	142.53	99.30
Number of tillers	18.64	19.57	22.15	18.90	20.83	15.33	17.00	18.37
Number of productive tillers	16.94	17.40	19.24	0.70	17.36	13.28	15.87	16.12
Flag leaf length	35.41	51.52	37.74	20.17	42.63	35.34	65.73	36.58
Flag leaf width	0.90	1.43	1.19	0.80	1.18	1.12	1.38	1.15
Panicle length	19.78	28.00	24.04	23.13	22.50	19.78	25.43	19.51
Number of seeds per panicle	117.55	151.12	119.30	139.33	115.85	133.56	149.40	131.52
Grain length	6.23	3.77	6.45	4.17	7.55	8.16	8.67	7.76
Grain width	2.40	1.70	2.66	1.40	3.23	2.53	3.30	3.00
1000 grain weight	17.39	37.87	30.98	19.67	25.13	23.97	33.33	28.65
Days to maturity	135.25	143.83	138.27	141.33	141.73	131.58	140.67	112.44
Single plant yield	20.01	36.65	26.03	31.27	26.91	27.05	29.03	29.40
Vegetative vigour	4.25	3.00	4.20	5.00	4.20	4.25	3.00	6.33
Tillering ability	5.00	4.00	3.80	5.00	4.20	5.00	5.00	6.00
Leaf blade pubescence	2.13	3.00	2.80	3.00	2.40	3.00	3.00	2.42
Leaf blade colour	2.38	2.50	2.00	5.00	2.80	2.88	5.00	2.00
Auricle colour	0.75	1.00	0.80	2.00	0.40	1.13	0.00	0.58
Apiculus colour	1.88	2.00	3.40	1.00	4.20	2.25	7.00	3.33
Panicle type	2.25	1.00	1.60	2.00	2.00	1.25	1.00	1.67
Secondary branches of panicle	1.50	2.50	2.20	1.00	1.60	2.75	2.00	1.50
Panicle curvature of main axis	4.25	2.00	3.40	1.00	3.80	4.00	5.00	3.00
Panicle exsertion	7.50	1.00	5.80	5.00	8.60	5.50	9.00	6.17
Seed colour	3.13	2.00	3.40	5.00	4.20	2.00	4.00	2.08

maturity. However, the traits such as number of productive tillers and single plant yield were found to be higher among the released varieties (**Table 7**). Similar results for these observations were also reported by Umakanth *et al.* (2017). Among the landraces, Aanai Komban recorded the highest mean value for seedling height, days to 50% flowering, plant height, number of seeds per panicle, 1000 grain weight and days to maturity respectively. Thus, this genotype with higher yielding habits and longer duration could be evaluated for its similar performance across locations in future to develop higher yielding lines. Further, Arumpatham Kuruvai exhibited a least mean value for days to 50% flowering and days to maturity. Hence, this genotype could be used for the development of early maturing varieties. In addition, Chinnar and Kollan Samba exhibited highest mean value for grain length and grain width respectively. These genotypes could be used to develop bolder grains of rice based on the consumer preference and evaluation in future. In line with these findings, similar evaluations for rice landraces with unique traits were also reported by Amudha *et al.* (2021).

Regarding the number of productive tillers and single plant yield, the genotype TPS 3 excelled with its higher mean performance. The flag leaf length and flag leaf width were found to be higher in Karuppu Kavuni and Kichili Samba. This emphasized the presence of a higher leaf area in these genotypes. Among the landraces, Seeraga Samba recorded lower mean value for the yield attributing traits. Further within all the genotypes, Aanai Komban, Arumpatham Kuruvai, Chinar, Kollan Samba, Karuppu Kavuni and TPS 3 had a significantly higher mean performance for yield attributing traits. Therefore, these genotypes could be utilized in the crop improvement programmes for the development of high yielding varieties (**Table 7**) Similar characterization of rice landraces for yield attributing traits was also reported by Rashmi *et al.* (2019) and Amudha *et al.* (2021).

Eleven qualitative characteristics have been utilised to differentiate rice varieties (**Table 9**). These qualitative features in future could be used as morphological markers in the identification of rice landraces (Raut, 2003). Regarding growth and development and vegetative vigour it was extra vigorous in Anaikomban and Milagu Samba. The tillering ability was also high for the two genotypes mentioned above. Regarding the leaf characteristics, the leaf blade was glabrous in four genotypes and pubescent in 28 genotypes. Out of 42 genotypes, three genotypes had leaf anthocyanin colouration, out of which one genotype was found to be exhibiting a strong anthocyanin pigmentation while two genotypes were found to have pigmentation in the leaf margin. Among all the genotypes, 29 genotypes exhibited the presence of auricle. Out of these, 26 were with light green coloured auricle and three were observed to have purple-coloured auricles. Apiculus colour was characterized and it was found that 22 genotypes exhibited a straw coloured apiculus. Five genotypes were found to have white, red and red apex auricle respectively, whereas, two genotypes were found to have purple and purple apex respectively. Similar characterization of rice genotypes for qualitative variations were reported by Singh *et al.* (2015).

Regarding panicle characters, the panicle type, secondary branches of panicle, panicle curvature of main axis and panicle exsertion were recorded (**Table 9**). Panicle type was compact in 15 genotypes, intermediate in 25 genotypes and open in two genotypes respectively. The characterization of secondary branches of panicle revealed that the secondary branches were present in all the 42 genotypes. These genotypes were classified into light, heavy and clustered secondary branches. It was observed that from 42 genotypes, 17 were light, 13 were heavy and 12 were clustered with secondary branches respectively. The panicle curvature of main axis was found to be upright in three genotypes, semi-upright in 26 genotypes, slightly drooping in 12 genotypes and strongly drooping in one genotype respectively.

Panicle exsertion was characterized as panicle enclosed within the leaf for two genotypes, just exserted near the collar of the flag leaf blade for 17 genotypes, moderately well exserted above the collar of the flag leaf blade for 14 genotypes and well exserted above the collar of the leaf blade for nine genotypes respectively. In addition to this, the seed colour was also characterized and found that none of the genotypes showed a white colour. Whereas, a variable purple colour among all the genotypes were observed. Twenty-seven genotypes had light brown seed, four genotypes had speckled green, eight genotypes had brown seed, one genotype showed red seed and two genotypes had purple seeds respectively. Similar features of rice genotypes for seed colour were reported by Manjunatha *et al.* (2018).

The interrelationship by correlation and path analysis for various traits from this study revealed significant positive correlation of number of productive tillers, flag leaf length, flag leaf width, number of seeds per panicle, grain length and 1000 grain weight with single plant yield (**Table 10**). Similar relationship for these traits were reported in rice by Aristya *et al.* (2021). This indicated that these traits could be used as major selection indices for improving the yield parameters in rice.

Similarly, the yield attributing traits were found to be correlated with other traits. The flag leaf length was positively and significantly inter correlated with seedling height, shoot length, plant height, flag leaf width, panicle length and 1000 grain weight. Followed by this, the flag leaf width was positively and significantly correlated with flag leaf length and 1000 grain weight. Plant height was observed to have a positive significant correlation with shoot length, days to 50% flowering, flag leaf length, panicle length and days to maturity. Number of productive tillers showed positive and significant correlation with number of tillers. Under inter correlation, the grain length

Table 7. Mean performance of quantitative traits for 42 genotypes

Genotypes	SH	DFF	SL	HT	NT	NPT	FLL	FLW
Aanai Komban	48.47	113.33	142.03	171.57	21.27	18.87	58.13	1.34
ADT (R) 45	36.63	78.00	91.83	109.00	19.47	17.60	32.27	1.20
Amman Ponni	38.27	87.33	86.73	108.67	15.53	12.60	29.97	1.01
Arumpatham Kuruvai	50.57	66.33	73.70	89.53	16.53	14.40	30.47	1.12
ASD 16	41.20	75.33	67.57	91.37	15.53	14.60	38.77	1.13
Chinnar	37.30	109.33	60.20	80.29	15.93	13.87	38.57	1.07
CO 51	42.27	75.33	70.87	89.37	19.60	15.27	30.33	1.01
CO 52	39.10	102.00	73.67	96.47	17.60	15.23	40.00	1.20
CO 53	45.43	83.33	90.17	109.27	16.73	15.13	35.17	1.02
CO 54	43.93	83.33	86.30	109.80	19.13	16.27	32.10	1.12
CO 55	40.29	83.33	73.27	91.97	13.40	10.33	36.17	1.33
CR1009Sub 1	34.23	102.00	60.63	82.30	19.53	17.40	37.60	1.12
JGL	38.57	78.33	63.07	79.13	15.87	14.73	56.87	1.38
Kalasar	36.97	108.00	58.57	76.90	11.27	9.13	27.87	1.04
Karudan Samba	44.30	81.67	72.57	93.90	10.40	9.73	33.20	1.07
Karumkuruvai	45.87	109.00	94.53	115.97	25.33	19.67	43.27	1.17
Karuppu Kavuni	50.37	108.67	106.10	142.53	17.00	15.87	65.73	1.38
Keerai Samba	44.20	108.67	79.67	110.90	19.07	16.40	38.07	1.44
Kichadi Samba	39.94	111.33	130.57	157.03	17.87	15.93	44.90	1.51
Kollan Samba	46.03	98.00	89.53	113.17	13.07	12.20	35.27	1.09
Kothamalli Samba	44.80	108.00	89.83	114.27	21.67	18.87	44.60	1.29
Kottaram Samba	52.53	77.67	89.23	108.70	14.53	13.00	40.90	1.21
Kulipadichan	44.80	109.33	88.67	112.00	20.67	15.60	36.90	1.03
Kullakar	49.50	81.00	82.93	112.23	27.07	23.47	39.77	1.01
Kuttakar	39.97	78.33	92.67	115.80	20.33	17.47	33.63	1.09
Kuzhaiyadi Samba	39.17	113.33	89.00	109.77	12.27	25.50	44.03	0.83
Mapillai Samba	45.43	113.33	135.87	159.00	14.73	11.20	45.83	1.33
Milagu Samba	41.77	113.33	93.00	119.07	18.20	16.07	40.43	0.80
Navara	56.87	108.67	91.23	110.83	21.40	18.47	37.50	0.93
Norungan	42.37	109.33	96.87	120.67	30.13	25.40	36.43	1.02
Poongar	51.03	72.67	83.10	104.80	20.33	17.47	34.40	1.18
Rajae Samba	54.93	78.00	90.50	110.87	16.40	13.20	42.23	1.29
Rakthasali	35.10	97.33	67.80	83.00	24.20	20.07	22.47	0.83
Seeraga Samba	38.47	109.33	132.17	153.80	19.40	14.07	33.00	1.03
Sithiraikar	41.97	108.67	89.10	113.00	21.00	18.60	41.97	1.20
Sivapu Kavuni	31.57	111.33	71.90	95.03	18.90	0.70	20.17	0.80
Sornamasuri	36.60	108.00	55.77	78.13	19.00	17.93	39.37	1.08
Thanga Samba	43.33	98.00	98.60	113.87	16.67	12.80	27.97	1.04
Thooyamalli	35.83	96.33	106.63	124.00	16.87	13.33	33.43	1.03
TPS 3	37.80	102.00	91.40	109.63	27.80	26.60	42.03	1.36
TPS 5	40.70	86.67	58.53	73.97	25.93	24.33	31.80	1.03
Vellakar	50.67	113.33	118.70	141.30	14.47	10.20	42.20	0.64
Min	31.57	66.33	55.77	73.97	10.40	0.70	20.17	0.64
Max	56.87	113.33	142.03	171.57	30.13	26.60	65.73	1.51
Standard Deviation	5.84	14.81	21.07	23.08	4.39	4.87	8.57	0.19

Table 8. Mean performance of qualitative traits for 42 genotypes

Genotypes	Vg	Ti	LBP	LBC	AC	ApC	PnT	PnBr	PnCMa	Exs	SC
Aanai Komban	1	1	3	3	1	2	1	3	1	1	2
ADT (R) 45	7	7	3	2	1	5	2	1	3	7	2
Amman Ponni	5	5	3	2	1	2	1	3	5	7	2
Arumpatham Kuruvai	5	3	2	2	1	6	2	1	1	5	2
ASD 16	7	7	3	2	1	2	1	1	3	7	2
Chinnar	1	5	3	7	2	5	1	3	5	5	2
CO 51	7	5	2	1	0	2	2	2	3	5	2
CO 52	5	5	3	1	1	1	1	3	3	5	2
CO 53	7	5	2	1	1	2	2	1	3	5	2
CO 54	5	7	2	2	0	2	2	1	3	9	2
CO 55	5	5	3	2	1	2	1	3	5	5	2
CR1009Sub 1	3	5	3	3	1	1	2	1	3	5	2
JGL	7	7	3	2	1	5	2	1	3	5	2
Kalasar	5	5	3	3	1	4	2	3	3	5	2
Karudan Samba	7	7	3	2	1	2	1	3	3	5	2
Karumkuruvai	3	3	3	3	0	4	2	1	3	9	4
Karuppu Kavuni	3	5	3	5	0	7	1	2	5	9	4
Keerai Samba	5	3	2	2	0	5	1	3	3	5	3
Kichadi Samba	5	7	3	2	1	2	1	2	3	1	2
Kollan Samba	5	5	3	2	0	2	2	2	3	5	4
Kothamalli Samba	5	5	2	2	0	6	2	2	5	9	2
Kottaram Samba	7	7	3	3	1	2	1	3	3	5	2
Kulipadichan	3	3	3	2	1	4	1	3	5	7	4
Kullakar	3	3	2	3	0	2	3	1	5	7	2
Kuttakar	5	5	2	2	0	7	2	1	3	7	2
Kuzhaiyadi Samba	5	5	3	2	1	2	2	1	3	7	4
Mapillai Samba	5	5	3	3	0	4	2	2	5	9	7
Milagu Samba	1	3	2	3	1	2	2	1	5	9	3
Navara	3	3	1	3	1	2	2	2	3	9	4
Norungan	3	3	3	2	2	4	2	2	3	7	4
Poongar	5	7	1	3	0	2	1	3	3	7	3
Rajae Samba	7	5	3	2	1	3	1	2	3	7	2
Rakthasali	5	5	1	2	1	2	3	2	5	5	2
Seeraga Samba	5	7	2	3	0	2	2	2	7	9	3
Sithiraikar	5	5	3	3	1	5	2	1	3	7	4
Sivapu Kavuni	5	5	3	5	2	1	2	1	1	5	5
Sornamasuri	3	3	3	3	1	1	1	3	5	7	2
Thanga Samba	5	5	3	1	1	2	2	2	3	7	2
Thooyamalli	5	5	1	3	1	1	2	1	3	9	7
TPS 3	5	5	3	2	1	2	2	1	3	5	2
TPS 5	7	7	3	2	0	2	2	1	5	5	2
Vellakar	5	7	3	2	1	2	2	2	3	7	2
Min	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	2.00
Max	7.00	7.00	3.00	7.00	2.00	7.00	3.00	3.00	7.00	9.00	7.00
Standard Deviation	1.66	1.53	0.67	1.11	0.58	1.69	0.56	0.83	1.25	1.96	1.30

Table 9. Grouping of 42 rice genotypes based on DUS descriptors

Qualitative traits	Scores	Character State	Genotypes
Vegetative vigour	1	Extra vigour	Aanai Komban, Milagu Samba
	3	Vigour	Kullakar, Norungan, Kuliyadichan, Karum Kuruvai, Sornamasuri, Karuppu Kavuni, CR1009Sub 1, Navara
	5	Normal	Seeraga Samba, Kichadi Samba, Sivapu Kavuni, Sithiraikar, Arumpatham Kuruvai, Mapillai Samba, Kothamalli Samba, TPS 3, CO 52, CO 54, CO 55, Kalasar, Keerai Samba, Kollan Samba, Thanga Samba, Poongar, Amman Ponni, Kuttakar, Vellakar, Kuzhiyadichan, Thooyamali, Rathashali
	7	Weak	TPS 5, ASD 16, CO 51, CO 53, Rajae Samba, Kottaram Samba, JGL, ADT (R) 45, Karudan Samba
	9	Very weak	-
Tillering ability	1	Very high	Aanai Komban, Milagu Samba
	3	Good	Kullakar, Norungan, Kuliyadichan, Karum Kuruvai, Milagu Samba, Sornamasuri, Arumpatham Kuruvai, Keerai Samba, Navara
	5	Medium	Sivapu Kavuni, Sithiraikar, Chinnar, Karuppu Kavuni, Mapillai Samba, Kothamalli Samba, CR1009Sub 1, TPS 3, CO 51, CO 52, CO 53, CO 55, Kalasar, Kollan Samba, Thanga Samba, Rajae Samba, Amman Ponni, Kuttakar, Kuzhiyadichan, Thooyamalli, Rathasali
	7	Low	Seeraga Samba, Kichadi Samba, TPS 5, ASD 16, CO 54, Kottaram Samba, JGL, ADT (R) 45, Poongar, Vellakar, Karudan Samba
	9	Very low	-
Leaf blade pubescence	1	Glabrous	Poongar, Navara, Thooyamalli, Rathashali
	2	Intermediate	Kullakar, Seeraga Samba, Milagu Samba, Arumpatham Kuruvai, Kothamalli Samba, CO 54, CO 53, CO 51, Keerai Samba, Kuttakar
	3	Pubescent	Aanai Komban, Kichadi Samba, Norungan, Kuliyadichan, Sivapu Kavuni, Sithiraikar, Karum Kuruvai, Chinnar, Sornamasuri, Karuppu Kavuni, Mapillai Samba, CR1009Sub 1, TPS 5, ASD 16, TPS 3, CO 52, CO 55, Kalasar, Kollan Samba, Thanga Samba, Rajae Samba, Kottaram Samba, JGL, ADT (R) 45, Amman Ponni, Vellakar, Karudan Samba, Kuzhiyadichan
Leaf blade colour	1	Light green	CO 51, CO 52, CO 53, Thanga Samba
	2	Green	Kichadi Samba, Norungan, Kuliyadichan, Arumpatham Kuruvai, Kothamalli Samba, TPS 5, TPS 3, ASD 16, CO 54, CO 55, Keerai Samba, Kollan Samba, Rajae Samba, JGL, ADT (R) 45, Amman Ponni, Kuttakar, Vellakar, Karudan Samba, Kuzhiyadichan, Rathashali
	3	Dark green	Kullakar, Seeraga Samba, Aanai Komban, Sithiraikar, Karum Kuruvai, Milagu Samba, Sornamasuri, Mapillai Samba, CR1009Sub 1, Kalasar, Kottaram Samba, Poongar, Navara,Thooyamalli
	4	Purple tips	-
	5	Purple margins	Sivapu Kavuni, Karuppu Kavuni
	6	Purple blotch	-
	7	Purple	Chinnar
Auricle colour	0	Absent	Kullakar, Seeraga Samba, Karum Kuruvai, Karuppu Kavuni, Mapillai Samba, Kothamalli Samba, TPS 5, CO 51, CO 54, Keerai Samba, Kollan Samba, Poongar, Kuttakar
	1	Light green	Aanai Komban, Kichadi Samba, Kuliyadichan, Sithiraikar, Milagu Samba,Sornamasuri, Arumpatham Kuruvai, CR1009Sub 1, ASD 16, TPS 3, CO 52, CO 53, CO 55, Kalasar, Thanga Samba, Rajae Samba, Kottaram Samba, JGL, ADT (R) 45, Amman Ponni, Navara, Vellakar, Karudan Samba, Kuzhiyadichan, Thooyamalli, Rathashali
	2	Purple	Norungan, Sivapu Kavuni, Chinnar

Apiculus colour	1	White	Sivapu Kavuni, Sornamasuri, CR1009Sub 1, CO 52, Thooyamalli
	2	Straw	Kullakar, Seeraga Samba, Aanai Komban, Kichadi Samba, Milagu Samba, TPS 5, TPS 3, ASD 16, CO 51, CO 53, CO 54, CO 55, Kollan Samba,Thanga Samba, Kottaram Samba, Poongar, Amman Ponni, Navara,Vellakar, Karudan Samba, Kuzhiyadichan, Rathashali
	3	Brown	Rajae Samba
	4	Red	Norungan, Kuliyadichan, Karum Kuruvai, Mapillai Samba, Kalasar
	5	Red apex	Sithiraikar, Chinnar, Keerai Samba, JGL, ADT (R) 45
	6	Purple	Arumpatham Kuruvai, Kothamalli Samba
	7	Purple apex	Karuppu Kavuni, Kuttakar
Panicle type	1	Compact	Aanai Komban, Kichadi Samba, Kuliyadichan, Chinnar, Sornamasuri, Karuppu Kavuni, ASD 16, CO 52, CO 55, Keerai Samba, Rajae Samba, Kottaram Samba, Poongar, Amman Ponni, Karudan Samba
	2	Intermediate	Seeraga Samba, Norungan, Sivapu Kavuni, Sithiraikar,Karum Kuruvai, Milagu Samba,Arumpatham Kuruvai,Mapillai Samba, Kothamalli Samba, CR1009Sub 1, TPS 3, TPS 5, CO 54,CO 53, CO 51, Kalasar, Kollan Samba, Thanga Samba, JGL, ADT (R) 45, Kuttakar, Navara, Vellakar, Kuzhiyadichan, Thooyamalli
	3	Open	Kullakar, Rathashali
Secondary branches of panicle	0	Absent	-
	1	Light	Kullakar, Sivapu Kavuni, Sithiraikar, Karum Kuruvai, Milagu Samba, Arumpatham Kuruvai, CR1009Sub 1, TPS 3, TPS 5, ASD 16, CO 54, CO 53, JGL, ADT (R) 45, Kuttakar, Kuzhiyadichan, Thooyamalli
	2	Heavy	Seeraga Samba, Kichadi Samba, Norungan, Karuppu Kavuni, Mapillai Samba, Kothamalli Samba, CO 51, Kollan Samba, Thanga Samba, Rajae Samba, Navara, Vellakar, Rathashali
	3	Clustered	Aanai Komban, Kuliyadichan, Chinnar, Sornamasuri, CO 52, CO 55, Kalasar, Keerai Samba, Kottaram Samba, Poongar, Amman Ponni, Karudan Samba
Panicle curvature of main axis	1	Upright	Aanai Komban, Sivapu Kavuni, Arumpatham Kuruvai
	3	Semi-upright	Kichadi Samba, Norungan, Sithiraikar, Karum Kuruvai, CR1009Sub 1, ASD 16, TPS 3, CO 51, CO 52, CO 53, CO 54, Kalasar, Keerai Samba, Kollan Samba, Thanga Samba, Rajae Samba, Kottaram Samba, JGL, ADT (R) 45, Poongar, Kuttakar, Navara, Vellakar, Karudan Samba, Kuzhiyadichan, Thooyamalli
	5	Slight drooping	Kullakar, Kuliyadichan, Milagu Samba, Chinnar, Sornamasuri, Karuppu Kavuni, Mapillai Samba, Kothamalli Samba, TPS 5, CO 55, Amman Ponni, Rathashali
	7	Strongly drooping	Seeraga Samba
Panicle exsertion	1	Enclosed	Aanai Komban, Kichadi Samba
	3	Partly exserted	-
	5	Just exserted	Sivapu Kavuni, Chinnar, Arumpatham Kuruvai, CR1009Sub 1, TPS 3, TPS 5, CO 51, CO 52, CO 53, CO 55, Kalasar, Keerai Samba, Kollan Samba, Kottaram Samba, JGL, Karudan Samba, Rathashali
	7	Moderately exserted	Kullakar, Norungan, Kuliyadichan, Sithiraikar, Sornamasuri, ASD 16, Thanga Samba, Rajae Samba, ADT (R) 45, Poongar, Amman Ponni, Kuttakar, Vellakar, Kuzhiyadichan
	9	Well exserted	Seeraga Samba, Karum Kuruvai, Milagu Samba, Karuppu Kavuni, Mapillai Samba, Kothamalli Samba, CO 54, Navara,Thooyamalli
Seed colour	1	White	-
	2	Light brown	Kullakar, Aanai Komban, Kichadi Samba, Chinnar, Sornamasuri, Arumpatham Kuruvai, Kothamalli Samba, CR1009Sub 1, TPS 3, TPS 5, ASD 16, CO 51, CO 52, CO 53, CO 54, CO 55, Kalasar, Thanga Samba, Rajae Samba, Kottaram Samba, JGL, ADT (R) 45, Amman Ponni, Kuttakar, Vellakar, Karudan Samba, Rathashali
	3	Speckled brown	Seeraga Samba, Milagu Samba, Keerai Samba, Poongar
	4	Brown	Norungan, Kuliyadichan, Sithiraikar, Karum Kuruvai, Karuppu Kavuni, Kollan Samba, Navara, Kuzhiyadichan
	5	Red	Sivapu Kavuni
	6	Variable purple	-
	7	Purple	Mapillai Samba, Thooyamalli

Table 10. Correlation of morphological traits to grain yield per plant

	SH	DFF	SL	HT	NT	NPT	FLL	FLW	PnL	NSPP	GrL	GrW	1000 GW	DTM	YLD
SH	1.00														
DFF	-0.18	1.00													
SL	0.32*	0.37*	1.00												
HT	0.34*	0.42**	0.98**	1.00											
NT	-0.01	0.11	0.04	0.05	1.00										
NPT	0.07	0.05	0.01	0.02	0.69**	1.00									
FLL	0.36*	0.26	0.39*	0.46**	-0.02	0.26	1.00								
FLW	0.13	-0.11	0.18	0.22	0.02	0.10	0.53**	1.00							
PnL	0.20	0.42**	0.47**	0.59**	0.01	-0.04	0.39*	0.27	1.00						
NSPP	-0.08	-0.03	-0.09	-0.07	-0.03	0.03	0.23	0.09	0.06	1.00					
GrL	0.10	-0.29	-0.42**	-0.44**	-0.40**	-0.09	0.04	0.10	-0.35*	0.08	1.00				
GrW	0.40**	-0.21	-0.13	-0.14	-0.26	0.03	0.16	0.11	-0.04	-0.02	0.76**	1.00			
1000 GW	0.28	-0.11	0.09	0.12	0.23	0.16	0.43**	0.55**	0.12	0.11	-0.05	-0.02	1.00		
DTM	-0.16	0.99**	0.39*	0.42**	0.05	0.03	0.30	-0.09	0.40**	-0.07	-0.24	-0.18	-0.09	1.00	
YLD	0.04	-0.12	-0.09	-0.08	0.24	0.21*	0.33*	0.51**	0.01	0.43**	0.08*	0.14	0.51**	-0.12	1.00

*, ** significant at 5% and 1% probability levels

was found to have negative significant correlation with shoot length, plant height and number of tillers. Further, grain width showed positive significant correlation with grain length and seedling height. In addition, 1000 grain weight was positively and significantly correlated with flag leaf length and flag leaf width. This suggested that selection for these inter correlated traits namely seedling height, days to 50% flowering, shoot length, plant height, flag leaf length, flag leaf width, panicle length and 1000 grain weight and days to maturity would also have a positive influence in improving the yield attributes of rice. Similar results for the intercorrelation of these traits were reported by Manasa *et al.* (2022).

Path analysis revealed high positive direct contribution of number of productive tillers, flag leaf width, number of seeds per panicle and grain length towards single plant yield, whereas, days to maturity revealed a moderate positive direct contribution towards single plant yield (**Table 11**). Similarly, other traits were also observed to influence the yield attributing traits indirectly. The path analysis depicted a high indirect contribution for single plant yield which was conferred by flag leaf length through shoot length, plant height and flag leaf width. Further, a moderate indirect contribution towards single plant yield was exerted by panicle length. Inclusively, flag leaf width also exhibited a high indirect contribution towards single plant yield by means of shoot length and plant height. Further, again the single plant yield was found to be moderately and indirectly influenced by panicle length. Grain length contributed indirectly to single plant yield through shoot length and plant height. It was found to be moderately influencinfg yield through panicle length and grain width. The trait, grain width was found to indirectly contribute towards single plant yield *via* shoot length, plant height and grain length. Subsequently, 1000 grain weight exhibited a significant high indirect contribution towards single plant yield through flag leaf length and plant height. Followed by this, the flag leaf width exhibited a moderate indirect contribution towards single plant yield *via* flag leaf length. Similar results were reported by Sivasankar *et al.* (2018), Manasa *et al.* (2022) and Parte *et al.* (2022) for path coefficient analysis in rice. Other traits were observed to be as independent, while the correlation between grain yield and its attributing traits were partitioned into direct and indirect effects. Thus, the traits namely shoot length, plant height, grain length and flag leaf length were observed to have a major influence towards single plant yield and could be used as major selection indices in future breeding programs.

From this study, it is concluded that the landraces collected from the same geographical areas were grouped into various clusters. As a result, geographical diversity had null significant impact on genetic diversity among genotypes (Rashmi *et al.,* 2018). All the 42 rice germplasm were observed to exhibit a wide range of variation for all quantitative and qualitative traits. The clustering pattern for quantitative and qualitative traits were distinct and this further revealed the importance of characterising the genotypes with DUS (Rashmi *et al*.2019). From, the correlation and path analysis it was observed that, the traits namely number of productive tillers, flag leaf length, flag leaf width, number of seeds per panicle, grain length

Table 11. Path analysis of morphological traits to grain yield per plant

	SH	DFF	SL	HT	NT	NPT	FLL	FLW	PnL	NSPP	GrL	GrW	1000 GW	DTM	YLD
SH	**0.44**	0.00	-0.13	0.19	0.00	-0.14	0.02	-0.16	-0.17	0.02	0.08	-0.03	0.00	0.01	0.04
DFF	0.02	**0.00**	-0.67	0.73	0.00	0.02	-0.04	-0.09	-0.28	-0.01	0.10	-0.08	-0.01	0.21	-0.12
SL	0.03	0.00	**-1.74**	1.72	0.00	0.01	-0.06	0.15	-0.36	-0.03	0.15	-0.05	0.01	0.08	-0.09
HT	0.05	0.00	-1.72	**1.74**	0.00	0.01	-0.07	0.17	-0.44	-0.03	0.16	-0.05	0.01	0.09	-0.08
NT	0.00	0.00	-0.10	0.09	**-0.04**	0.21	0.00	0.02	0.00	-0.01	0.14	-0.10	0.02	0.01	0.24
NPT	-0.21	0.00	-0.06	0.04	-0.03	**0.30**	-0.04	0.09	0.04	0.01	0.03	0.01	0.02	0.01	0.21*
FLL	-0.05	0.00	-0.77	0.80	0.00	0.08	**-0.14**	0.42	-0.27	0.09	-0.01	0.07	0.05	0.06	0.33*
FLW	-0.09	0.00	-0.36	0.40	0.00	0.03	-0.08	**0.75**	-0.20	0.04	-0.04	0.04	0.06	-0.02	0.51**
PnL	0.11	0.00	-0.88	1.08	0.00	-0.02	-0.05	0.21	**-0.71**	0.01	0.13	-0.02	0.01	0.08	0.01
NSPP	0.02	0.00	0.14	-0.12	0.00	0.01	-0.03	0.07	-0.01	**0.40**	-0.03	-0.01	0.01	-0.01	0.43**
GrL	-0.10	0.00	0.74	-0.78	0.02	-0.03	-0.01	0.07	0.26	0.03	**-0.36**	0.29	-0.01	-0.05	0.08*
GrW	-0.03	0.00	0.23	-0.23	0.01	0.01	-0.03	0.09	0.04	-0.01	-0.27	**0.38**	0.00	-0.04	0.14
1000 GW	0.02	0.00	-0.20	0.22	-0.01	0.05	-0.06	0.44	-0.08	0.05	0.02	-0.01	**0.11**	-0.02	0.51**
DTM	0.02	0.00	-0.69	0.74	0.00	0.01	-0.04	-0.07	-0.27	-0.03	0.09	-0.07	-0.01	**0.21**	-0.12

(Diagonal bold values represent the direct effect)

SH: Seedling height (cm), DFF: Days to 50% flowering, SL: Shoot length(cm), HT: Plant height (cm), NT: Number of tillers, NPT: Number of productive tillers, FLL: Flag leaf length (cm), FLW: Flag leaf width (cm), PnL: Panicle length (cm), NSPP: Number of seeds per panicle, GrL: Grain length (mm), GrW: Grain width (mm), 1000 GW: 1000 grain weight (g), DTM: Days to maturity, YLD: Single plant yield (g), Vg: Vegetative vigour, Ti: Tillering ability, LBP: Leaf blade pubescence, LBC: Leaf blade colour, AC: Auricle colour, ApC: Apiculus colour, PnT: Panicle type, PnBr: Secondary branches of panicle, PnCMa: Panicle curvature of main axis, Exc: Panicle exsertion, SC: Seed colour.

and 1000 grain weight were the major yield contributing traits and could be used as major indicators for selecting desirable genotypes in future from this population. Overall from all the genotypes, Aanai Komban, Kichadi Samba, Karupukavuni, Norungan, Kuliyadichan, TPS 3, Keerai Samba and Kollan Samba from the clusters II, VII and III could be further evaluated and used as parents in rice hybridization programs.

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