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Diversity Analysis of Some Traditional Rice Genotypes in Sri Lanka

A. L. Ranawake[1*], U. G. S. Amarasinghe[1] and S. G. J. N. Senanayake[1]

[1]Faculty of Agriculture, University of Ruhuna, Sri Lanka.

Authors' contributions

This work was carried out in collaboration between all authors. Author ALR designed the study, wrote the first draft of the manuscript. Author UGSA managed the analyses of the study and literature searches. Author SGJNS supervised the work. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To study the diversity of traditional rice genotypes in Sri Lanka using cluster analysis and principle component analysis.
Study Design: The experiment was carried out using one hundred rice genotypes with six modern rice cultivars and ninety four traditional rice cultivars. Rice genotypes were planted according to a randomized complete block design with four replications and 20 plants per plot with 15 cm X 20 cm spacing.
Place and Duration of Study: A field experiment was carried out during 2011/2012 *Maha* season and 2012 *Yala* season at Faculty of Agriculture, University of Ruhuna, Sri Lanka.
Methodology: Plant height (cm), number of tillers/plant and number of productive tillers/plant were measured before harvesting. Panicle length (cm), panicle weight (g), number of spikelets/panicle, number of fertile spikelets/panicle, 100 grain weight (g) and

**Corresponding author: Email: lankaranawake@agbio.ruh.ac.lk;*

yield/plant (g) were measured after harvesting and drying of grains for 14% moisture content. Principal component analysis (PCA) and cluster analysis were performed using SPSS statistical software.
Results: Among nine studied variables three principal components exhibited more than one Eigen value and showed about 89.6 % variability. The principal components (PC) 1, 2 and 3 had 51.07%, 22.08% and 16.46% variability among the genotypes for the evaluated traits respectively. The first PC was more related to panicle weight, number of spikelets/panicle, number of fertile spikelets/panicle, spikelet fertility percentage and yield (g/plant). Number of tillers/plant, number of productive tillers/plant and yield (g/plant) were more related traits in the second principal component. The highest contribution in third principal component was from the panicle weight, 100 grain weight and yield (g/plant). Based on the nine yield and yield attributing characters, the genotypes were grouped in to seven clusters in cluster analysis. The genotypes under cluster V recorded the highest divergence among them as it exhibited the highest intra-cluster distance. The lowest intra-cluster distance was recorded in the cluster VI. The modern rice cultivar BG 379/2 was fallen in to the cluster VI with 3 traditional rice cultivars namely Karayal I, Bathkiri el and Hondarawala.
Conclusion: One hundred rice genotypes were grouped in to divergent groups by principle component analysis and cluster analysis. This clustering pattern can be used for the selection of parental materials with diverse characters.

Keywords: Principle component analysis; cluster analysis; dendrogram; traditional rice cultivars; Sri Lanka.

1. INTRODUCTION

Yield is a complex trait controlled by cumulative effect of various traits. Selection of parents only on the basis of yield is not reasonable [1] due to this multi-trait behavior. Significance of association of yield with yield components must be taken in to account to determine a selection criterion [2]. Different morphological traits play very important role for more rice production with new plant types associated with the crop yield [3,4]. In many rice growing countries, landraces carrying a vast amount of genetic diversity were distributed in remote villages. The number of landraces in the field began to decline in 1970's when high-yielding varieties were introduced. Most of the old landraces are now available in certain gene banks only, not in the hands of farmers [5]. Land races are less productive but they have excellent adaptation to local conditions and they are diverse in genetic potential which is needed for rice improvement [6-8]. In Sri Lanka traditional rice cultivars are conserved at plant genetic resource centre, Gannoruwa. Characterization of available germplasm has become an important aspect in modern crop improvement [9] for broadening the cultivated rice gene pool. In the present study ninety-four traditional rice cultivars were evaluated at the field conditions to understand their field performances and diversity.

Cluster analysis is a powerful tool to analyze diversity in rice genotypes [10-14]. Cluster analysis categorizes data in to meaningful and useful groups in scientific base [15]. This can be used to categorize individuals, based on the characteristics they possess, so that individuals with the similar characters are mathematically gathered into the same cluster [16]. Better clustering creates when the similarity within a group is higher and the difference between the groups is wider [15]. This type of clustering exhibits greater within-cluster homogeneity and between-cluster heterogeneity. In other words, when the classification is completed the individuals within a cluster are closer and individuals in different clusters are farther apart [16].

Cluster analysis and principal component analysis (PCA) are identified as multivariate analytical techniques most commonly used in science [17-19]. This multivariate statistical algorithm can be applied for classifying germplasm according to the variability to dissect relationships among different genotypes [20]. This can be performed on morphological data [21] of rice with diverse characteristics. Principal component analysis provides artificial factors with balanced weighting of traits, which leads to an effective contribution of different characters on the basis of respective variation [20]. The present study classifies one hundred traditional and modern rice cultivars in to clusters using principal component analysis and cluster analysis on the basis of quantitative morphological traits.

2. MATERIALS AND METHODS

One hundred rice genotypes including six modern rice cultivars obtained from Plant Genetic Resources Center (PGRC), Gannoruwa, Sri Lanka were geminated and planted in nursery beds. Ten day old seedlings were transplanted in the experimental field at the Faculty of Agriculture, Mapalana, Kamburupitiya, Sri Lanka. The experiment was carried out according to a randomized complete block design with four replications and 20 plants per plot with 15 cm X 20 cm plant spacing. Fertilizer was not added. Pesticide was applied according to the necessity and the field was properly covered by a Bird’s nest to protect the grain yield from the birds.

Plant height (cm), number of tillers per plant and number of productive tillers per plant were measured before harvesting. Panicle length (cm), panicle weight (g), number of spikelets per panicle, number of fertile spikelets per panicle, 100 grain weight (g) and yield per plant (g) were measured after harvesting and drying of grains for 14% moisture content. Principal component analysis and cluster analysis were done using IBM SPSS 20 statistical software [22].

3. RESULTS AND DISCUSSION

Days to flowering of traditional rice genotypes were varied from 78-107 (Table 1). Mean performance of all the genotypes are included in the Table 5 in Annex 1.

The principal component analysis (PCA) was performed for the yield and yield attributing traits of ninety-four traditional rice genotypes and six modern rice genotypes (Table 2 and 3).

Out of nine traits, two traits; plant height and panicle length were excluded during principal component analysis. Three principal components (PC) exhibited more than one Eigen value and showed 89.6% variability among the studied traits (Table 2).

Table 1. PGRC accession number, name and days to flowering of studied rice genotypes

PGRC acc. no.	Name	DF	PGRC acc. no.	Name	DF	PGRC acc. no.	Name	DF	PGRC acc. no.	Name	DF
3519	*Manchel Perunel*	78	3669	*Rajes*	89	3572	*Suduru Samba*	93	3671	*Suduru Samba*	95
3518	*H 10*	79	3691	*Gunaratna*	89	3508	*Madael Galle*	93	3666	*Podisayam*	95
3477	*Sudu Goda w ee*	80	3445	*Yakada wee*	89	3511	*Maha Murunga Badulla*	93	3434	*Kokuvellai*	95
3479	*Kiri Naran*	80	3645	*Muthumanikam*	89	3514	*Madael Kalutara*	93	3607	*Kiri Murunga wee*	95
3562	*Thunmar Hamara*	80	3646	*Induru Karayal*	89	3686	*Karayal*	94	3673	*Kaluhandiran*	96
3639	*Polayal*	81	3651	*Balakara*	89	3487	*Palasithari 601*	94	3679	*Kottakaram*	96
3506	*MI 329*	81	3567	*Dingiri Menika*	89	3658	*Ingrisi wee*	94	3681	*Dandumara*	97
3416	*A 6-10-37*	81	3570	*Madael*	90	3661	*Polayal*	94	3670	*Madoluwa*	97
3668	*Ranruwan*	83	3498	*Geeraga Samba*	90	3664	*Tissa wee*	94	3440	*Kaharamana*	97
3395	*Podi sudu wee*	84	3401	*Wanni Heenati*	90	3665	*Sudu Karayal*	94	3647	*Kalu gires*	97
3463	*Karayal*	85	3613	*Lumbini*	90	3435	*Matara wee*	94	3410	*BG 35-7*	97
3415	*BG 34-8*	86	3614	*Sinnanayam*	90	3652	*Buruma Thavalu*	94	3417	*Periamorungan*	97
3676	*Dena wee*	87	3469	*Sudu wee*	91	3517	*Seeraga Samba Batticaloa*	94	3482	*Akuramboda*	98
3677	*Herath Banda*	87	3507	*Suwanda Samba*	91	3497	*Sinnanayan 398*	94	3490	*Murungakayan 101*	98
3438	*Murunga wee*	87	3480	*Karayal*	92	3504	*Dik wee 328*	94	3641	*Heendik wee*	98
3409	*BG 35-2*	87	3496	*Bala Ma wee*	92	3389	*Sirappu Paleusithri*	94	3612	*Jamis wee*	98
3675	*Kotathavalu*	88	3423	*Giress*	92	3595	*Kaharamana*	94	3394	*Muthu Samba*	99
3655	*Rata wee*	88	3571	*Miti Riyan*	92	3598	*Bala Ma wee*	94	3713	*Kalukanda*	99
3688	*Handiran*	88	3588	*Heenpodi wee*	92	3606	*Chinnapodiyan*	94	3616	*Jamis wee*	100
3427	*Naudu wee*	88	3510	*Sudu wee Ratnapura*	92	3615	*Yakada wee*	94	3550	*Bathkiri el*	100
3638	*Lumbini*	88	3594	*Suduru Samba*	92	3678	*Hondarawala*	95	3610	*Heendikki*	101
3642	*Kahata Samba*	88	3486	*Puwakmalata Samba*	93	3687	*Dewaredderi*	95	3591	*Mudukiriel*	102
3674	*Kirikara*	89	3447	*Karabewa*	93	3489	*Murungakayan 3*	95	3383	*EAT Samba*	105
3660	*Suduru*	89	3451	*Halabewa*	93	3654	*Pokuru Samba*	95	3589	*Gangala*	106
3659	*Kotathavalu*	89	3650	*Madabaru*	93	3653	*Kalu Karayal*	95	3516	*Seevalee Ratnapura*	107

Table 2. Eigen value, % of variance and cumulative variance of yield and yield attributing traits of evaluated rice genotypes

Principal Component (PC)	Eigen values	% of variance	Cumulative %
1	4.09	51.07	51.07
2	1.77	22.08	73.14
3	1.32	16.46	89.60
4	0.68	8.48	98.08
5	0.07	0.90	98.99
6	0.04	0.55	99.54
7	0.02	0.29	99.83
8	0.01	0.17	100.00

The PC 1, 2 and 3 had 51.07%, 22.08% and 16.46% variability among the genotypes for the evaluated traits respectively. Eigen value associated with each PC, decreased gradually and stopped at 0.01 (Table 2). The first PC was more related to number of fertile spikelets per panicle, number of spikelets per panicle, spikelet fertility percentage, yield (g/plant) and panicle weight (Table 3).

PCA and factor analysis have been performed for genetic diversity identification, parental selection, tracing the pathway to evolution of crops, identification of centre of origin and diversity, and study interaction between the environments [20].

Table 3. Principal Components (PCs) for yield and yield attributing traits of evaluated rice genotypes

Traits	Components		
	1	2	3
Number of tillers/plant	.147	.976	-.027
Number of productive tillers/plant	.142	.980	.007
Panicle weight (g)	.609	.030	.747
Number of spikelets/panicle	.873	.063	.133
Number of fertile spikelets/panicle	.981	.142	.046
Spikelet fertility percentage	.766	.207	-.070
100 grain weight (g)	-.107	-.023	.962
Yield (g/plant)	.663	.549	.448

In the second principal component the number of tillers per plant, number of fertile tillers per plant and yield (g/plant) were the more related traits. The third principal component exhibited positive relations with number of productive tillers per plant, panicle weight, and number of spikelets per panicle, number of fertile spikelets per panicle, 100 grain weight and yield (g/plant). These traits acquired the maximum variation among each principal component (Table 2).

Three pcs extracted from the nine studied traits by PCA were used for clustering genotypes (Table 4, Fig. 1). The similar genotypes were classified in to the same cluster based on their various yield and yield attributing traits.

Table 4. Clusters of traditional and modern rice genotypes constructed on the basis of yield and yield attributing traits

Cluster number	Genotypes
Cluster *I*	*Muthu Samba, Lumbini II, Herath Banda, Dena wee, Chinnaodiyan, BG 34-8, Ranruwan, Sinnanayan 398, Suduru, Suduru Samba II, Kalu gires, Thunmar Hamara, Polayal I*
Cluster *II*	*Muthumanikam, Miti Riyan, Heenpodi wee, Suwanda Samba, Podi Sayam, Geeraga Samba, Suduru Samba III*
Cluster *III*	*Karayal I, BG 379/2, Bathkiri el, Hondarawala*
Cluster *IV*	*Kaluhandiran, Kirikara, Puwakmalata Samba, Murungakayan 3, Murungakayan 101, Suduru Samba I, Murunga wee, Karabewa, Halabewa, Yakada wee I, Polayal II, Periamorungan*
Cluster *V*	*Kottakaram , Dewaredderi, Sudu Goda wee, Kiri Naran, Karayal II, Ingrisi wee, Kotathavalu II, Kalu Karayal, Rajes, Madoluwa, Handiran, Gunaratna, Tissa wee, Sudu Karayal, Kokuvellai, Karayal III, Kaharamana I, Induru Karayal, Balakara, Buruma Thavalu, H 10, Manchel Perunel, Dingiri Menika, Madael, Dik wee 328, BG 35-7, Mudukiriel, Bala Ma wee II, Yakada wee II*
Cluster *VI*	*Giress, Lumbini I, Heendik wee, Madabaru, Seeraga Samba Batticaloa, Madael Galle, Wanni Heenati, A 6-10-37*
Cluster *VII*	*Kotathavalu I, Dandumara, Sudu wee, Akuramboda, Palasithari 601, Bala Ma wee I, Pokuru Samba, Rata wee, Naudu wee, Matara wee, Kahata Samba, Gangala, MI 329, Sudu wee Ratnapura, Maha Murunga Badulla, Madael Kalutara, Seevalee Ratnapura, EAT Samba, Sirappu Paleusithri, Podi sudu wee, BG 35-2, Kaharamana II, Kiri Murunga wee, Heendikki, Jamis wee I, Sinnanayam, Jamis wee II, Kalukanda*

Estimation of genetic distance is one of the appropriate tools for parental selection in hybridization programs [23]. Agro-morphological diversity and variation among the rice accessions play a very important role for the crop improvement [24,25].

By incision of the dendrogram at diversity index 5, the genotypes were categorized into seven clusters. First cluster contained 13 traditional rice genotypes and those were separated in to two sub groups. Most of the genotypes in the first cluster are partly sterile and they have low tillering ability. There were two sub groups in cluster II. One of the sub groups belonged to cluster II included cultivar Podisayam, Geeraga Samba and Suduru samba which are semi dwarf in plant type with low tillering ability and high spikelet fertility. The modern rice cultivar BG 379/2 was clearly separated in to one group with traditional rice cultivars; Karayal I, Bathkiri el and Hondarawala. These genotypes are medium in tillering ability and high in spikelet fertility. These genotypes felt at extreme top in the first quarter of 2D scatter diagram indicating the differences in the genetic constitution of the genotypes among others (Fig. 2). Twelve rice cultivars belonged to two sub groups in cluster IV. Cluster V was the largest and most diverse cluster consisting 29 traditional rice genotypes. Most of the genotypes grouped in to this cluster recorded intermediate plant structure, low tillering ability and high spikelet sterility. This cluster divided in to five sub groups at varying degree of similarities. Cluster VI is a uniform group with 8 rice genotypes: There were no sub groups in cluster VI. Cluster VII is diverse group with many sub groups. The single genotype EAT Samba was in one of the sub groups in cluster VII (Fig. 1).

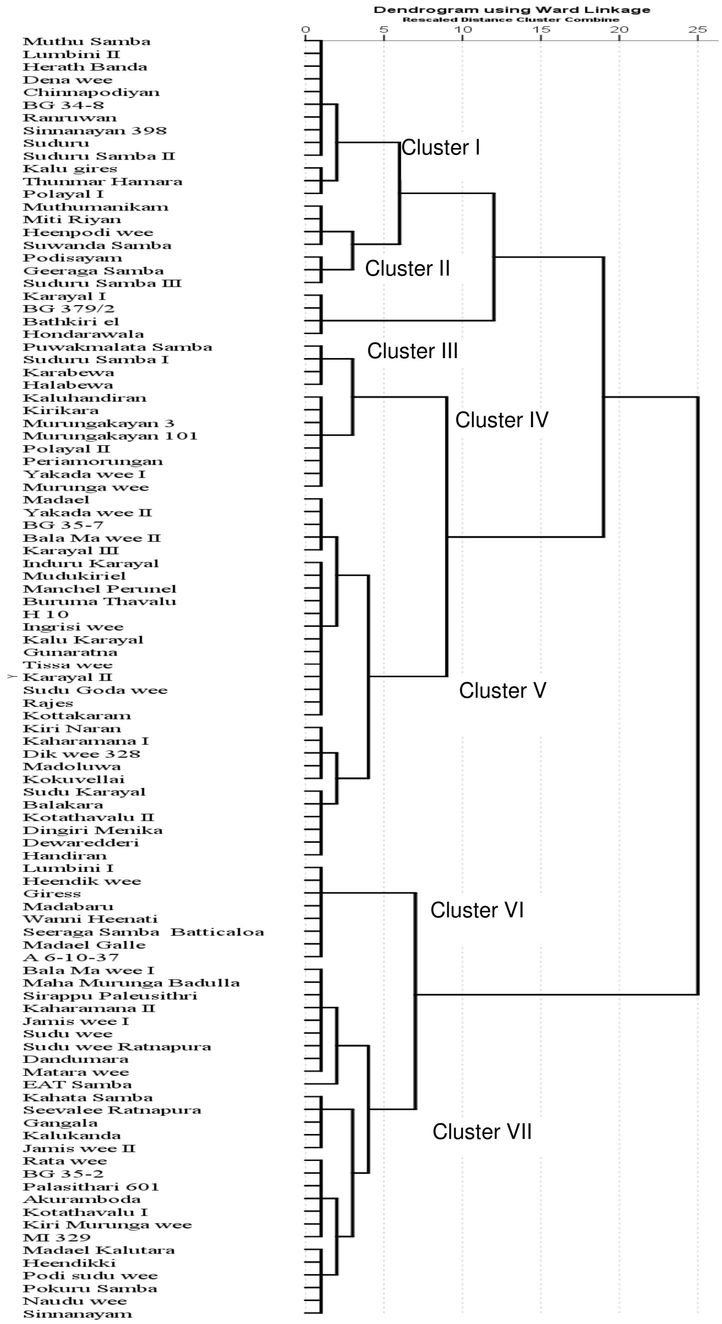

Fig. 1. Cluster analysis showing the relationship and diversity among rice genotypes based on yield and yield attributing characters

The diversity in these genotypes is more distinct in 2D scatter plot diagram (Fig. 2). Most of the genotypes felt in to the second and the third quadrants in the scatter plot diagram and a few included in to the first and the fourth quadrants (Fig. 2). Considerable overlapping among the various genotypes was evident in the scatter plot diagram, which suggests that genetic variation among them is rather narrow [26].

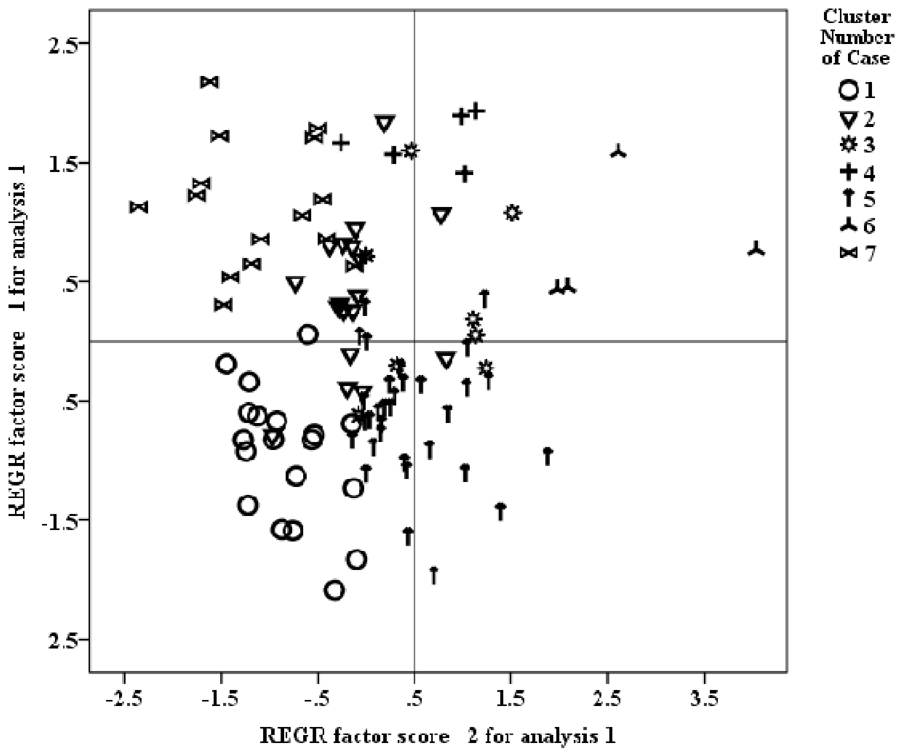

Fig. 2. Two dimensional (2D) scatter plot diagram representing the clusters of traditional and modern rice genotypes on the basis of their yield and yield attributing characters. 1,2,3,4, represent the first, second third and fourth quadrants respectively

Sharma et al. [27] discussed the variations in rice landraces that leads to the determination of genetic diversity among them. Similar studies to dissect diversity of rice genotypes have been done in the same way previously [28-30]. Appropriate selection of the parents is essential to enhance the genetic recombination for the considered character [23]. The findings of the present study will be useful for such selections.

4. CONCLUSION

In the present study one hundred rice genotypes were grouped in to VII divergent groups by principle component analysis and cluster analysis. This clustering pattern can be used for the selection of parental materials with diverse characters. Further this gives a picture of similarities and dissimilarities of individual rice genotypes those are not familiar to the local farmers and researchers. Bath kiri el, Hondarawala and Karayal I were grouped together with improved rice cultivar Bg 379/2 indicating suitability of these cultivars for the farmer field.

CONSENT

All authors declare that written informed consent was obtained for publication of this research article.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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ANNEX 1

Table 5. Mean performance of all the genotypes at no fertilizer conditions

Name	PH (cm)	NT	NFT	PL (cm)	PW (g)	NS	NFS	FG (%)	HG W(g)	YLD g/plant
Kaluhandiran	151.93	3.40	3.10	26.34	1.74	77.20	46.50	61.30	2.64	3.83
Kirikara	101.63	3.40	3.20	24.51	2.04	91.30	50.00	54.00	2.56	4.15
Kotathavalu I	131.00	5.30	5.10	20.50	2.21	107.40	82.10	76.20	2.31	8.58
Dena wee	116.45	5.60	5.40	20.55	1.80	95.70	67.30	70.10	2.14	7.03
Herath Banda	119.35	5.30	4.50	22.65	1.36	67.90	45.20	66.40	2.35	4.90
Hondarawala	154.38	11.20	10.00	26.48	3.41	150.40	128.30	85.70	2.43	31.28
Kottakaram	100.90	5.10	4.80	25.05	2.96	106.40	80.50	75.80	3.01	10.52
Dandumara	151.65	5.50	4.90	23.03	4.65	157.10	110.30	70.80	3.21	15.68
Karayal I	144.58	8.40	7.80	22.04	3.14	135.30	110.10	81.10	2.50	19.26
Dewaredderi	128.10	5.10	4.50	24.94	2.04	72.20	33.00	43.50	3.16	3.52
Sudu wee	110.85	5.20	4.80	21.74	4.18	156.10	107.80	69.30	2.87	13.90
Sudu Goda wee	119.13	5.30	4.90	24.85	2.98	107.30	70.10	65.90	3.00	9.99
Kiri Naran	126.33	4.50	4.20	24.88	2.79	96.10	57.50	59.90	3.15	7.43
Karayal II	114.35	5.30	5.00	25.43	2.73	114.20	65.90	56.90	2.60	8.62
Akuramboda	114.90	5.70	5.00	25.48	3.32	156.60	100.80	64.40	2.28	11.43
Puwakmalata Samba	119.00	3.90	3.10	23.26	1.52	95.80	55.40	58.10	1.25	2.06
Palasithari 601	126.55	5.30	4.80	25.14	2.64	104.10	83.90	80.90	2.76	11.03
Murungakayan 3	120.63	4.10	3.50	25.20	2.05	89.60	55.80	62.60	2.55	4.95
Murungakayan 101	88.40	3.90	3.50	24.75	1.99	83.10	50.50	60.90	2.54	4.43
Bala Ma wee I	120.60	5.20	4.70	30.90	3.50	123.40	91.40	74.20	3.02	13.10
Pokuru Samba	128.58	5.20	4.80	20.37	3.50	169.90	119.40	70.40	2.20	12.41
Rata wee	142.43	5.10	4.90	19.93	3.11	140.50	90.00	64.10	2.43	10.62
Suduru	118.75	5.20	4.90	21.70	1.50	104.20	54.30	52.20	1.31	3.50
Ingrisi wee	111.90	5.40	5.00	24.61	2.32	102.30	53.50	53.70	2.55	6.81
Kotathavalu II	110.20	5.80	5.50	22.16	2.60	101.70	51.20	50.80	2.85	7.93
Kalu Karayal	106.23	5.60	5.10	22.66	2.47	107.70	57.00	54.50	2.56	7.42
Ranruwan	102.48	5.00	4.80	23.99	1.57	97.30	48.00	50.00	1.49	3.36
Rajes	97.33	5.10	4.80	22.51	2.80	110.30	60.10	54.50	2.82	8.16
Madoluwa	99.43	4.00	3.70	22.78	3.54	106.70	56.70	53.30	3.60	7.52
Suduru Samba I	101.60	3.50	3.30	23.92	1.15	100.10	50.00	50.70	1.45	2.41
Handiran	134.98	5.30	4.90	23.52	3.00	129.30	36.40	28.00	2.55	4.49
Gunaratna	133.28	5.30	5.10	20.50	2.33	94.00	64.80	69.50	2.81	9.14
Polayal I	130.10	6.60	6.20	21.01	1.65	69.60	44.30	65.20	1.69	4.57
Tissa wee	130.65	5.70	5.20	24.75	2.76	115.70	64.90	56.30	2.64	8.90
Sudu Karayal	117.75	5.80	5.60	22.66	2.51	107.20	31.90	29.80	2.62	4.65
Podisayam	110.40	3.90	3.60	23.09	1.53	129.60	94.30	73.40	1.41	4.77
Giress	113.88	3.70	3.40	23.35	2.82	145.10	90.60	62.60	2.15	6.55
Naudu wee	120.53	5.10	4.60	26.30	3.03	140.30	110.50	78.50	2.37	12.10
Kokuvellai	125.93	5.20	4.80	22.53	4.02	125.60	70.30	56.30	3.44	11.64
Karayal III	124.90	6.60	6.20	23.36	3.79	137.10	80.60	59.40	2.98	14.97
Murunga wee	111.85	4.50	4.30	23.77	1.41	75.10	18.30	24.40	2.28	1.80
Matara wee	120.43	4.60	4.30	23.73	4.14	147.80	94.00	64.90	3.00	12.28
Kaharamana I	123.15	4.60	4.20	22.53	3.15	108.50	55.10	51.20	3.17	7.27
Karabewa	108.60	3.80	3.30	23.56	1.66	97.60	52.20	55.50	2.01	3.40
Halabewa	99.58	3.40	2.90	22.78	1.63	96.40	64.90	68.40	2.00	3.71
Yakada wee I	109.83	3.90	3.60	23.41	1.53	58.40	33.00	58.20	3.16	3.71
Lumbini I	73.90	3.40	3.10	23.30	3.02	110.10	87.70	79.80	3.02	8.12
Polayal II	79.40	3.30	3.10	21.69	1.64	72.30	36.30	47.90	2.69	3.08
Heendik wee	73.18	4.10	3.90	25.14	3.49	147.50	106.00	72.10	2.57	10.49
Kahata Samba	125.48	6.10	5.80	26.19	3.49	173.90	138.80	80.20	2.18	17.43
Muthumanikam	106.13	7.50	6.40	20.44	1.87	141.20	86.10	62.30	1.53	8.52
Induru Karayal	151.45	6.50	4.90	24.36	2.52	103.80	74.10	71.80	2.71	9.85
Kalu gires	119.15	7.30	6.60	22.41	1.79	96.00	43.50	45.50	2.18	6.23
Madabaru	98.20	3.50	3.10	22.66	3.02	172.70	111.80	65.00	1.92	6.60

Table 5 continued………………

Balakara	97.15	6.50	5.20	21.41	1.71	69.30	30.50	44.20	2.90	4.60
Buruma Thavalu	89.48	6.70	5.30	28.76	2.07	94.40	57.40	61.10	2.51	7.18
Seeraga Samba Batticaloa	96.33	3.90	3.00	25.08	4.05	171.50	117.60	68.60	2.42	8.36
H 10	98.50	7.00	5.50	25.24	2.42	97.30	67.70	71.00	2.78	10.44
Manchel Perunel	113.48	5.90	5.00	23.18	2.30	101.60	71.90	71.00	2.56	9.31
Thunmar Hamara	122.15	8.20	7.10	26.46	1.85	97.60	59.80	62.60	2.21	9.30
Dingiri Menika	120.98	6.10	5.20	20.38	2.87	101.20	53.80	55.10	3.13	8.74
Madael	119.83	7.10	6.50	22.23	2.55	105.20	78.80	74.80	2.72	13.77
Miti Riyan	112.50	7.30	6.30	32.26	1.70	120.30	93.20	77.40	1.66	9.67
Suduru Samba II	119.30	6.00	5.30	24.91	1.57	94.90	69.00	72.40	1.21	4.36
Gangala	112.25	7.30	6.40	26.28	3.89	167.20	137.50	82.00	2.50	21.82
Heenpodi wee	108.45	7.30	6.50	23.03	1.54	104.20	77.40	73.60	1.48	7.51
Sinnanayan 398	92.15	5.50	5.20	24.01	1.45	107.80	56.40	52.30	1.62	4.74
Geeraga Samba	108.48	5.80	5.10	24.73	1.49	129.80	102.50	79.00	1.05	5.59
Dik wee 328	128.15	4.60	4.20	30.64	3.80	140.80	33.70	24.30	2.91	4.10
MI 329	103.38	4.60	4.10	27.84	2.24	104.20	81.20	77.60	2.44	8.04
Suwanda Samba	107.68	8.60	6.70	25.03	1.87	156.50	131.00	82.80	1.39	12.25
Madael Galle	113.45	3.70	3.50	23.54	3.88	164.70	137.80	83.10	2.54	12.13
Sudu wee Ratnapura	116.53	5.60	4.90	19.86	4.29	144.10	116.40	78.70	3.03	17.57
Maha Murunga Badulla	111.73	5.70	4.80	29.83	4.52	168.00	81.70	48.70	2.61	10.31
Madael Kalutara	118.90	5.60	4.40	24.03	4.11	170.10	143.80	84.00	2.59	14.68
Seevalee Ratnapura	119.45	7.40	6.90	22.88	3.47	189.60	157.80	83.20	1.99	21.80
EAT Samba	118.88	5.80	5.30	26.81	4.99	181.60	154.30	84.60	3.81	31.04
Sirappu Paleusithri	116.03	5.30	4.90	25.03	3.42	121.00	96.90	79.90	3.05	14.55
Muthu Samba	106.93	6.10	5.10	22.59	2.46	178.20	39.40	22.20	1.54	3.02
Podi sudu wee	109.28	5.40	4.50	21.26	3.51	171.40	149.70	82.40	2.33	16.05
Wanni Heenati	99.98	2.50	2.10	22.57	2.34	133.30	109.10	81.60	1.98	4.11
BG 35-2	98.38	5.50	4.70	23.15	2.97	118.60	92.70	77.80	2.75	10.88
BG 35-7	98.63	7.30	5.90	25.24	2.58	111.80	87.20	77.20	2.57	13.30
BG 34-8	96.00	6.00	5.30	24.05	2.15	103.70	77.20	74.10	2.36	8.72
A 6-10-37	99.08	4.00	3.30	23.00	3.80	181.20	155.00	85.60	2.27	11.31
Periamorungan	111.28	3.80	3.40	28.98	1.44	55.60	30.40	52.50	2.61	2.60
Mudukiriel	120.85	6.00	5.70	20.88	2.45	100.70	74.40	73.10	2.70	11.22
Suduru Samba III	91.10	6.80	6.10	26.02	1.02	173.10	145.30	83.90	0.66	5.21
Kaharamana II	97.95	5.40	4.90	24.78	3.66	137.50	111.30	79.70	2.87	15.61
Bala Ma wee II	88.70	7.00	6.70	24.45	2.91	127.20	101.00	79.30	2.53	17.01
Chinnapodiyan	89.65	5.60	5.20	23.07	2.05	89.30	63.10	70.70	2.29	7.53
Kiri Murunga wee	117.40	5.50	5.00	29.00	2.48	116.00	89.80	77.30	2.14	9.75
Heendikki	86.33	5.40	5.00	23.54	4.04	167.70	141.60	83.70	2.60	18.22
Jamis wee I	118.05	5.40	5.00	25.78	3.71	133.40	107.40	80.20	3.00	16.15
Lumbini II	108.65	5.10	4.90	23.78	1.69	82.60	56.60	68.10	2.04	5.72
Sinnanayam	87.93	4.70	4.40	24.77	2.56	142.10	115.80	81.20	2.01	10.18
Yakada wee II	128.70	6.60	6.30	20.95	2.31	98.80	75.20	76.10	2.64	12.48
Jamis wee II	133.80	6.60	6.30	26.62	4.47	165.00	121.50	73.70	2.89	22.12
Bathkiri el	129.33	8.90	8.70	23.90	4.03	176.30	150.30	84.90	2.47	32.05
Kalukanda	122.78	7.00	6.60	27.26	4.42	180.00	154.00	85.60	2.63	26.55

PH = Plant height (cm), NT = Number of tillers/plant, NFT = Number of fertile tillers/plant, PL = Panicle length (cm), PW = Panicle weight (g), NS = Number of spikelets per panicle, NFS = Number of fertile spikelets per panicle, FG = Filled grain percentage, HGW = 100 grain weight (g), YLD = Yield (g/plant)

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