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Relationship of Yield and Yield Related Traits of Some Traditional Rice Cultivars in Sri Lanka as Described by Correlation Analysis

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Authors' contributions

This work was carried out in collaboration between both authors. Author ALR designed the study. Author UGSA collected and tabulated data. Both authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aims: To understand the relationship between individual trait and yield of one hundred rice cultivars according to Pearson's correlation coefficient.
Study Design: Completely randomized block design with four replicates. Twenty plants were evaluated in each replicate and eighty plants were evaluated in each cultivar in four replicates.
Place and Duration of Study: Faculty of Agriculture, University of Ruhuna, Sri Lanka in 2011-2013.
Methodology: Data were collected in 80 plants of four replicates on: plant height (cm), number of tillers per plant, number of fertile tillers per plant panicle length (cm), panicle weight (g), number of spikelets per panicle, number of fertile spikelets per panicle, 100 grain weight (g), days to maturity and yield per plant (g). Pearson's correlation coefficients were calculated using SPSS.
Results: According to statistical analysis grain yield was significantly and highly correlated with number of fertile spikelets/panicle (r = 0.765), panicle weight (r = 0.727), number of spikelets/panicle (r = 0.638), filled grain percentage (r = 0.620), number of fertile tillers/plant (r = 0.611), number of tillers/plant (r = 0.575). Hundred grain weight (r = 0.336) and plant height (r = 0.278) were also correlated with at 1% significant level. None of the studied trait was negatively correlated with the yield.
Conclusion: Fertile spikelets per panicle, panicle weight, number of spikelet per panicle

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and filled grain percentage can be considered as good criteria for selection of rice cultivars suitable for breeding programs.

Keywords: Traditional rice; correlation analysis; yield; yield related characters.

1. INTRODUCTION

Rice yield is determined by combined effect of various yield determination factors. Effective parental selection must not be totally dependent on the final yield of rice due to this combined effect of different traits [1]. Hence significant association between the yield and the trait should be considered to determine a selection criterion for rice [2]. Different morphological traits act differently on rice production [3,4]. Which traits must be considered for the cultivar selection, must be an equation of traits which explain the extent and significance of association of yield with yield components. Relative contribution of different traits on yield determination can be explained by correlation studies [5]. Correlation coefficient quantifies the degree of association between a response variable and a predictor variable [6]. This can be used as a tool for selection of rice lines in breeding programs [7]. The existence of correlation is attributed to the presence of genetic effect of genes or environmental effect or in combination of all factors [8]. Utilizing these relationships effectively is critical in rice breeding [9].

Grain yield in rice is significantly correlated with days to heading [10,11], total tillers [11,12,13,14,15,16,17], flag leaf length [18], flag leaf width [11,19,20,21,22,23,24], flag leaf area [18], number of productive tillers [11,12,13], days to maturity [11], number of grain per panicle [11,16] and plant height [11,18,25,26,27,28] but Hairmansis et al. [29] found that plant height has negative effect on grain yield. Further, panicle length [18,15], number of grains per panicle [30,10,31,32,33,19,18,34,15] and grain weight [20,33,22,32,19,21] have positive and significant correlations with grain yield. Present study was carried out to understand interrelationships between yield and yield-related traits of rice (*Oryza sativa* L.) using correlation coefficient.

2. MATERIALS AND METHODS

One hundred rice cultivars including six modern and ninety-four traditional rice cultivars were collected from Plant Genetic Resource Center, Gannoruwa, Sri Lanka (Table 1). The experiment was carried out in the field of Faculty of Agriculture, University of Ruhuna, Sri Lanka during 2011 to 2013 according to a randomized complete block design (RCBD) with four replications. Twenty-day-old seedlings were transplanted with 20 cm X 15 cm line and row spacing. Each row contained twenty plants and three rows were included in to each replicate. All necessary measures were taken to ensure an optimum yield: recommended fertilizer, weed control, proper fencing and bird's net to protect the crop from the birds. Data were collected in 80 plants of four replicates on: plant height (cm), number of tillers per plant, number of fertile tillers per plant, panicle length (cm), panicle weight (g), number of spikelets per panicle, number of fertile spikelets per panicle, 100-grain weight (g), days to maturity and yield per plant (g). Days to maturity was taken when 85% of grains on panicle were matured. Data were subjected to statistical analysis. Correlation analysis was carried out to see the relationships among evaluated morphological traits of rice using SPSS Inc [35].

Table 1. Rice accessions used for the study

Serial number	*Accession number	Name	Serial number	*Accession number	Name
1	3673	Kaluhandiran	51	3645	Muthumanikam
2	3674	Kirikara	52	3646	Induru Karayal
3	3675	Kotathavalu	53	3647	Kalu gires
4	3676	Dena wee	54	3650	Madabaru
5	3677	Herath Banda	55	3651	Balakara
6	3678	Hondarawala	56	3652	Buruma Thavalu
7	3679	Kottakaram	57	3517	Seeraga Samba Batticaloa
8	3681	Dandumara	58	3518	H 10(Improved)
9	3686	Karayal I	59	3519	Manchel Perunel
10	3687	Dewaredderi	60	3562	Thunmar Hamara
11	3469	Sudu wee	61	3567	Dingiri Menika
12	3477	Sudu Goda wee	62	3570	Madael
13	3479	Kiri Naran	63	3571	Miti Riyan
14	3480	Karayal II	64	3572	Suduru Samba II
15	3482	Akuramboda	65	3589	Gangala
16	3486	Puwakmalata Samba	66	3588	Heenpodi wee
17	3487	Palasithari 601	67	3497	Sinnanayan 398
18	3489	Murungakayan 3	68	3498	Geeraga Samba
19	3490	Murungakayan 101	69	3504	Dik wee 328
20	3496	Bala Ma wee I	70	3506	MI 329(Improved)
21	3654	Pokuru Samba	71	3507	Suwanda Samba
22	3655	Rata wee	72	3508	Madael Galle
23	3660	Suduru	73	3510	Sudu wee Ratnapura
24	3658	Ingrisi wee	74	3511	Maha Murunga Badulla
25	3659	Kotathavalu II	75	3514	Madael Kalutara
26	3653	Kalu Karayal	76	3516	Seevalee Ratnapura
27	3668	Ranruwan	77	3383	EAT Samba
28	3669	Rajes	78	3389	Sirappu Paleusithri
29	3670	Madoluwa	79	3394	Muthu Samba
30	3671	Suduru Samba I	80	3395	Podi sudu wee
31	3688	Handiran	81	3401	Wanni Heenati
32	3691	Gunaratna	82	3409	BG 35-2(Improved)
33	3661	Polayal I	83	3410	BG 35-7(Improved)
34	3664	Tissa wee	84	3415	BG 34-8(Improved)
35	3665	Sudu Karayal	85	3416	A 6-10-37(Improved)
36	3666	Podisayam	86	3417	Periamorungan
37	3423	Giress	87	87	3591
38	3427	Naudu wee	88	3594	Suduru Samba III
39	3434	Kokuvellai	89	3595	Kaharamana II
40	3463	Karayal III	90	3598	Bala Ma wee II
41	3438	Murunga wee	91	3606	Chinnapodiyan
42	3435	Matara wee	92	3607	Kiri Murunga wee
43	3440	Kaharamana I	93	3610	Heendikki
44	3447	Karabewa	94	3612	Jamis wee I
45	3451	Halabewa	95	3613	Lumbini II
46	3445	Yakada wee I	96	3614	Sinnanayam
47	3638	Lumbini I	97	3615	Yakada wee II
48	3639	Polayal II	98	3616	Jamis wee II
49	3641	Heendik wee	99	3550	Bathkiri el
50	3642	Kahata Samba	100	3713	Kalukanda

**PGRC accession numbers are given*

3. RESULTS AND DISCUSSION

Correlation analysis was performed to understand the association of the yield with the agronomic characters of studied rice cultivars. Some morphological traits associated with plant architecture of rice have been found to have close relationship with yielding ability of rice varieties [3,4].

Pearson's correlation coefficients among yield and yield attributing characters of rice cultivars were calculated using SPSS software [35] (Table 2). Grain yield was significantly correlated with number of fertile spikelets/panicle ($r = 0.765$), panicle weight ($r = 0.727$), number of spikelets/panicle ($r = 0.638$), filled grain percentage ($r = 0.620$), number of fertile tillers/plant ($r = 0.611$), number of tillers/plant ($r = 0.575$), 100 grain weight ($r = 0.336$) and plant height ($r = 0.278$) at 0.01 significant level (Table 2). Positive and significant correlations of panicle length, flag leaf area and number of grains per panicle have been reported previously [18]. Further, grain yield is significantly correlated with number of tillers per plant, number of filled grains per panicle and 1000-grain weight [16]. Plant height recorded a significant positive but weak correlation ($\alpha = 0.01$, $r = 0.278$) with yield. The same kind of a relationship has been reported by Ruben and Katuli, [25], Kumar, [26], Khan et al. [18] and Bhadru et al. [27]. However, Hairmansis et al. [29] noted a negative effect of plant height on final grain yield.

Grain yield /plant exhibited positive significant correlations with number of tillers/plant ($\alpha = 0.01$, $r = 0.575$). The similar results were reported by Gunasekaran et al. [13], Osman et al. [16] and Satheeshkumar and Saravanan [17]. Liu et al. [14] stated that the tiller number is the most important agronomic character in rice which determines the panicle number, a key component in grain yield.

Number of fertile tillers/plant recorded a significantly and positively correlation with the yield/plant in the present study ($\alpha = 0.01$, $r = 0.611$). Sabesan et al. [12] also observed that the grain yield is positively associated with plant height and productive tillers per plant. Further Gunasekaran et al. [13] suggested that the productive tillers followed by filled grains per panicle and 100 grain weight are the important characters to improve the yield potential of rice.

Yadav et al. [28] concluded that the panicle length, number of tillers per hill, number of spikelets per panicle, plant height as the main contributors to yield. Among those parameters panicle length, number of tillers per hill and number of spikelet per panicle are the most important characters that directly contribute to yield [30]. In the present study panicle length was not significantly correlated with the yield. This might be the reason of broad variation in filled grain percentage of individual rice cultivars regardless of panicle length. According to the correlation analysis there is no correlation in between panicle length and filled grain percentage as well (Table 2).

Table 2. Pearson's correlation coefficients among yield and yield attributing characters of evaluated rice cultivars

	Plant height (cm)	**Number of tillers/ plant**	**Number of fertile tillers/plant**	**Panicle length (cm)**	**Panicle weight (g)**	**Number of spikelets /panicle**	**Number of fertile spikelets /panicle**	**Filled grain percentage**	**100 grain weight (g)**
Plant height (cm)									
Number of tillers/plant	.317**								
Number of fertile tillers/plant	.349**	.971**							
Panicle length (cm)	-.024	.082	.040						
Panicle weight (g)	.206*	.103	.130	.111					
Number of spikelets/panicle	.054	.222*	.219*	.100	.721**				
Number of fertile spikelets/panicle	.011	.278**	.273**	.097	.616**	.849**			
Filled grain percentage	-.023	.258**	.247*	.073	.296**	.406**	.806**		
100 grain weight (g)	.178	-.101	-.072	.033	.592**	-.062	-.050	-.043	
Yield/plant (g)	.278**	.575**	.611**	.127	.727**	.638**	.765**	.620**	.336**

*** Correlation is significant at the 0.01 level (2-tailed)*

** Correlation is significant at the 0.05 level (2-tailed)*

According to correlation analysis, grain yield was significantly correlated with panicle weight ($\alpha = 0.01$, $r = 0.727$) (Table 2). Singh [33] also reported a positively correlations of number of grains per panicle and grain weight per panicle with grain yield. Further panicle weight was positively and significantly correlated with plant height ($\alpha = 0.05$, $r = 0.206$). Plant height was considered as the distance between base of the plant and the tip of the longest panicle. Longer panicles contribute to the plant height parameter in evaluated rice cultivars. Number of spikelets per panicle ($\alpha = 0.01$, $r = 0.721$), number of fertile spikelets per panicle ($\alpha = 0.01$, $r = 0.616$), filled grain percentage ($\alpha = 0.01$, $r = 0.296$) and 100 grain weight ($\alpha = 0.01$, $r = 0.592$) also exhibited positive significant correlations with panicle weight. It is obvious that number of filled grains directly contributes to the panicle weight in rice (Table 2). Supporting this, Bhatti et al. [19] also reported positive genotypic correlation of number of grains per panicle and 1000-grain weight with grain yield.

Number of spikelets per panicle was positively and significantly correlated with the grain yield/plant ($\alpha = 0.01$, $r = 0.638$) (Table 2). Sharma and Choubey [31], Prasad et al. [32] have also reported a significant correlation between grain yield per plant and the number of spikelets per panicle. Grain yield was positively and significantly correlated with number of fertile spikelets per panicle ($\alpha = 0.01$, $r = 0.765$). Number of grains per panicle is one of the most important components of yield and probably this character will help to break the yield plateau [20].

Filled grain percentage was positively and significantly correlated with the yield/plant ($\alpha = 0.01$, $r = 0.620$). Bhatti et al. [19], Bai et al. [20] and Luzikihupi, [22] also reported a highly significant correlation in between filled grains/panicle and grain yield. Rice grain filling is a critical and dynamic factor that determines the grain yield [23, 24]. Many factors effect on filled grain percentage such as climate, soil, variety, fertilizer application and insect and pest attacks [36].

In the present study, 100 grain weight was positively and significantly correlated with the yield/plant ($\alpha = 0.01$, $r = 0.336$). This finding is aligned with the finding of Prasad et al. [32] and Bhatti et al. [19]. Ashraf et al. [37], reported that the thousand-grain weight is a genetic character least influenced by environment. However in this study the correlation coefficient of 100 grain weight and yield was only 0.336 at 1% significant level. Hundred-grain weight gives an idea about the size of the grain. Both size of the grain and number of grains per panicle decide the panicle weight.

4. CONCLUSION

According to Pearson's correlation analysis, grain yield is significantly and highly correlated with number of fertile spikelets/panicle, panicle weight, number of spikelets/panicle, filled grain percentage, number of fertile tillers/plant, and total number of tillers/plant. However, 100 grain weight and plant height are not highly correlated with the yield. Hence fertile spikelets per panicle, panicle weight, number of spikelet per panicle, filled grain percentage and number of fertile tillers per plant can be considered as good criteria for selection of rice cultivars suitable for breeding programs. Total number of tillers also contributes towards higher yield in rice but not up to the level of the other characteristics such as fertile spikelets per panicle, panicle weight, number of spikelet per panicle and number of fertile tillers per plant.

CONSENT

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

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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