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Correlation and genetic distance on sixteen rice varieties grown under SRI

Abstract

An experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from December, 2011 to May, 2012 to study the interpretation of correlation analysis among phenotypic characters and also among 16 varieties of rice. Experiment was outlined in Randomized Complete Block Design with three replications. From the study it was observed that plant dry weight was significantly correlated with time of harvest (.758**), number effective tiller (.693**) while leaf area index was significantly correlated with weed population (.716**), weed dry matter (.857**) and number effective tiller (.499*). Weed population was significantly correlated with time of harvest (.720**) and number effective tiller (.695**). Time of harvest was significantly correlated with number of effective tiller (.946**), number of ineffective tiller (.775**), number of fertile spikelets (.624**) and dry grain yield (.524*). Panicle length was significantly correlated with number of total spikelets (.737**) and number of sterile spikelets (.751**). Number of total spikelets was significantly correlated with number of fertile spikelets (.924**). The varieties formed two major groups; Group A (Cluster I and Cluster II) and Group B which showed the relationship among the varieties. It was observed maximum proximity dissimilarity was 133.0 while minimum was 43.1. Hence, selection of any of these traits or varieties by observing their relationship will give better result on the breeding program.

Keywords: rice varieties' pearson correlations, hierarchical cluster, proximity distance, fertile spikelets, leaf area, genetic variability, breeding, grain yield, genetic resources, hybrid dhan 3, zinc sulphate, plant shoot length, plant root length, shoot length, plant dry weight

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Introduction

In Bangladesh, people take rice as a main meal while it is treated as one of the most important cereal crops and provides the staple food for about half of the world's population especially for people in developing countries.[1] In order to meet the huge demand for rice grain, development of high yielding genotypes with desirable agronomic traits is necessity. Any crop improvement program depends on the utilization of germplasm stock available in the world. Grain yield is a complex trait, controlled by many genes, environmentally influenced and nature of their genetic variability.[2] Yield component traits increasing grain yield (directly or indirectly) if they are highly heritable and positively correlated with grain yield.[3] Breeders have applied indirect selection for yield based on plant traits[4] but many researchers applied indirect selection for yield based on yield components and found more efficient than direct selection for yield on several crop species.[5–7] The success of breeding program depends upon the amount of genetic variability present and extent to desirable heritable traits while different morphological traits play very important role for more rice production with new plant type characteristics associated with the plant yield.[8–10] Parents identified on the basis of divergence for any breeding program would be more promising.[11] Plant breeders usually select for yield component traits which indirectly increase yield. The relationship between rice yield and its contributing characters has been studied widely at phenotypic level.[12–15] The grain yield is a complex trait, quantitative in nature and a combined function of a number of constituent traits. So the selection for yield may not be much satisfying unless other yield component traits are taken into consideration.[16] Understanding of correlation between yield and yield components are basic and fore most effort to find out strategies for plant selection. Correlation between yield and its component traits has effectively been used in identifying useful traits as selection criteria to improve grain yield in rice.[3,12,14,17,18] This study was undertaken to identify the causal relationships among morphological traits of sixteen rice varieties.

Materials and method

Location, period, varieties, experimental design and plot size

The experiment was conducted at Agronomy field, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh from December, 2011 to May, 2012. The experiment consisted sixteen variety viz. BR 3(V_1), BR 14 (V_2), BR 16 (V_3), BRRI dhan 28(V_4), BRRI dhan 29(V_5), BRRI dhan 36(V_6), BRRI dhan 45(V_7), BRRI dhan 50 (V_8), BINA 6(V_9), BINA 9(V_{10}), BRRI hybrid dhan 1(V_{11}), BRRI hybrid dhan 2 (V_{12}), BRRI hybrid dhan 3 (V_{13}), Chamak(V_{14}), Hira 1(V_{15}) and Bhajan (V_{16}) following RCBD design with three replications. The size of unit plot was 3m×2.7m (8.1m^2). The distances between plot to plot and replication to replication were 0.75 m and 1.0m respectively.

Seed collection

Seeds of V_1-V_8 and V_{11}-V_{13} were collected from Genetic Resources and Seed Division, BRRI, Joydebpur, Gazipur; V_9 and V_{10} from BINA, BAU, Maymensingh-2202; V_{14}-V_{16} was collected from Supreme Seed Co. Ltd., Amin Court (8th Floor) 62-63, Motijheel, Bangladesh.

Seed sprouting

Seeds selected by specific gravity method were immersed in water in a bucket for 24hours. These were then taken out of water and kept tightly in gunny bags. The seeds started sprouting after 48hours which were suitable for sowing in 72hours.

Preparation of seedling

Sprouted seeds were sown as broadcast in 16 portable trays for 16 varieties containing soil and cow dung. Thin plastic sheets were placed at the base of trays to protect water loss. Trays were kept inside a room at night to protect the seedlings from freezing temperature of season and kept in sunlight at daytime for proper development of seedlings.

Seed Sowing

Seeds were sown in the portable trays on December 27, 2011.

Fertilization on the main field

Plot was fertilized with 110, 90, 76, 60, 7kg ha^{-1} Urea, TSP, MP, Gypsum and Zinc Sulphate respectively. The entire amounts of TSP, MP, Gypsum and Zinc Sulphate were applied as basal dose at final land preparation. Urea was top-dressed in three equal installments viz. after seedling recovery, vegetation stage and 7 days before panicle initiation.

Uprooting and transplanting of seedlings

12 days old seedlings were uprooted from the trays and transplanted on January 7, 2011. Trays were brought to main field and seedlings were planted in prepared plot just after uprooting and this process was completed within one minutes.

Application of irrigation water

Alternate wetting and drying of crop field is desired in SRI method. Water level should be dried in such a level that hairline cracks should develop in field. Irrigation must be applied to such amount that field remains moist but not fully submerged. Field was allowed to dry for 4 to 5days during panicle initiation period for better root growth that increases tillering. From panicle initiation (PI) to hard dough stage, a thin layer of water (2-3cm) was kept on the plots. Again water was drained from the plots during ripening stage.

Data collection

Data were collected on growth, development and yield characters viz. seedling mortality, plant height, plant root length, plant shoot length, plant root length, shoot length, plant dry weight, leaf area index, time of first flowering, time of 50% flowering, weed population and weed dry matter, time of harvest, number effective tiller, number ineffective tiller, panicle length, number of total spikelets, number of fertile spikelets, number of sterile spikelets, weight of 1000-grains, dry grain yield, dry straw yield, biological yield and harvest index.

Leaf area index were estimated measuring the length and average width of lead and multiplying by a factor of 0.75 followed by Yoshida (1981). The sub-samples of 2hills/plot were uprooted from predetermined lines which were oven dried until constant level. From which the weight of above ground dry matter were recorded at 30days intervals and at harvest. Grain yield was determined from the central area of each plot and expressed as t/ha and adjusted with 14% moisture basis. Grain moisture content was measured by using a digital moisture tester. Straw yield was determined from the central 6m^2 area of each plot. After separating of grains, the sub-sample was oven dried to a constant weight and finally converted to t/ha. Grain yield and straw yield were all together retarded as biological yield. Biological yield was calculated with the following formula Biological yield=Grain yield+Straw yield

It denotes the ratio of economic yield (grain yield) to biological yield and was calculated with following formula

Harvest index (%)=grain yield/biological yield×100

Statistical analysis

All the collected data were analyzed using Statistical Package for the Social Sciences (SPSS version 19.0).

Results and discussion

Interpretation of Pearson's correlations of varietals means for 22 quantitative characters 16 rice varieties

Plant height was significantly correlated with plant shoot length (.875**), plant root length (.541*), panicle length (.686**), number of total spikelets (.671**) and number of fertile spikelets (.636**). Plant shoot length was significantly correlated with plant root length (.703**), number of total spikelets (.575*) and number of fertile spikelets (.667**). Plant root was significantly correlated with plant dry weight (.595*), time of harvest (.510*), number of ineffective tiller (.511*), dry grain yield (.551*) and biological yield (.505*). Plant dry weight was significantly correlated with weed population (.507*), time of harvest (.758**), number effective tiller (.693**), number ineffective tiller (.591*), number of fertile spikelets (.580*) and dry grain yield (.500*). Leaf area index was significantly correlated with weed population (.716**), weed dry matter (.857**) and number effective tiller (.499*). Weed population was significantly correlated with time of harvest (.720**) and number effective tiller (.695**). Weed dry matter was significantly correlated with dry straw yield (498*). Time of harvest was significantly correlated with number of effective tiller (.946**), number of ineffective tiller (.775**), number of fertile spikelets (.624**) and dry grain yield (.524*). Number of effective tiller was significantly correlated with number of ineffective tiller (.701**), number of fertile spikelets (.612*) and dry grain yield (.560*). Panicle length was significantly correlated with number of total spikelets (.737**), number of fertile spikelets (.559*) and number of sterile spikelets (.751**). Number of total spikelets was significantly correlated with number of fertile spikelets (.924**) and number of sterile spikelets (.610*). Dry grain yield was significantly correlated with dry straw yield (.530*) and biological yield (.776**). Dry straw yield was significantly correlated with biological yield (.945**) (Table 1).

Positive correlation of grain yield with plant height;[19] 100 seed weight;[20,21] panicle length;[22] number of filled grains per panicle[23,24] and panicle weight.[25] Panicle length associated with flag leaf area, number of primary branches per panicle, number of spikelets per panicle, number of seeds per panicle and grain weight per panicle that traits also directly or indirectly associated with the plant yield;[26,27] panicle with yield[28] while correlation between yield and other yield traits were reported[29,30] Similarly correlation study was also conducted in rice,[31] *Linum usitatissimum*[32] and strawberry.[33]

Dendrogram analysis

The results of the cluster analysis (Ward's method) based on morphological characteristics of 16 rice varieties are presented in the Figure 1; the cluster diagram (also called cluster trees). The horizontal axis of the dendrogram represents the distance or dissimilarity between clusters. The vertical axis represents the objects and clusters. The dendrogram is fairly simple to interpret. Remember that our main interest is in similarity and clustering. Each joining (fusion) of two clusters is represented on the graph by the splitting of a horizontal line into two horizontal lines. The horizontal position of the split, shown by the short vertical bar, gives the distance (dissimilarity) between the two clusters. The verities formed two clusters/two major groups; Group A and Group B. Group A included two clusters; Cluster I and Cluster II. Cluster I was divided into two groups i.e., a and b while b was divided into two i.e., i and ii. Cluster I of A had eight varieties (V_2, V_5, V_6, V_{11}, V_{12}, V_{14}, V_{15} and V_{16}). Cluster II of A was found as the smallest group containing only one variety (V_{10}). On the other hand, Group B included two cluster; Cluster I and Cluster II. Cluster I of B had two varieties (V_1 and V_3). Cluster I of B had five varieties (V_2, V_6, V_7, V_8 and V_{13}) (Figure 1).

Dendrogram shows that varieties in one cluster are mostly identical and have less diversity and most similar objects are linked by gradually diminished criteria of similarity.[34,35] The varieties in one cluster were mostly similar characteristics and had less diversity variation. Relationship or genetic distances among the genotype was also built by dendrogram in rice,[36] gerbera,[37] summer tomato,[38] cassava.[39] Cluster analysis allows determining groups of genes with similar patterns of expression[40] thus may be useful to choose the right parent during crossing. If crossing between varieties within same group or closely distant group there is a possibility to get less variation while crossing between long distant groups will give the more variation.

Proximity matrix of Euclidean distance among 16 rice varieties

The maximum proximity dissimilarity was found between **V_7** and V_9 (133.0) while minimum was found from V_{12} and V_{14} (43.0) (Table 2). Similarly genetic distance was also analyzed using Euclidean Distance method by Sikder et al.[36] and Adewale et al.[41] For the determination of phylogenetic relationship and evolutionary pattern among genotypes, genetic distance and proximity of genotypes for different characters are very important[42] and they also analyzed genetic distance and proximity of genotypes on rice.

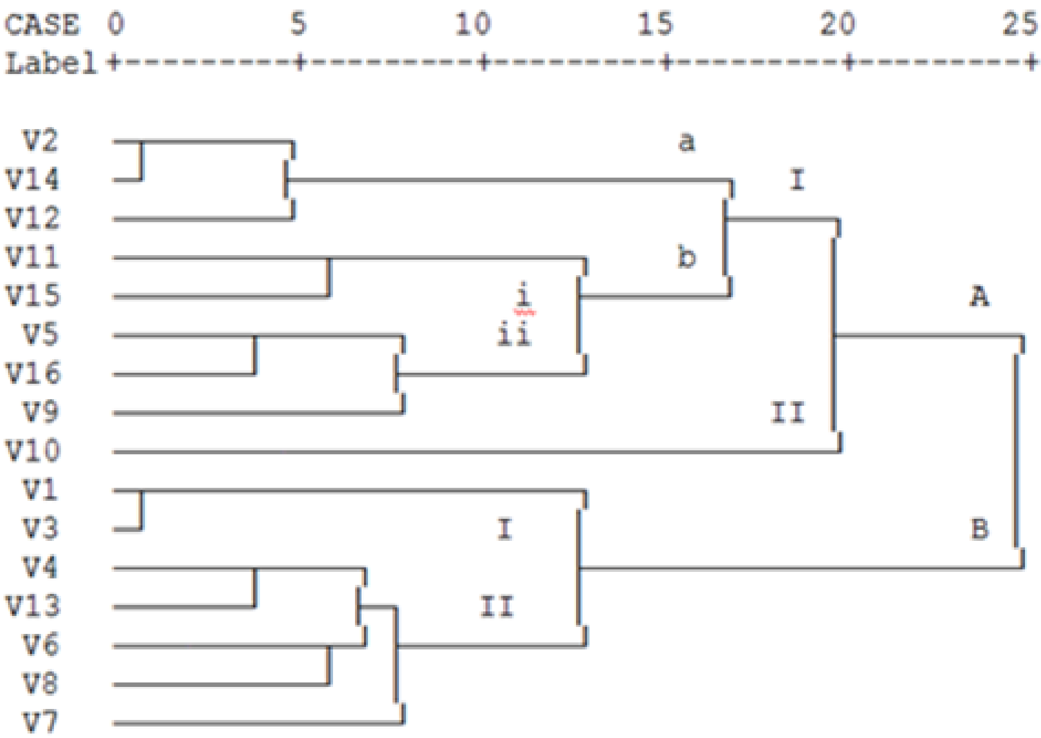

Figure 1 Dendrogram of 16 rice varieties grown in SRI using average linkage (between groups) rescaled distance cluster combine (WARD's method). Here, BR 3 (V_1), BR 14 (V_2), BR 16 (V_3), BRRI dhan 28 (V_4), BRRI dhan 29 (V_5), BRRI dhan 36 (V_6), BRRI dhan 45 (V_7), BRRI dhan 50 (V_8), BINA 6 (V_9), BINA 9 (V_{10}), BRRI hybrid dhan 1 (V_{11}), BRRI hybrid dhan 2 (V_{12}), BRRI hybrid dhan 3 (V_{13}), Chamak (V_{14}), Hira 1 (V_{15}) and Bhajan (V_{16}).

Table 2 Proximity dissimilarity matrix among sixteen rice varieties by Euclidean distance

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16
V1	0	78	30.6	66.2	97.9	65.1	73.2	55.9	126.2	113.8	84.7	95.3	70.5	81.6	91.9	91.3
V2		0	77.6	66.1	83.2	60.3	83.3	72.1	94.4	88	74.3	46.8	56.2	29.6	66.4	80.6
V3			0	62.1	101	54.5	72.8	58.9	131.6	120.6	79.4	92.9	73.3	79.4	92.8	98.4
V4				0	87.5	46.3	48.1	47.2	106.6	79.7	67.6	69.2	43.6	71.4	66.2	74.9
V5					0	93.3	122.3	95.6	56.4	91.6	61.1	64.9	82.9	74.7	68.5	43.9
V6						0	64.1	47.8	120.7	100.6	67.5	63.1	57.5	67.8	72.2	85.7
V7							0	53.2	133	91.3	95.9	95.8	53.4	93.2	85.4	100.6
V8								0	114.4	80.7	73.7	76.6	50.7	80.1	63.7	77.4
V9									0	73.3	80.5	73	91.5	84.9	72	50.7
V10										0	86.6	76.7	69.3	93.2	53.1	63
V11											0	59.4	69.7	72.2	48.1	54.9
V12												0	60.1	43.1	54.4	59.5
V13													0	61.3	59.4	65.3
V14														0	72.7	76.4
V15															0	49.5
V16																0

Here, BR 3 (V_1), BR 14 (V_2), BR 16 (V_3), BRRI dhan 28 (V_4), BRRI dhan 29 (V_5), BRRI dhan 36 (V_6), BRRI dhan 45 (V_7), BRRI dhan 50 (V_8), BINA 6 (V_9), BINA 9 (V_{10}), BRRI hybrid dhan 1 (V_{11}), BRRI hybrid dhan 2 (V_{12}), BRRI hybrid dhan 3 (V_{13}), Chamak (V_{14}), Hira 1 (V_{15}) and Bhajan (V_{16}).

Conclusion

According to the result and discussion of the current study it can be concluded that different morphological characters related to growth and yield of rice have a relationship with each other. Relationship among these phenotypic characters and variety and the proximity distance among the variety may helpful for future rice breeding.

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Conflict of interest

The author declares no conflict of interest.

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