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Correlation and Path Coefficient Analysis For Some Yield-Related Traits in Rice (*Oryza Sativa* L.) Under Thrace Conditions

Halil SÜREK, Necmi BEŞER
Thrace Agricultural Research Institute, P.O. Box 16, Edirne - TURKEY

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Abstract: The associations among yield components, and their direct and indirect influence on the grain yield of rice were investigated. For this purpose, 80 breeding lines derived from 11 different cross populations in the F_6 generation and their 10 parents were tested in a randomised complete block experiment design with two replications at the Thrace Agricultural Research Institute in 1995. According to the results from the first year, 49 breeding lines were selected, and they and their 10 parents were tested in a randomised complete block experiment design with three replications in the same institute in 1996. The phenotypic correlations among the traits and their path coefficient were estimated in both years. Grain yield was significantly correlated with its component characters like the number of productive tillers per square metre (r = 0.241** and r = 0.274**), biological yield (r = 0.803** and r = 0.312**), harvest index (r = 0.250** and r = 0.677**), and the number of filled grains per panicle (r = 0.495** and r = 0.633**) in both years. Path coefficient analysis revealed that biological yield (0.748 and 0.481) and harvest index (0.413 and 0.704) had the highest positive direct effects on grain yield in both years. In addition, the yield components had positive direct effects on grain yield. According to the magnitude of the direct effects on grain yield, the order of yield components was the number of filled grain per panicle (0.297 and 0.285 > the number of productive tillers per square metre (0.233 and 0.197) > 1000-grain weight (0.165 and 0.136). The improvement in grain yield will be efficient, if the selection is based on the biological yield, the harvest index, the number of productive tillers per square metre and the number of filled grains per panicle under temperate conditions. These traits may also be utilised for pure line selection in late generations. However, both high biological yield and high harvest index should be taken into account together in this selection due to their negative correlations and indirect effects each other.

Key Words: Rice (*Oryza sativa* L.), path coefficient, phenotypic correlation, yield components.

Trakya Koşullarında, Çeltikte (*Oryza sativa* L.) Tane Verimi ile İlgili Bazı Karakterler için Korelasyon ve Path Analizi

Özet: Bu araştırmada, çeltiğin verim komponentleri arasındaki ilişkiler ile bunların çeltik tane verimi üzerindeki doğrudan ve dolaylı etkileri incelenmiştir. Bunun için 1995 yılında, 11 farklı F_6 populasyonundan elde edilen 80 çeltik hattı ve bunların 10 anacı ile birlikte, Trakya Tarımsal Araştırma Enstitüsünde, tesadüf blokları deneme deseninde iki tekerrürlü bir deneme kurulmuştur. 1996 yılında, ilk yıl sonuçlarına göre seçilen 49 hat ve bunların 10 anacı ile birlikte, aynı enstitüde üç tekerrürlü ikinci bir deneme daha kurulmuştur. Her iki yıl için, karakterler arasındaki ilişkiler ve bunların path katsayıları belirlenmiştir. Her iki yılda, tane verimi ile metrekarede fertil kardeş sayısı (r = 0.241** ve r = 0.274**), biyolojik verim (r = 0.803** ve r = 0.312**), hasat indeksi (r = 0.250** ve r = 0.677**), ve salkımda fertil tane sayısı (r = 0.495** ve r = 0.633**) gibi karakterler arasında önemli ilişkiler tespit edilmiştir. Yine her iki yılda, path analizi sonucuna göre, biyolojik verim (0.748 ve 0.481) ve hasat indeksinin (0.413 ve 0.704) tane verimi üzerinde en yüksek pozitif doğrudan etkiye sahip olduğu görülmüştür. Aynı zamanda, verim komponentleri de tane verimi üzerinde pozitif doğrudan etkiye sahip olmuşlardır Tane verimi üzerindeki doğrudan etkinin büyüklüğüne göre, verim komponentlerinin etki sıralaması, şu şekilde olmuştur; salkımda fertil tane sayısı (0.297 ve 0.285)> metrekarede fertil kardeş sayısı (0.233 ve 0.197 > 1000 tane ağırlığı (0.165 ve 0.136). Eğer ılıman iklim koşullarında seleksiyonda, biyolojik verim, hasat indeksi, salkımda fertil tane sayısı ve metrekarede fertil kardeş sayısı gibi karakterler üzerinde durulursa, tane veriminin iyileştirilmesinde etkili olabilir. Bu karakterler aynı zamanda, ileri generasyonlarda, saf hat seleksiyonunda da kullanılabilir. Ancak, aralarındaki negatif ilişkiden dolayı, yüksek biyolojik verim ve yüksek hasat indeksi birlikte göz önünde bulundurulmalıdır.

Anahtar Sözcükler Çeltik (*Oryza sativa* L.), path katsayısı, fenotipik korelasyon, verim komponentleri

Correspondence to: surekhalil@hotmail.com

Introduction

The advantage of path analysis is that it permits the partitioning of the correlation coefficient into its components, one component being the path coefficient that measures the direct effect of a predictor variable upon its response variable; the second component being the indirect effect(s) of a predictor variable on the response variable through another predictor variable (Dewey and Lu, 1959). In agriculture, path analysis has been used by plant breeders to assist in identifying traits that are useful as selection criteria to improve crop yield (Dewey and Lu, 1959; Milligan et al., 1990).

The correlation of economic yield components with yield and the partitioning of the correlation coefficient into its components of direct and indirect effects have been extensively studied. Highly significant associations of grain yield were observed with 1000-grain weight and tiller number per plant (Subramanian and Rathinam, 1984; Sharma and Choubey, 1985; Dhanraj and Jagadish, 1987; Jangle et al., 1987; Ram, 1992; Sürek et al., 1998), the number of filled grains per panicle (Deosarkar et al., 1989; Ram, 1992; Ganapathy et al., 1994), biological yield (Peiyan, 1988; Ram, 1992; Mehetre et al., 1994; Sürek et al., 1998) and harvest index (Subramnian and Rathinam, 1984; Peiyan 1988; Roy and Kar, 1992; Sürek et al., 1998).

Grain yield has been reported to be influenced by high direct effects of total tillers and days to flowering (Amirthadevarathinam, 1983), the number of panicles per plant, the number of filled grains per panicle and 1000-grain weight (Yang, 1986), the number of filled grains per panicle and plant height (Ruben and Katuli, 1989), productive tillers, panicle length and flowering time (İbrahim et al., 1990), plant height and tiller number (Kumar, 1992), panicle number per plant and spikelet number per panicle (Lin and Wu, 1981), the number of effective tillers per plant, grains per panicle and 1000-grain weight (Ram, 1992), grains per panicle and productive tillers (Sundaram and Palanisamy, 1994), the number of filled grains per panicle and 1000-grain weight (Mehetre et al., 1994; Samonte et al., 1998) and biological yield, harvest index and 1000-grain weight (Sürek et al., 1998).

In this study, an attempt was made to study the direct and indirect influences of some important yield components on grain yield in breeding lines by adopting correlation and path coefficent analysis under Thrace conditions. The results might be used to adopt selection criteria in further studies. It may increase the selection efficiency. Therefore, breeders save time and expenses during selection.

Materials and Methods

Eighty rice breeding lines derived from 11 different cross populations in the F_6 generation (Table 1) and their 10 parents were evaluated in a randomised complete block experiment design with two replications at the Thrace Agricultural Research Institute in 1995. Each plot was 2 m long and consisted of two rows spaced 25 cm apart. The rice was drill-seeded at a rate of 20 g seed per square metre on 27 May, 1995. The lines which had high values for biological yield, harvest index, productive tillers per square metre, and number of filled grains per panicle were selected for the second year's experiment; they and their 10 parents were tested in a randomised complete block experiment design with three replications at the same institute in 1996. Each plot was 5 m long and consisted of 4 rows, spaced 25 cm apart. Also this experiment drill-seeded at a the rate of 400 seeds per square metre on 29 May, 1996. At the seedling stage, the plants were thinned to an uniform density in both years. Nitrogen (in the form of ammonium sulphate) and phosphorus (in the form of triple super phosphate) were applied at rates of 150 and 80 kg/ha^{-1}, respectively, in both years. The entire dose of phosphorus was applied as basal at planting. Half of the nitrogen was applied at tillering initiation and the remaining 75 kg N^{-1} at panicle

Table 1. The rice breeding lines and their parents used in the experiments in 1995 and 1996.

No.	Cross	The number of breeding lines 1995	1996
1	Baldo x Rodina	8	4
2	İpsala x Titanio	7	5
3	Baldo x Balilla	8	5
4	Delta x Baldo	12	5
5	Slava x Baldo	11	7
6	Baldo x Calendal	9	5
7	Delta x Balilla	4	3
8	Titanio x Rodina	4	4
9	Titanio x Krasnodarsky-424	5	5
10	Baldo x Krasnodarsky-424	6	3
11	Rodina xH-33	6	3
Total		80	49

initiation. The soil was sandy clay loam with pH 6.8 and 1.10% organic matter in 1995 and it had same soil texture with pH 7.8 and 0.60% organic matter in 1996.

Meteorological data for Edirne province (where the experiment was conducted) for 1995, 1996 and the long term are given in Table 2. The number of rainy days and rainfall in 1995 were more than those in 1996, while the highest and average temperatures in 1996 were slightly higher than those in 1995.

Data were collected on days to heading, plant height, panicle length, the number of productive tillers per square metre, the number of filled grains per panicle, 1000-grain weight, the grain yield, biological yield and harvest index. The path and correlation analyses were conducted following the methods of Dewey and Lu (1959) and Snedecor and Cochran (1987), respectively. The data in 1995 and 1996 were analysed separately. The averages of replications were used for the analysis.

Results and Discussion

The analysis of variance revealed highly significant differences among the genotypes for all the characters studied in both years (Table 3).

The correlations among all pairs of variables in 1995 and 1996 are shown in Table 4. The traits significantly correlated with grain yield at the 0.01 level were biological yield, number of filled grains per panicle, harvest index and number of productive tillers per square metre in both years. The other characters expressed a nonsignificant correlation, except for days to flowering; it had a negative and significant correlation with grain yield only in 1996.

The results obtained in this present study were in agreement with the findings of Deosarkar et al., (1989), Ram (1992), Rema Bai et al., (1992), and Kannan Babu and Soundrapandian (1993) for the number of productive tillers per square metre; Ram (1992), Deosarkar et al., (1989), and Ganapathy et al., (1994) for the number of filled grains per panicle; those of Rana (1986), Peiyan (1988), Mehetre et al., (1994) and Sürek et al., (1998) for biological yield; and those of Subramanian and Rathinam (1994), Peiyan (1988), Roy and Kar (1992) and Sürek et al., (1998) for the harvest index.

Path coefficent analysis (Table 5) revealed that biological yield had the highest positive direct effect on grain yield in 1995, while harvest index had the highest positive direct effect in 1996. These traits had a positive direct effect on grain yield in both years. However, three yield component; the number of productive tillers per square metre, the number of filled grains per panicle and 1000-grain weight provided a positive direct contribution to grain yield at the same level in both years. The effect of the number of filled grains per panicle was higher than that of the others. Similar results were reported by Yang (1986), Li et al., (1991) and Ram (1992) for these components; by Peiyan (1988) and Sürek et al., (1998) for biological yield; and by Peiyan (1988), Murty and Babu (1992) and Sürek et al., (1998) for harvest index. In contrast, Sundaram and Palanisamy (1994) observed a negative direct effect of dry matter on grain yield.

Days to flowering had a negative direct effect on grain yield in both years. Sürek et al., (1998) obtained similar results in another experiment under the same conditions.

Table 2. Meteorological data for Edirne province for 1995, 1996 and the long term.

	Rice growing period														
	May		Jun		Jul		Aug		Sep		Long term (x)				
	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996	May	Jun	Jul	Aug	Sep
Highest temperatures (°C)	30.9	32.4	34.7	35.0	34.0	38.4	33.9	37.2	31.6	30.2	26.4	31.9	33.7	33.7	28.9
Lowest temperatures (°C)	2.8	11.2	13.0	10.2	13.5	13.2	11.0	13.8	6.3	6.4	8.4	12.6	15.6	14.2	10.6
Average temperature (°C)	17.5	20.6	23.7	23.3	24.2	25.3	23.2	23.8	19.7	18.1	18.0	21.9	24.2	23.8	19.9
Solar radiation (cal cm^{-2})	422	398	450	461	405	458	385	367	308	272	402	435	416	356	288
Rainy days	7	8	9	1	11	--	6	10	9	11	11.1	9.1	5.4	4.3	3.1
Total rainfall (mm)	11.8	21.3	32.6	1.4	65.6	--	42.4	38.1	33.2	65.2	53.9	47.7	26.2	21.9	18.9
Average relative humidity (%)	60.7	62.9	59.3	51.1	60.1	48.0	60.1	60.0	64.7	68.9	69.6	63.2	57.3	57.9	61.8

(x): The averages of the data recorded in the long rice growing period from 1980 to 1994.

Table 3. Range in mean values and analysis of variance for the characters in 1995 and 1996.

				Mean sum of squares	
Characters	Year	Mean ± SE	Range	Entries	Error
Days to flowering	1995	80.4 ± 0.5	63.0-92.0	44.74**	1.73
	1996	90.1 ± 0.6	78.0-96.3	38.3**	4.62
Plant height (cm)	1995	103.7 ± 0.9	85.3-120.5	146.26**	24.44
	1996	106.3 ± 0.8	90.1-114.7	77.33**	23.86
Panicle length (cm)	1995	17.6 ± 0.5	13.7-22.2	39.34**	31.82
	1996	17.0 ± 0.2	14.7-23.6	5.68**	2.82
No. of productive tillers per square metre	1995	294.8 ± 4.8	211.0-408.0	4149.78**	971.81
	1996	336.8 ± 4.1	297.6-408.6	1923.53**	169.31
No. of filled grains per panicle	1995	63.1 ± 1.5	37.5-97.0	382.10**	73.87
	1996	53.1 ± 0.4	35.7-78.3	308.39**	78.51
1000-grain weight (g)	1995	38.5 ± 0.4	25.8-45.5	26.42**	2.28
	1996	34.1 ± 0.5	22.2-41.0	34.5**	2.35
Biological yield (g m^{-2})	1995	1456.6 ± 23.8	950.0-1940.0	99697.75**	25108.95
	1996	1825.5 ± 20.5	1402.5-2309.3	1.58**	0.78
Harvest index (%)	1995	46.0 ± 0.4	34.0-59.0	30.44**	9.98
	1996	35.5 ± 0.9	22.7-45.3	86.64**	23.66
Grain yield (g m^{-2})	1995	657.4 ± 10.6	437.5-839.0	19751.49**	8086.1
	1996	610.5 ± 13.0	398.3-775.8	0.36**	0.18

** significant at P = 0.01 level

Table 4. Phenotypic correlations among the traits in 1995 and 1996.

Characters	Year	Grain yield	Days to flower	Plant height	Panicle length	No. of productive tillers per square metre	Biological grain yield	1000-grain Harvest weight	Harvest index
Days to Flowering	1995	0.027	--						
	1996	-0.444**	--						
Plant height	1995	0.079	0.358**	--					
	1996	-0.097	0.151**	--					
Panicle length	1995	0.000	-0.081	0.097	--				
	1996	0.058	-0.236**	0.280**	--				
No. of productive tillers per square metre	1995	0.241**	-0.005	-0.023	-0.005	--			
	1996	0.274**	-0.080	-0.171*	-0.001	--			
Biological yield	1995	0.803**	0.136	0.178*	-0.022	0.263**	--		
	1996	0.312**	0.274**	0.170*	-0.106	0.249**	--		
1000-grain weight	1995	0.063	-0.004	0.160*	0.064	-0.073	-0.017	--	
	1996	0.129	-0.045	0.168*	-0.098	-0.105	0.026	--	
Harvest index	1995	0.250**	-0.158	-0.142*	0.025	-0.068	-0.288**	0.097	--
	1996	0.677**	-0.672**	-0.249**	0.210**	0.077	-0.393**	0.079	--
No. of filled grains per panicle	1995	0.495**	0.053	0.010	-0.032	-0.502**	0.405**	-0.348**	0.171*
	1996	0.633**	-0.373**	-0.125	0.147*	-0.250**	0.122	-0.338**	0.573**

* and ** significant at P = 0.05 and 0.01, respectively.

Table 5. Path analysis showing direct and indirect effect of traits on grain yield in 1995 and 1996.

Characters	Year	Days to flower	Plant height	Panicle length	No. of productive tillers per square metre	Biological yield	1000-grain weight	Harvest index	No. of filled grains per panicle	Correlation with grain yield
Days to Flowering	1995	-0.018	-0.005	-0.001	-0.001	0.101	-0.001	-0.065	0.016	0.027
	1996	-0.005	-0.010	0.021	-0.016	0.132	-0.006	-0.473	-0.106	-0.444**
Plant height	1995	-0.006	-0.014	0.001	-0.005	0.133	0.026	-0.058	0.003	0.079
	1996	-0.001	0.067	-0.024	-0.034	0.082	0.023	-0.175	-0.035	-0.097
Panicle length	1995	0.001	-0.001	0.006	-0.001	-0.017	0.011	0.010	-0.010	0.000
	1996	0.001	0.019	-0.087	-0.000	-0.051	-0.013	0.148	0.042	0.058
No. of productive tillers per square metre	1995	0.001	0.000	0.000	0.233	0.197	-0.012	-0.028	-0.149	0.241**
	1996	0.000	-0.011	0.000	0.197	0.120	-0.014	0.054	-0.071	0.274**
Biological yield	1995	-0.002	-0.003	0.000	0.061	0.748	-0.003	-0.119	0.120	0.803**
	1996	-0.001	0.011	0.009	0.049	0.481	0.005	-0.277	0.035	0.312**
1000-grain weight	1995	0.000	-0.002	0.000	-0.017	-0.013	0.165	0.033	-0.103	0.063
	1996	0.000	0.011	0.008	-0.021	0.012	0.136	0.077	-0.096	0.129
Harvest index	1995	0.003	0.002	0.000	0.016	-0.215	0.013	0.413	0.050	0.250**
	1996	0.003	-0.017	-0.018	0.015	-0.189	0.015	0.704	0.163	0.677**
No. of filled grains per panicle	1995	-0.001	0.000	0.000	-0.117	0.303	-0.057	0.070	0.297	0.495**
	1996	0.002	-0.008	-0.013	-0.049	0.059	-0.046	0.404	0.285	0.633**

** significant at P = 0.01 level

The indirect effects of the number of productive tillers per square metre via 1000-grain weight, and the number of filled grains per panicle were negative and via biological yield was positive in both years. Biological yield had positive indirect effects through the number of productive tillers per square metre, and the number of filled grains per panicle, and a negative indirect effect via harvest index in both years.

Harvest index had a negative indirect effect via biological yield and a positive effect through the number of productive tillers per square metre, 1000-grain weight and the number of filled grains per panicle in 1995 and 1996. The indirect effects of filled grains per panicle via plant height, panicle length, the number of productive tiller per square metre, and 1000-grain weight were negative and via biological yield and harvest index were positive in both years. The indirect effects of 1000-grain weight through the number of productive tillers per square metre, and the number of filled grains per panicle were negative and via the harvest index was positive.

The biological yield and harvest index seem to be very important traits affecting rice yield in temperate areas like the Thrace region. De Datta (1981) reported that the ripening stage (from flowering to maturity) took 25-35 days regardless of variety in the tropics, whereas it took 45-60 days in temperate countries such as Japan, Australia and the United States. During this longer ripening period, the plants produce more dry matter and this contributes to grain yield. A prolonged ripening phase results in more filled spikelets. On the other hand, Vergara (1991) pointed out that better rice cultivars had a higher harvest index (grain yield/total dry matter). Thus, at lower temperatures, the higher harvest index could account for higher yields in temperate areas, while the rice plant produces more straw than grain in the tropics. The highest rice grain yields are harvested in temperate countries, such as Australia, the United States and Spain. Sürek et al., (1998) conducted research under the same conditions and they obtained results similar to those mentioned above.

The number of filled grains per panicle and the number of productive tillers per square metre seem to be important yield determining characters under Thrace conditions. However, the environmental effect on the number of productive tillers per square metre is very high, it should be kept in mind if this trait is used in the selection. The number of filled grains per panicle seems to be more reliable than the number of productive tillers per square metre for selection.

Conclusion

When the results of correlation and path coefficient analysis are examined, it is observed that the number of filled grains per panicle, the number of productive tillers per square metre, biological yield and harvest index recorded a direct positive effect on grain yield, and they had a positive indirect effect via each other except between biological yield and harvest index and between the number of productive tillers per square metre and the number of filled grains per panicle. Therefore, they do not affect each other adversely.

In addition, these traits had significant and positive correlations with grain yield. Thus, selection for the improvement of grain yield can be efficient, if it is based on biological yield, harvest index, the number of filled grains per panicle and the number of productive tillers per square metre in temperate conditions.

These traits may be utilised for pure line selection in late generations; however, both high biological yield and high harvest index should be taken into account together in this selection due to their negative correlation and indirect effect via each other.

References

Amirthadevarathinam, A., 1983. Genetic variability, correlation and path analysis of yield components in upland rice. Madras Agricultural Journal. 70(12): 781-785.

De Datta, S.K., 1981. Principles and Practices of Rice Production. John Wiley and Sons, New York.

Deosarkar, D.K., M.B. Misal and Y.S. Nerkar, 1989. Variability and correlation studies for yield and yield contributing characters in breeding lines of upland rice. J. Maharashtra Agric. Univ. 14(1): 28-29.

Dewey, D.R. and K.H. Lu, 1959. A correlation and path co-efficient analysis of components of crested wheat grass and seed production. Agron. J. 51: 515-518.

Dhanraj, A. and C.A. Jagadish, 1987. Studies on character association in the F_2 generation of ten selected crosses in rice (*Oryza sativa* L.). J. Res. APAU, 15(1): 64-65.

Ganapathy, S., V. Sivasubramanian, K. Balakrishnan and A. Arjunan, 1994. Association studies on yield parameters in short duration rice. Madras Agric. J. 81(6): 335-336.

Ibrahim, S.M., A. Ramalingam and M. Subramanian, 1990. Path analysis of rice grain yield under rainfed lowland conditions. IRRN 15(1): pp 11.

Jangle, R.D., S.D. Ugale and A.D. Dumbre, 1987. A study of cause and effect relationship among quantitative traits in upland paddy. Journal Maharashtra Agriculture Univ. 12(1): 31-34.

Kannan Babu, J.R.K. and G. Soundrapandian, 1993. Genetic variability and association studies in F3 generation of rice (*Oryza sativa* L.). Madras Agric. J. 80(12): 711-712.

Kumar, C.R.A., 1992. Variability and character association studies in upland rice. Oryza 29(1): 31-34.

Li, Q.L., V.T. Li, G.Z. Gou, G. Jiang and Y. Zhu, 1991. Study on high yield breeding and genetic analysis of yield components of main rice cultivars in Jilin, China. Hereditas-Beijing 13: 3-6.

Lin, F.H. and Y.L. Wu, 1981. Relationships between harvest index and grain yield of rice in Taiwan. J. Agric. Assoc. China 115: 33-41.

Mehetre, S.S., C.R. Mahajan, P.A. Patil, S.K. Lad and P.M. Dhumal, 1994. Variability, heritability, correlation, path analysis, and genetic divergence studies in upland rice. IRRN, 19(1): 8-9.

Milligan, S.B., K.A. Gravois, K.P. Bischoff and F.A. Martin, 1990. Crop effects on genetic relationships among sugarcane traits. Crop Sci. 30: 927-931.

Murty, P.S.S. and V. Babu, 1992. Path coefficient analysis of physiological parameters in hybrid rices. Oryza 29: 379-380.

Peiyan, L. 1988. Inheritance of biological yield and harvest index and their relationship with grain yield in rice. Trop. Agric. Res. Ser. 21: 233-230.

Ram, T., 1992. Character association and path coefficient analysis in rice hybrids and their parents. Jour. Andaman Sci. Assoc. 8(1): 26-29.

Rana, R.S., 1986. Selecting for alkali soils. Int. Rice Res. Newsl. 11(5): 10.

Rema Bai, N., A. Regina, R. Devika and C.A. Joseph, 1992. Genetic variability and association of characters in medium duration rice genotype. Oryza 29: 19-22.

Ruben, S.O.W. and S.D. Katuli, 1989. Path analysis of yield components and selected agronomic traits of upland rice breeding lines. IRRN, 14(4): 11-12.

Roy, A. and M.K. Kar, 1992. Heritability and correlation studies in upland rice. Oryza, 29: 195-199.

Samonte, S.O.P.B., L.T. Wilson and A.M. McClung, 1998. Path analyses of yield and yield-related traits of fifteen diverse rice genotypes. Crop Sci. 38: 1130-1136.

Sharma, R.S. and S.D. Choubey, 1985. Correlation studies in upland rice. Indian J. Agron. 30(1): 87-88.

Snedecor, W. and W.G. Cochran, 1987. Statistical Methods. Oxford and IBM Calcutta, pp 593.

Subramanian, S. and M. Rathinam, 1984. Association of grain yield attributes in the hybrids of crosses between tall and semi-dwarf varieties of rice. Madras Agric.-J. 71(8): 536-538.

Sundaram, T. and S. Palanisamy, 1994. Path analysis in early rice (*Oryza sativa* L.). Madras Agric. J. 81(1): 28-29.

Sürek, H., Z.K. Korkut and O. Bilgin, 1998. Correlation and path analysis for yield and yield components in rice in a 8-parent half diallel set of crosses. Oryza 35(1): 15-18.

Vergara, B.S., 1991. Rice Plant Growth and Development. In Rice Production, Edited by Bor S. Luh. University of California, Davis, Vol 1: 13-22.

Yang, H.S., 1986. Studies on the main traits of intervarietal hybrid progenies in indica rice. Fujan-Agricultural Science and Technology. 6: 2-4.