Indian J. Pl. Genet. Resources 13(3): 239-246, 2000

GENETIC VARIABILITY, CORRELATION COEFFICIENT AND PATH ANALYSIS FOR QUANTITATIVE CHARACTERS UNDER RAINFED ECOSYSTEM IN THE NATIVE LANDRACES OF RICE

J. B. TOMAR, B. S. DABAS[1] AND P. L. GAUTAM[2], National Bureau of Plant Genetic Resources (NBPGR), Base Centre, Ranchi (Bihar); [1]NBPGR, New Delhi; [2]National Director, National Agricultural Technology Project, LBS Building, IARI, New Delhi 110 012

A study to find out the genetic parameters, correlation coefficients among yield and yield components, direct and indirect effects of yield components on the yield in the native landraces of rice under Rainfed ecosystem was carried out. 124 rice landraces collected from Bolangir district of Orissa were transplanted in two replications and the data was recorded on ten competitive plants in each accession. The estimates for PCV were higher than GCV for all the traits indicating the effect of environment on the manifestation of traits. The flag leaf width showed the highest estimate followed by panicle length, number of primary branches/panicle, yield/plant and number of effective tillers/plant. From the study of PCV and GCV, the flag leaf width, panicle length, number of primary branches/panicle, yield/plant and number of effective tillers/plant were found to be the important characters. Both the heritability and genetic advance were found high for the number of grains/panicle, number of primary branches/panicle and 1000-grain weight, which indicated the governance by additive gene action. The panicle length, 1000-grain weight, harvest index, biological yield, flag leaf length and its width had high heritability but low genetic advance suggesting that these traits had greater influence of the non-additive gene action with a big role of non-genetic factors in their expression. Moderate heritability estimates associated with moderate genetic advance for some traits suggested that additive and non-additive gene effects were equally important in the inheritance of these characters. The coheritability estimates were highest between harvest index and 1000-grain (48.71) followed by yield/plant and number of grains/panicle (44.71), flag leaf length and plant height (43.15), and number of grains/panicle and panicle length (41.72). A negative coheritability was found between biological yield and harvest index (–39.41), 1000-grain weight and number of grains/panicles (–33.31), 50% flowering and panicle length (–2.74) and 50% flowering and number of primary branches/panicle (–2.94). The yield/plant had positive association with plant height, number of effective tillers, panicle length, primary branches/panicle, number of grains/panicle and 1000-grain weight, harvest index, biological yield, flag leaf length and its width and days to 50% flowering. The path coefficient analysis at phenotypic level revealed that 1000-grain weight had the maximum direct effect on the grain yield followed by number of primary branches, harvest index, number of effective tillers and flag leaf length. Plant height though showed the positive correlation with grain yield but had negative direct effect and contributed indirectly through harvest index. At the genotypic level, panicle length had maximum direct effect on the grain yield followed by number of grain/panicle, 1000-grain weight, harvest index and flag leaf width.

Key words : Rice, genetic variability, path analysis, correlation coefficient

Grain yield in rice is a complex character and greatly influenced by the agroclimatic conditions. The knowledge of associations between yield and yield components under the rainfed ecosystem may be beneficial and helpful to enhance the grain yield. The significant associations of grain yield with 1000-grain weight and tiller number per plant have been reported (Subramanian and Rathinam, 1984; Sharma and Choubey, 1985; Dhanraj and Jagdish, 1987 and Jangle *et al.*, 1987). The correlation between grain yield and total biomass (Rana, 1986 and Mehetre *et al.*, 1994) and grain yield and harvest index (Subramanian and Rathinam, 1984 and Roy and Kar, 1992) have been reported. The grain yield has been reported to be influenced by high direct effects of total tillers and days to flowering (Amrithadevarathinam, 1983), number of panicles per plants, number of filled grains per panicle and 1000-grain weight (Yang, 1986), number of filled grains per panicle and plant height (Reuben and Katali, 1989), productive tillers, panicle length and flowering duration (Ibrahim *et al.*, 1990) and plant height and tiller number (Kumar, 1992).

Very little systematic information regarding the genetic variability and correlation among the yielding contributing traits in the native landraces of rice germplasm under rainfed ecosystem is available. The present study was therefore, planned to estimate genetic parameters, correlation coefficients among the different yield attributes at the phenotypic as well as genotypic levels, coheritability and nature and extent of direct and indirect effects of the yield components on the yield under rainfed ecosystem in the native landraces of rice germplasm.

MATERIALS AND METHODS

One hundred twenty four native rice land races were collected from Bolangir district of Orissa during 1988. 25-day of old seedlings were transplanted in a randomized block design with two replications. Each plot consisted of two rows of 5 meters length with a spacing of 30 × 20 cms. One row gap was left between two plots. In each genotype, 10 plants were taken randomly to record the observations on days to 50% flowering, plant height, number of tillers, number of effective tillers, panicle length, primary branches per panicle, number of grains per panicle, 1000-grain weight, yield per plant, harvest index, biological yield, flag leaf length and its width. The analysis of variance was carried out on the mean values of each character. The phenotypic, genotypic coefficient of variability, heritability in broad sense, genetic advance at 5% selection intensity were computed as suggested by Johanson *et al.* (1955). The phenotypic and genotypic correlations were calculated as per methods of Al-Jobouri *et al.* (1958). Coheritability was calculated using the formula suggested by Nei (1960). The path analysis was carried out as per method of Dewey and Lu (1959).

RESULTS AND DISCUSSION

A wide range of variability was observed for all the characters. The range for days to 50% flowering (79-129), plant height (77-186 cm), number of tillers (4-15), number of effective tillers (3-13), panicle length (13-32 cm) primary branches per panicle (7-17), number of grains per panicle (50-469), 1000-grain weight (12-29 gm), yield per plant (5-20 gm), Harvest index (0.21-0.40), biological yield (15-60 gm), flag leaf length (26-63 cm) and flag leaf width (1.23-2.46) was observed. The range, mean, standard error of mean and critical difference at 5% level of significance are given in the Table 1. Analysis of variance revealed that the differences among the landraces (genotypes) were highly significant. The phenotypic and genotypic variances were also calculated and it was found that phenotypic variances were higher than genotypic variances for all the characters. It indicated the effect of environment in the expression of traits. Similarly phenotypic coefficient of variation (PCV) estimates

Table 1. Range and mean of the various quantitative characters in the native land races of rice germplasm.

Characters	Range	Mean	Sem	CD (5%)
Days to 50% flowering	79-129	115	1.89	5.30
Plant height (cm.)	77-186	130	2.82	7.92
No. of tillers/plant	04-15	8	0.89	2.49
No. of effective tillers/plant	03-13	7	0.70	1.96
Panicle length (cm.)	13-32	20	0.52	1.45
No. of primary branches/panicle	06-17	9	0.63	1.76
No. of grains/panicle	50-469	150	4.35	12.18
1000-grain weight (gm)	12-29	23	1.01	2.82
Yield/plant (gm)	05-20	12	1.09	3.05
Harvest index	0.21-0.40	0.31	0.08	0.07
Biological yield (gm)	14-60	30	0.88	2.29
Flag leaf length (cm)	26-63	41	2.14	5.99
Flag leaf width (cm)	1.23-2.46	1.52	0.09	0.25

were found higher than genotypic coefficient of variation (GCV) estimates indicating again the effect of environment on the manifestation of these traits. However the differences between PCV and GCV were not very high. The flag leaf width showed the highest estimate followed by panicle length, number of primary branches per panicle, yield per plant and number of effective tillers. Thus these traits further offered scope for genetic improvement. Rest of the characters showed the moderate GCV. From the study of PCV and GCV, the flag leaf width, panicle length, number of primary branches per panicle, yield per plant and number of effective tillers emerged to be the most important characters. These findings are not in conformity with the previous findings of Ramalingam *et al.* (1994) who reported that grain yield, and number of grains/panicle had high GCV.

The heritability estimate h^2 ranged from 70.25 (flag leaf length) to 95.84 (number of grains per panicle). The genetic advance ranged from 2.21 (flag leaf width) to 61.52 (primary branches/panicle). The number of grains per panicle, primary branches per panicle, number of effective tillers and days to 50% flowering ahad high genetic advance (> 35) as well as heritability (> 75) (Table 2). It suggested that these attributes were controlled predominantly by additive gene action. Hence genetic improvement through selection for these traits may be effective. The panicle length, 1000-grain weight, harvest index, biological yield, flag leaf length and its width had high heritability but low genetic advance suggesting that these traits had greater influence of the non-additive gene action with a big role of non-genetic factors in their expression. Moderate heritability estimates associated with moderate genetic advance suggested that additive and non-additive gene effects were equally important in the inheritance of the characters. Chauhan (1996) reported that grain yield per plant, spikelets per panicle, grain weight, biological yield and harvest index had high expected genetic advance associated with high heritability. Low to moderate heritability values for grain yield were reported by Ananda Kumar (1992), Roy and Kar (1992) and Chauhan *et al.* (1993).

Coheritability

Coheritability value of the character combination suggests that the increase/decrease in one of the characters of a particular combination will lead to an corresponding increase/decrease in its coheritable character. The yield per plant had high coheritability with number of grain per panicle (44.71), days to 50% flowering (37.94), biological yield (36.24), 1000-grain weight (35.74), flag leaf width (35.61), harvest index (34.14) and flag leaf length (31.24) in the positive direction. The coheritability estimate was the highest between harvest index and 1000-grain (48.71) followed by between yield per plant and number of grains per panicle (44.71), between flag leaf length and

Table 2. Genetic parameters for yield and its attributes in the native landraces of rice germplasm

Characters	σ^2 ph	σ^2_g	PCV	GCV	h2	GA
Days to 50% flowering	464.80	353.00	18.74	16.32	75.9	39.0
Plant height (cm)	459.20	373.00	16.84	14.85	61.3	17.0
No. of tillers/plant	9.79	7.06	39.11	33.21	72.2	37.0
No. of effective tillers/plant	9.17	7.40	43.26	38.86	80.7	35.0
Panicle length (cm.)	94.25	84.80	48.54	46.04	90.0	3.6
Primary branches/panicle	18.94	14.40	48.35	42.22	76.3	62.0
No. of grains/panicle	372.90	357.00	12.87	12.60	95.8	57.0
1000-grain weight (gm)	69.27	61.20	36.18	34.01	88.4	43.0
Yield/plant (gm)	29.29	23.00	45.10	39.94	78.5	31.0
Harvest index	110.20	90.90	34.40	29.79	75.0	3.6
Biological yield (gm)	74.74	52.90	28.81	24.25	70.8	3.8
Flag leaf length (cm)	94.25	66.20	23.67	19.84	70.3	5.8
Flag leaf width (cm)	0.90	0.67	62.41	53.85	74.7	2.2

plant height (43.15) and between number of grain per panicle and panicle length (41.72). A negative coheritability was found between biological yield and harvest index (–39.41), 1000-grain weight and number of grains/panicles (–33.31), 50% flowering and panicle length (–2.74) and 50% flowering and number of primary branches/panicle (–2.94). Rest of the character combinations showed from very low to moderate coheritability (Table 3). It was interesting to note that panicle length, number of effective tillers, 1000-grain weight and number of grains per panicle was positively coheritable with yield per plant which also had high expected genetic advance coupled with high heritability in broad sense. Thus selection for these traits may be effective for yield the improvement.

Simple correlation coefficients

Both the phenotypic and genotypic correlation coefficients were calculated and found that in general the magnitude of phenotypic correlations were higher than the genotypic correlations. Phenotypic expression of correlations was enhanced mostly under the influence of

Table 3. Coheritability values in per cent for different combinations of characters in the indigenous local cultivars

Characters	No. of tillers	No. of effective tillers	Panicle length	Primary Branches	No. of grains per panicle	1000 grain wt.	Yield per plant	Harvest index	Biological yield	Flag leaf length	Flag leaf width	Days to 50% flowering
Plant height	1.90	1.81	29.34	3.95	21.42	2.15	3.42	33.14	36.29	35.12	43.15	1.10
Number of tillers/plant		4.24	1.42	0.67	0.67	4.24	6.25	4.81	31.21	3.74	6.74	2.90
Number of effective tillers/plant			3.42	6.24	3.94	6.24	36.14	24.34	25.74	3.47	5.81	3.29
Panicle length				35.94	41.72	2.14	36.74	31.24	36.94	1.24	3.79	–2.74
Primary branches/panicle					38.74	11.24	31.91	29.64	26.59	3.42	5.71	–2.94
No. of grain/panicle						33.31	44.71	31.74	29.74	3.24	7.61	2.31
1000 grain weight							35.74	48.71	36.75	31.24	26.74	37.14
yield/plant								34.14	36.24	31.24	35.61	37.94
Harvest index									–39.41	25.74	31.41	38.75
Biological yield										25.74	21.74	36.74
Flag leaf length											25.74	24.24
Flag leaf width												1.25

Table 4. Estimate of genotypic and phenotypic correlation coefficients between different pairs of characters in the indigenous rice cultivars

Characters	No. of tillers/ plant	No. of effective tillers	Panicle length	Primary branches	No. of grains/ panicle	1000 grain weight	Yield per plant	Harvest index	Biological yield	Flag leaf length	Flag leaf width	50% flowering
Plant height	0.008	0.064	0.185*	0.025	0.194*	0.023	0.200*	0.184*	0.341	0.183*	0.189*	0.021
	0.065	0.054	0.194	0.014	0.183	0.011	0.184	0.173	0.284	0.164	0.182	0.018
No. of tillers		0.112	0.092	0.102	0.084	0.097	0.069	0.029	0.150	0.094	0.113	0.126
		0.094	0.091	0.096	0.061	0.009	0.074	0.084	0.156	0.063	0.126	0.134
No. of effective tillers			0.140	0.129	0.124	0.136	0.199*	0.189*	0.201*	0.111	0.121	0.134
			0.134	0.111	0.131	0.124	0.178	0.190	0.194	0.101	0.125	0.121
Panicle length				0.341**	0.384**	0.096	0.192*	0.294**	0.304**	0.009	0.151	–0.160
				0.284	0.290	0.111	0.189	0.299	0.311	0.084	0.158	–0.152
Primary branches					0.401**	0.151	0.211*	0.274**	0.261**	0.141	0.161	–0.161
					0.394	0.142	0.194	0.294	0.272	0.129	0.159	–0.164
No. of grain/panicle						–0.421*	0.461**	0.274**	0.271**	0.134	0.141	0.136
						–0.392	0.394	0.281	0.262	0.131	0.139	0.129
1000 grain wt.							0.344**	0.481**	0.394**	0.241**	0.381**	0.261**
							0.341	0.460	0.381	0.250	0.305	0.258
Yield/plant (gm)								0.401**	0.393**	0.392**	0.409**	0.414**
								0.400	0.398	0.396	0.397	0.384
Harvest index									–0.409*	0.297**	0.281**	0.301**
									–0.419	0.301	0.290	0.321
Biological yield										0.411**	0.390**	0.311**
										0.401	0.387	0.301
Flag leaf length											0.309**	0.443**
											0.311	0.394
												0.151
Flag leaf width												0.142

environment. But in some cases the genotypic correlations were higher than the phenotypic correlations coefficients which were in the same direction either plus or minus. It indicated the elimination of environmental effects and a fairly strong inherent association. The yield per plant had positive association with plant height, number of effective tillers, panicle length, primary branches per panicle, number of grains per panicle and 1000-grain weight, harvest index, biological yield, flag leaf length and its width and days to 50% flowering. Days to 50% flowering showed negative correlations with panicle length and primary branches per panicle. A highly significant negative correlation was recorded between 1000-grain weight and number of grains/panicle. Biological yield also showed a strong and significant negative correlation with harvest index (Table 4). Thus selection for high number of grains per panicle, 1000-grain weight, number of primary branches per panicle will improve the harvest index as a result enhancement of yield. The positive association of grain yield with biological yield and harvest index was observed (Roy and Kar, 1992 and Chauhan *et al.*, 1993). A significant positive correlation of number of grain yield per panicle with grains per panicle, panicle length, and primary branches was reported by Sharma and Dubey

Table 5. Path coefficient analysis among the quantitative characters of native rice landraces

Characters	Days to 50% flowering	Plant height (cm)	No. effective tillers	Panicle length (cm)	Primary branches	No. of grains/ panicle	1000-grain wt.	Harvest index	Biological yield	Flag leaf length	Flag leaf width	Correlation with yield/ plant
Days to 50% flowering	*0.040*	0.004	0.012	0.031	0.073	0.061	0.051	0.014	0.054	0.034	0.030	0.414
Plant height (cm)	0.012	*–0.101*	0.001	0.08	–0.033	0.042	0.031	0.062	0.021	0.081	0.004	0.200
No. of effective tillers	–0.015	–0.002	*0.121*	–0.001	0.004	0.024	0.011	0.102	–0.042	–0.001	–0.002	0.199
Panicle length (cm)	–0.002	0.023	–0.003	*0.084*	0.101	0.094	–0.079	0.054	–0.071	–0.004	–0.005	0.192
Primary branches	0.003	–0.041	–0.042	0.071	*0.131*	0.061	0.072	0.042	–0.031	–0.034	–0.021	0.211
No. of grain/panicle	–0.039	–0.018	0.074	0.043	0.058	*0.124*	0.201	0.082	–0.043	–0.010	–0.012	0.461
1000 grain weight (gm)	–0.042	–0.053	0.008	0.031	0.042	0.102	*0.172*	0.134	0.030	–0.040	–0.045	0.344
Harvest index	0.019	0.023	0.021	0.011	0.021	0.053	0.151	*0.131*	–0.071	0.031	0.011	0.401
Biological yield	0.011	0.161	0.054	0.043	0.022	0.054	0.103	–0.084	*0.074*	–0.040	–0.004	0.393
Flag leaf length	–0.013	–0.006	0.016	–0.002	0.047	0.010	0.012	0.034	0.084	*0.111*	0.104	0.397
Flag leaf width	–0.085	–0.037	0.022	0.041	0.034	0.041	0.117	0.032	0.092	0.051	*0.101*	0.409

Residual effect = 0.028

Table 6. Genotypic path coefficient analysis among the quantitative characters of native rice landraces under rainfed ecosystem

Characters	Days to 50% flowering	Plant height	No. of effective tillers	Panicle length	Primary branches	No. of grain panicle	1000 grain wt.	Harvest index	Biological yield	Flag leaf length	Flag leaf width	Correlation with yield/ plant
Days to 50% flowering	*0.027*	0.091	0.054	0.062	0.014	0.011	0.082	0.021	0.014	0.005	0.003	0.384
Plant height	0.021	*0.012*	0.001	0.080	0.011	0.009	0.022	0.015	0.032	–0.020	–0.008	0.184
No. of effective tillers	–0.054	–0.021	*0.109*	0.022	0.044	0.008	0.032	0.017	–0.034	0.034	0.021	0.178
Panicle length	–0.004	0.011	–0.064	*0.134*	0.060	0.120	–0.024	0.054	–0.064	–0.020	–0.011	0.189
Primary branches	–0.074	0.012	–0.053	0.124	*0.074*	0.084	0.043	–0.037	0.012	0.034	–0.025	0.194
No. of grain/panicle	0.009	–0.044	–0.059	0.119	0.064	*0.124*	0.071	0.094	–0.040	0.036	0.020	0.394
1000 grain weight	0.012	0.063	–0.041	–0.052	–0.073	0.038	*0.121*	0.024	0.134	0.064	0.051	0.341
Harvest index	–0.043	–0.059	0.061	0.031	0.049	0.111	0.152	*0.121*	–0.043	0.008	0.012	0.400
Biological yield	0.034	0.064	0.032	0.034	0.021	0.076	0.094	–0.061	*0.084*	0.034	–0.014	0.398
Flag leaf length	–0.024	0.025	0.044	0.104	0.021	–0.040	0.029	0.031	0.045	*0.102*	0.054	0.396
Flag leaf width	0.012	0.024	0.031	0.011	0.024	0.030	0.051	0.048	0.034	0.019	*0.113*	0.397

Residual effect = 0.027

(1997). Chauhan (1996) found positive association of yield with spikelets number per panicle, biological yield and harvest index. The grain yield per plant showed significant positive correlation with number of grains per panicle at both the phenotypic as well as genotypic levels but with 1000-grain weight, panicle length and flag leaf length at genotypic level only (Reddy *et al.*, 1997).

Path correlation coefficient

The path coefficient analysis carried out at both the phenotypic as well as genotypic level (Table 5 & 6). At the phenotypic level, 1000-grain

weight had the maximum direct effect on the grain yield followed by number of primary branches, harvest index, number of effective tillers and flag leaf length. Plant height, though showed the positive correlation with grain yield but had negative direct effect and contributed indirectly through harvest index. The path coefficient analysis at genotypic level revealed that panicle length had maximum direct effect on the grain yield followed by number of grains per panicle, 1000-grain weight, harvest index and flag leaf width. Path analysis revealed that panicle length, no. of grains per panicle, 1000-grain weight and flag leaf width are the major contributor towards grain yield. Sharma and Dubey (1997) found that longer panicle coupled with more grains, primary branches and secondary branches per panicle are important for yield improvement.

Present investigation revealed that panicle length, number of effective tillers, 1000-grain weight and number of grains per panicle was positively coheritable with yield per plant which also had high expected genetic advance coupled with high heritability in broad sense. Thus selection for these traits may be effective for yield the improvement.

REFERENCES

Al-Jobbery, H. A., P. A. Miller and H. F. Robinson. 1958. Genotypic and environmental variances and covariances in upland cotton cross of interspecific origin. *Agron. J.* 51: 633-636.

Amirthadevarathinam A. 1983. Genetic variability, correlation and path analysis of yield components in upland rice. *Madras Agric. J.* 70: 781-785.

Anand Kumar, C. R. 1992. Variability and character association studies in upland rice. *Oryza* 29: 11-13.

Chauhan J. S. 1996. Genotypic and phenotypic correlations between grain yield and other associated characters in very early duration elite breeding cultures of rice. *Oryza* 33 : 26-30.

Chauhan, J. S., V. S. Chauhan and M. Variar. 1993. Genetic variation and character association in rainfed upland rice. *Oryza* 30: 116-119.

Dewey, D. R. and K. H. Lu. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed populations. *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.

Ibrahim S. M., A. Ramalingam and M. Subramanian. 1990. Path analysis of rice grain yield under rainfed lowland conditions. *Int Rice Res. Newsl.* 15(1) : 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. *J. Maharashtra Agric. Univ.* 12(1) : 31-34.

Johnason H. N., H. F. Robinson and R. E. Comstock. 1955. Estimate of genetic and environmental variability in soybean. *Agron. J.* 27 : 314-318.

Kumar C. R. A. 1992. Variability and character association studies in upland rice. *Oryza* 29: 11-13.

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. *Int. Rice Res. Newsl.* 19(1) : 8-9.

Nie, M. 1960. Studies on the application of biometrical genetics to plant breeding. *Mum. Coll. Agric. Kyoto Univ. Japan* 82 : 1-100.

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

Reddy, J. N., R. N. De and A. V. Suriya Rao. 1997. Correlation and path analysis in lowland rice under intermediate (0-50 cm) water depth. *Oryza* 34 (3) : 187-190.

Reuben S. O. W. and S. D. Katali 1989. Path analysis of yield of yield components and selected agronomic traits of upland rice breeding lines. *Int. Rice Res. Newsl.* 14(4) : 11-12.

Ramalingam, J., N. Nadarajan, P. Rangasamy and C. Vannirajan. 1994. Genetic variability for panicle characters in rice. *Oryza* 31: 56-57.

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

Sharma, R. K. and S. D. Dubey. 1997. Variation and association among the panicle traits in rice. *Oryza* 34: 8-12.

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

Subramanian, S and M. Rathinam. 1984. Path analysis in early rice (*Oryza sativa* L.) *Madras Agric. J.* 81(1) : 28-29.

Yang, H. S. 1986. Studies on the main traits of intervarietal hybrid progenies in *indica* rice Fujan Agric Sci and Tech 6 : 2-4.