ISSN: 0974 - 0376

The Ecoscan : Special issue, Vol. VII: 117-122: 2015
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES
www.theecoscan.in

GENETIC VARIABILITY AND CORRELATIONAL ANALYSIS IN RICE (*ORYZA SATIVA* L.)UNDER TERMINAL STAGE DROUGHT CONDITION

Shubhnita Sahu and Satish B. Verulkar

KEYWORDS

GCV
PCV
Genetic variability
Heritability
Correlation

Proceedings of National Conference on
Harmony with Nature in Context of
Bioresources and Environmental Health
(HORMONY - 2015)
November 23 - 25, 2015, Aurangabad,
organized by
Department of Zoology,
Dr. Babasaheb Ambedkar Marathwada University
Aurangabad (Maharashtra) 431 004
in association with
National Environmentalists Association, India
www.neaindia.org

The Ecoscan
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES

SHUBHNITA SAHU* AND SATISH B. VERULKAR
Depatment Of Plant Molecular Biology And Biotechnology,
College Of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur - 492 006 Chhattisgarh, INDIA
e-mail: shubhnitasahu@gmail.com

ABSTRACT

Drought is the predominant cause of rice (*Oryza sativa* L.) yield reduction in rainfed rice ecosystems. The present investigation is carried out to RIL population of 124 lines of F14 generation of two indica genotypes, Danteshwari x Dagaddeshi were evaluated under terminal stage drought (TSD) condition. At phenotypic and genotypic level, grain yield exhibited highly significant and positive correlation with bundle weight of plant(0.529, 0.641 respectively) and Harvest index (0.68, 0.49 respectively). At genotypic level grain yield are positively and highly significant associated with panicle length (0.477), spikelets/panicle (0.437) and grain width (0.293).Hence, selection for this character under Terminal Stage Drought condition could bring improvement in yield.

*Corresponding author

INTRODUCTION

Rice has played a central role in human nutrition and culture for the past 10,000 years.At present scenario, rice has special significance as a source of providing over 75% of Asian population and 2.4 billion of world population's meal and is referred as "Global Grain" (Shalini and Tulsi, 2008). Global demand for rice is protected to grow at least equal to population growth, thus requiring a 70% (765 million tons) increase in supply of rice by the year 2025 (Nandeshwar, 2010). Further increase in rice production must be achieved mainly by increasing yield per unit area.

Grain yield is the result of a complex causal mechanism of plant ontogeny. From the beginning of a plant's life, environmental factors affect plant and crop traits,which, in turn, determine the final GY. Complex causal systems have been developed to study the traits that influence the final GY during plant development (W. Sinebo 2002; McClung *et al.*, 1998 Singh *et al* 2003; Maman*et al.,* 2004). In rice, GY depends on various growth and component traits and is the final outcome of a combination of different yield components. It was suggested that an increase in GY could be effectively achieved through yield component improvement since yield components have higher heritability than GY.

One of the main problems of rice cultivation and production is the lack of water resources, especially during periods of low rainfall which affect the vegetative growth rate and the amount of yield.According to statistics, the percentage of drought affected land areas more than doubled from the 1970s to the early 2000s in the world(Isendahl,2006).Breeding for drought tolerance is usually performed by selecting genotypes for high yield under water limited conditions (Arvind Kumar *et al.*, 2008). This yield based selection has further lead to a narrow genetic variability for yield and component traits in recently developed cultivars (Araus*et al.*, 2002). Therefore a trait based breeding approach has been proposed to improve rice yields under water limited conditions (Reynolds *et al.*, 2010). More emphasis has been diverted in recent days to improve several physiological traits which confer drought tolerance without much compromising with yield reduction.

The present study was conducted to determine how terminal stage drought affects grain yield and its component traits. Information on association of characters, direct and indirect effects contributed by each character towards yield will be an added advantage in aiding the selection process. Correlation analysis establishes the extent of association between yield and its components and also bring out relative importance of their direct and indirect effects, thus giving an obvious understanding of their association with grain yield. Ultimately, this kind of analysis could help the breeder to design his selection strategies to improve grain yield. In the light of the above scenario, the present investigation is carried out to study the character correlated and associated in grains for yield improvement in under terminal stage drought (TSD) condition.

MATERIALS AND METHODS

The experimental materials comprised of a recombinant inbred line (RIL) population of 124 lines in F14 generation was developed from a cross of two *indica* parent Danteshwari (susceptible to drought) and Dagaddeshi (tolerant to drought) and maintained by single grain descent method. Whole RIL population was evaluated under TSD conditions at research farm of IGKV, Raipur (C.G.). Seed was sown in RBD with two replications with single seedling was sowed per hill with 20x15 cm spacing. Sowing and transplanting for TSD experiments was delayed by approximately 20-25 days so as to coincide the reproductive-stage stress of the crop with the dry spell after the withdrawal of monsoon. The crop was irrigated till 4 weeks after transplanting and thereafter the paddy was drained. This situation led to exposure of the breeding material to terminal stage drought. The observations were recorded on five randomly selected plants from each plot for days to 50 per cent flowering, plant height, number of tillers per hill, number of panicles per plant, panicle length, number of spikelets per panicle,spikelet fertility,100 grain weight, biological yield, harvest index and grain yield. The statistical and biometrical analysis of GCV and PCV were calculated by formula given by Burton (1952), heritability in broad sense (h2) by Burton and de Vane (1953) and genetic advance *i.e.*, the expected genetic gain was calculated using the procedure given by Johnson *et al.,* (1955). The correlation coefficient was worked out as for the method recommended by Al-Jibouri *et al.* (1958). The estimated values were compared with table values of the correlation coefficient to test the significance of the correlation coefficient prescribed by Fisher and Yates (1967).

RESULTS AND DISCUSSION

The results from analysis of variance for twelveyield contributing traits of 124 genotypes are presented in Table 1. All the characters studied displayed highly significant differences in all the genotypes under study suggesting presence of the genotypes were keeping inherent genetic variances between themselves with respect to the characters studied. These finding of mean sum of squares are in accordance with findings of Idris *et al.* (2012) and Kumar *etal.* (2013), who also observed significant variability for yield and its components in rice.

Genotypic and phenotypic variance, heritability and genetic advance are given in Table 2. All the characters studied indicated the Grain length, Grain width, Panicle length, Days to 50% flowering, 100 Grain weigh showed low GCV and PCV under TSD condition. Spikelet/panicleSpikelet fertility,Grain yield, Harvest index, Panicles/ plant, Bundle weigh and Tiller showed high GCV and PCV under TSD condition. Much higher PCV as compared to GCV for above characters under stress condition indicated that the apparent variation is not only due to genotype but also environmental influence on the trait and selection of such traits may be misleading. (Chaubey, *et al.,* 1994; Rani *et al* 2001; KUMAR *et al.* 2015 and Alok *et al.*, 2013)

Days to 50% flowering ranged from 46-92 comprising the general mean of 81.49 indicating that most of genotypes in experiment showing medium to late days to 50% flowering under stress condition,plant height ranged from 85.10-172.40cm having the general mean 117.85cm, showing short to medium plant height under stress condition, tillers / plant ranged from 7.80-20.50 with having 14.41mean value showing medium number of tillers / plant under stress condition, panicles / plant ranged from 4.70 – 16.10 having 8.79 mean value indicating medium panicles / plant under stress condition, panicle length ranged from 19.10 – 28.73 cm having mean value 23.51 cm indicating medium panicles under stress condition, spikelets / panicle ranged from 52.30-194.60 with 97.71 mean value showing medium spikelets / panicle under stress condition, spikelet fertility ranged from29.00-116.00 with 57.30 mean value showing medium spikelet fertility under

Table 1: Analysis of variance for different traits under terminal stage drought (TSD) condition

s.no.	Source of variation	Degree of freedom	Days to 50% flowering	Plant height	Tiller	Panicle /plant	Panicle length	Spikelet/ panicle	Spikelet fertility	Seed length	Seed width	100 Grain weight(g)	Bundle weight	Grain yield	Harvest index %
1	Replication	1	76.75	2605**	65.33**	0.959	8.609*	5004**	1249*	0.023	0.033	0.022	1584	22401**	0.064**
2	Treatment	123	83.82**	900.8**	12.1**	6.612**	6.489**	1468**	555.8**	0.335**	0.048	0.214**	29558**	4082*	0.009**
3	Error	123	35.12	79.16	5.81	3.472	2.178	436.6	267.4	0.175	0.037	0.1	13196	2683	0.005

* and ** significant at 5%and 1%, respectively.

Table 2: Genetic parameters for different traits under terminal stage drought (TSD) condition

Character	Range	GM	PCV%	GCV%	h2 (%)	GA % by mean
Days to 50% flowering	46-92	81.7	9.44	6.04	40.951	7.97
Plant height(cm)	85.1-172.4	117.8	18.78	17.2	83.8	32.4
Tiller	7.8-20.5	14.41	20.77	12.31	35.1	15
Panicles/ plant	4.7-16.1	8.786	25.56	14.26	31.1	16.4
Panicle length (cm)	19.1-28.73	23.51	8.86	6.25	49.7	9.06
Spikelet/panicle	52.3-194.6	97.71	31.58	23.24	54.2	35.2
Spikelet fertility	29-116	57.3	35.4	20.96	35.0	25.5
Grain length (cm)	8.1-10.15	9.041	5.58	3.12	31.3	3.65
Grain width(cm)	2.1-3.2	2.449	8.38	3.04	13.2	2.45
100 Grain weight(g)	1.32-3.215	2.444	16.23	9.77	36.3	12.3
Bundle weight	319-1142	644.3	22.69	14.04	38.3	17.9
Grain yield(g)	95-310.5	182	31.96	14.53	20.7	13.6
Harvest index %	11-55	28	29.09	14.37	24.4	14

GM = General Mean, H = Heritability, GCV = Genotypic Coefficient of Variations, PCV = Phenotypic Coefficient of Variations, GA = Genetic Advance value % means

Table 3: Estimates of Phenotypic and Genotypic Correlation Coefficient for different traits under terminal stage drought (TSD) condition

Character		Days to 50% flowering	Plant height	Tiller	Panicle /plant	Panicle length	Spikelet / panicle	Spikelet fertility	100 Grain weight	Grain length	Grain width	Bundle weight	Grain yield	Harvest index %
Days to 50%	Rp	1	-0.17*	0.191*	0.189*	0.051	0.295**	0.162	-0.14	0.039	-0.21*	0.088	0.03	-0.07
flowering	Rg	1	-0.36**	0.579**	0.471**	-0.01	0.507**	0.421**	-0.33	0.139	-0.4**	0.12	-0.15	-0.29**
Plant height	Rp		1	-0.29**	-0.25**	0.417**	-0.09	-0.03	0.043	0.052	0.031	0.028	0.007	-0.02
	Rg		1	-0.52**	-0.59**	0.544**	-0.11	-0.05	0.112	0.205	0.082	0.154	0.115	-0.03
Tiller	Rp			1	0.422**	-0.13	-0.05	-0.15	-0.05	0.074	-0.08	0.029	-0.03	-0.08
	Rg			1	0.883**	-0.03	0.086	0.032	0.146	0.056	-0.65**	-0.01	0.081	-0.1
Panicle/plant	Rp				1	-0.07	-0.1	-0.15	0.021	-0.01	-0.11	0.115	0.041	-0.04
	Rg				1	-0.09	-0.05	-0.06	0.098	0.15*	-0.44**	0.179*	0.228*	-0.01
Panicle length	Rp					1	0.049	0.059	0.165	0.034	-0.02	0.067	0.129	0.077
	Rg					1	0.076	0.035	0.353**	0.279**	0.055	0.279**	0.477**	0.276**
Spikelet/ panicle	Rp						1	0.704**	-0.15	0.048	-0.16	0.187*	0.058	-0.09
	Rg						1	0.812**	-0.41**	0.115	-0.37**	0.442**	0.437**	0.003
Spikelet fertility	Rp							1	-0.13	0.03	-0.06	0.153	0.144	0.044
	Rg							1	-0.58**	0.254**	0.076	0.575**	0.059	0.533**
100 Grain weight	Rp								1	-0.13	0.131	-0	-0.06	-0.06
	Rg								1	-0.14	0.324**	0.026	-0.19*	-0.16
Grain length	Rp									1	0.064	0.095	0.025	-0.05
	Rg									1	0.262**	-0.02	-0.28	-0.21*
Grain width	Rp										1	0.017	0.07	0.043
	Rg										1	-0.05	0.293**	0.349**
Bundle weight	Rp											1	0.529**	-0.2*
	Rg											1	0.641**	-0.37**
Grain Yield	Rp												1	0.68**
	Rg												1	0.49**
Harvest index %	Rp													1
	Rg													1

* and ** significant at 5%and 1%, respectively

stress condition,grain length ranged from 8.10-10.15having 9.04 mean showing medium grain length under stress condition, grain width ranged from 2.10-3.20with 2.45cm mean value showing low grain width 100gm grain weigh ranged 1.32-3.22 having mean value 2.44 gm indicating medium grain weigh, biological yield ranged from 422 – 1047 g with having 644.25g mean value indicating some genotypes are closer to higher range of the trait, harvest index ranged from 11– 55% with mean value 28% showing medium harvest index, grain yield ranged from 95 – 310.50 g with mean value 181 g suggested that maximum genotypes exhibits medium grain yield which indicates marked difference among the RIL population for grain yield under stress condition, which indirectly indicates the lines have ability to cope with water stress. Such high stress levels were desirable because a high percentage reduction of yield is necessary to remove the effect of yield potential and clearly identify line that are drought resistance(Babu*etal* 2003)

High heritability along with high genetic advance was registered for plant height (83.8, 32.4 respectively)and Spikelet/panicle (54.2, 35.2 respectively), suggesting predominance of additive gene action in expression of these traits. A combination of high value of heritability and genetic advance helps the breeders in arriving at more reliable conclusion in formulating the selection procedure in his breeding materials. Similar result was observed by Babu*et al* 2003 and Kumar *et al* 2008.

Genotypic and phenotypic correlation coefficients for yield and its various traits are represented in Table-3. The results revealed that the estimates of genotypic coefficients were higher than phenotypic correlation coefficients for most of the characters under study which indicated strong inherent association between the characters which might be due to masking or modifying effects of environment and that modified the expression of the characters at phenotypic level. At phenotypic and genotypic level, grain yield exhibited highly significant and positive correlation with bundle weight of plant and Harvest index. At genotypic level grain yield were positively andhighly significant associated with panicle length,spikelet / panicle and grain width. Grain yield of plant was positively and significant correlated with panicles/plant and negative significant correlated with 100 grain weight.Apositive significant estimate of correlation indicates strong association of these traits with yield. Therefore, selection for these traits will be useful in improving grain yield significantly.Negativeassociation of character like 50% flowering date, 100 grain weight has to be considered critically while making selection for the yield attributing traits. When many traits are affecting a given character, splitting the correlation into direct and indirect effects of cause would give more meaningful interpretation to the cause of association between the dependent variable like yield and independent variables by earlier workers (Chaubey, *et al.*, 1994; Rani *et al* 2001). At genotypic and phenotypic level, a day of 50% flowering is highly significant and positively correlated with Spikelet/panicle. It is also highly significant and positively correlated with tiller no. of plant, panicle /plant and spikelet fertility in genotypic level. 50 % flowering is also significant & negatively correlated with plant height and grain width in phenotypic level. Similar findings were also evident in Bidhan *et al.* (2001) and Lingaraja *et al.* (2015).

Plant height showed highly significant and positive correlation with panicle length and highly significant and negative correlation with tiller and panicle /plant in both at genotypic and phenotypic level. The tiller is highly significant and positive correlation with panicle/plant & negatively highly significant with grain width in genotypic level. At genotypic level thepanicle/ plant showed highly significant and positive correlation with grain yield, bundle weight and grain length and highly significant negatively correlation with grain width. Panicle length is highly significant and positively correlation with 100 grain weight. Grain length, bundle weight and harvest index in genotypic level. Spikelet/panicle is highly significant & positively correlated with spikelet fertility in both genotypic & phenotypic level and only positively significant with bundle weight in genotypic level that also negatively highly significant with 100 grain weight and grain width. Spikelet fertility was highly significant and positively correlated with grain length, bundle weight and harvest index also negatively highly significant with 100 grain weight in genotypic level.

100 grain weight is highly significant and positively correlated with grain width and significantly and negatively correlated with grain yield of plant in genotypic level. Grain length is highly significant and positively correlated with grain width and significantly negative correlated with harvest index. Grain width is highly significant and positively correlated with grain yield & harvest index in genotypic level. The bundle weight is highly significant and positively correlated with grain yield at genotypic and phenotypic level and also highly significant and negatively correlated with harvest index in genotypic level and significant and negatively correlated with harvest index in phonotypic level. Harvest index is highly significant and positively correlated with grain yield both genotypic and phenotypic level that indicating harvest index is also a primary determinant of grain yield under stress. Therefore genetic improvement of harvest index would also improve grain yield. (Babu *et al.*, 2003). Information on the inter association of yield components showed the nature and extent of their relationship with each other. This will help in the simultaneous improvement of different characters along with yield in breeding programs.

REFERENCES

Al Jibouri, H. A., Miller, P. A. and Robinson, H. F. 1958. Genotypic and environmental variation and co-variation in an upland rice crop of inter specific origin. *Agron. J.* **50:** 626 636.

Araus, J. L., Slafer, G. A., Reynolds, M. P. and Royo, C. 2002. Plant breeding and drought in C3cereals: What should we breed for?. *Annals of Botany.* **89:** 925-940.

Babu, R. C., Nguyen, B. D., Chamarerk, V., Shanmugasundaram, P., Chezhian,P., Jeyaprakash, P., Ganesh, S. K., Palchamy, A., Sadasivam, S., Sarkarung, S., Wade, L. J. and Nguyen, H. T. 2003. Genetic analysis of drought resistance in rice by molecular markers: ociation between secondary traits and field performance *Crop Sci.* **43:** 1457-1469.

Babu Ravindra, V., Shreya, K., Dangi Singh Kuldeep, Usharani G., Siva Shankar, A. 2012. Correlation and Path Analysis Studies in Popular Rice Hybrids of India.International. *J. Scientific and Research Publications.* **2(3):** 2250-3153.

Bidhan, R., Hossain, M., Hossain, F. and Roy, B. 2001. Genetic Variability in yield components of rice (Oryza sativa L.). *Environ. and Ecol.* **19(1):** 186-189.

Burton, G. W. 1952. Quantitative inheritance of grasses. *Proc. 6thInternational Grassland Congress.***1:** 277-283.

Burton, G. W. and DeVane, E. W. 1953. Estimating heritability in tall Fescue (Festucaarundinacea) from replicated clonal material. *Agronomy J.* **45:** 478-81.

Chaubey, P. K. and Singh, R. 1994. Genetic variability correlation and path analysis of yield components of rice. *Madras Agric. J.* **81(9):** 468-470.

Idris, A. E., Justin, F. J., Dagash, Y. M. I. and Abuali, A. I. 2012. Genetic variability and inter relationship between yield and yield components in some rice genotypes. *American J. Experimental Agriculture.* **2(2):** 233-239.

Isendahl, N. and Schmidt, G. 2006. Drought in the mediterranean-WWF policy proposals. *In A,edited by W. Report. Madrid.*

Fisher, R. A. and Yates, F. 1967. Statistical Tables for Biological, Agricultural and Medical Research. *Longmen Group Limited, London.*

Johnson, H. W., Robinson, H. F. and Comstock, R. E. 1955. Estimates of genetic and environmental variability in soybean. *Agronomy J.* **47:** 314-18.

Kumar, A., Bernier Verulkar, S., Lafitte, H. R., Atlin, G. N. 2008. Breeding for drought tolerance: Direct selection for yield, response to selection and use of drought-tolerant donors in upland and lowland-adapted populations. *Field Crops Research.* **107:** 221-231.

Kumar, A., Rangare, N. R. and Vidyakar, V. 2013. Study of genetic variability of Indian and exotic rice germplasm in Allahabad agroclimate. *The Bioscan.* **8(4):** 1445-1451.

Kumar, Ravi, Babu Suresh, G., RaiSatish, K. and Sandhya, V. 2015. Genetic variability and divergence studies in elite rice. *The Ecoscan.* **9(1&2):** 209-212.

Lingaraja1 L, mohammad1 shafiqurrahaman, sriharsha, V. P. and Suresh, B. G. 2015. Estimation of genetic variability, direct and indirect effects of yield contributing traits on grain yield in aerobic rice (*oryzasativa* l.) Germplasm. The ecoscan. **9(1&2):** 357-361.

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

Nandeshwar, B. C., Pal, S., Senapati, B. K. and De, D. K. 2010. Genetic variability and character association among biometrical traits in F2 generation of some Rice crosses. *Electronic J. Plant Breeding.* **1(4):** 758-763.

Shalini, P. and Tulsi, T. 2008. Production potential and nutrient use efficiency of basmati rice (Oryza sativa L.) under integrated nutrient management. *Green Farming.* **1(9):** 11-13

Singh, N., Prasanna, B. and Mohammadi, S. 2003. Sequential path model for determining interrelationships among grain yield and related characters in maize, *Crop Sci.* **43:** 1690-1697.

Maman, N., Dhungana, P., Lyon, D. J. and Mason, S. C. 2004. Yield components of pearl millet and grain sorghum across environments in the Central *Great Plains, Crop Sci.* **44:** 2138-2145.

Rani, N., Shobha, Prasad., Rama, A. S., Prasad, P., Reddy Bhaskar G. S. V. and Krishnaveni, B. 2001. Genetic variability for yield components in aromatic and quality rice germplasms. Indian *J. Pt. Genetic Resources.* **14:** 206-209.

Reynolds, M., Bonnett, D., Chapman, S. C., Furbank, R. T., Manès, Y., Mather, D. E. and Martin, A. J. P. 2010. Raising yield potential of wheat. I. Overview of a consortium approach and breeding strategies. *J. Exp. Bot. DOI:* 10.1093/jxb/erq311.)

Sinebo, W. 2002. Yield relationships of barleys grown in a tropical highland environment. *Crop Sci.* **42:** 428-437.