The Pharma Innovation Journal 2021; 10(10): 1484-1487

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(10): 1484-1487

www.thepharmajournal.com
Received: 04-08-2021
Accepted: 06-09-2021

J Buelah
Department of Genetics and Plant Breeding, Agricultural College, PJTSAU, Polasa, Jagtial, Telangana, India

V Ram Reddy
Assistant Professor, Department of Genetics and Plant Breeding, Agricultural College, PJTSAU, Polasa, Jagtial, Telangana, India

B Srinivas
Scientist, Plant Breeding, PJTSAU, Regional Agricultural Research Station, Polasa, Jagtial, Telangana, India

N Balram
Scientist, Plant Pathology, PJTSAU, Regional Agricultural Research Station, Polasa, Jagtial, Telangana, India

Corresponding Author:
J Buelah
Department of Genetics and Plant Breeding, Agricultural College, PJTSAU, Polasa, Jagtial, Telangana, India

Heritability and gene action studies for yield and quality traits in hybrid rice (*Oryza sativa*. L)

J Buelah, V Ram Reddy, B Srinivas and N Balram

Abstract
The aim of this study is to estimate the gene action, heritability and genetic advance in rice (*Oryza sativa* L.). The experiment was laid out in a randomized block design (RBD) with two replications at Regional Agricultural Research Station, Polasa, Jagtial, during kharif, 2019 cropping season. The results revealed that the days to 50% flowering, plant height, panicle length, number of grains per panicle, 1000-grain weight, grain yield per plant, spikelet fertility, milling percentage, head rice recovery and gelatinization temperature exhibited greater SCA variance than GCA variance which indicated the predominance of non-additive gene action whereas number of productive tillers per plant, hulling percentage, amylose content, gel consistency and alkali spreading value which indicated the predominance of additive gene action. GCA variance and SCA variance are equal for the characters kernel breadth, kernel length and L/B ratio. High heritability coupled with high genetic advance estimates were recorded for number of productive tillers per plant, number of grains per panicle, 1000-grain weight (g), grain yield per plant, head rice recovery, amylose content, gel consistency and alkali spreading value indicating the role of additive gene action and selection for these traits is reliable.

Keywords: heritability, gene action, general combining ability, genetic advance and specific combining ability

1. Introduction

Rice is a highly self-pollinated crop belongs to the gramineae family, producing edible starchy cereal grains and originated in South East Asia. The genus *Oryza* has two cultivated and 22 wild species. The cultivated species are *Oryza sativa* and *Oryza glaberrima*. *Oryza sativa* is grown all over the world and species glaberrima has been cultivated in few areas like West Africa. The global area under rice is 1.58 billion hectares with a production of 470.2 million tonnes per annum. While in India it is grown in about 43.79 million hectares with a production of 116.48 million tonnes and productivity of 2659 kg/ha. Whereas, in Telangana State it is grown in 19.32 lakh hectares with the production of 66.70 million tonnes and productivity of 3452 kg/ha (www.indiastat.com, 2018-19) [12]. Rice is the leading food crop in the world, directly feeding nearly half of the world's population. Rice is the predominant food crop in India in terms of area, production and productivity. Rice plays an important role in ensuring food security and contributing to poverty and malnutrition alleviation. To meet the demand of increasing population and to combat food security in India, the present yield levels needs to be increased up to 121 million tonnes by 2050 and the production of rice needs to be increased by almost two million tons every year. In India, population improvement rate is 1.04%. Till date High Yielding Varieties (HYV's) have satisfied rice demand but they have reached their saturated levels.

To meet the demand of increasing population adoption of hybrid rice technology is an alternative. Since rice is a self-pollinated crop, hybrid seed production must be based on male sterility systems.

Heritability is the proportion of phenotypic variation in a population that is due to genetic variation between the individuals. In broad sense, Heritability can be defined as the ratio of total genetic variance (additive, dominance and epistatic) to the phenotypic variance (Falconer and Mackay, 1996) [8]. Phenotypic variation among individuals may be due to genetic, environmental factors and/or random chance. Heritability analyses the relative contributions of differences in genetic and non-genetic factors to the total phenotypic variance in a population. High heritable traits have smaller environmental influence and the traits having low heritability are highly influenced by the environmental fluctuations (Bhadru *et al.*, 2012) [6].

2. Material and Methods

2.1 Study sites

The present investigation was undertaken during *Rabi*, 2018-19 (crossing programme) and *Kharif*, 2019 (evaluation) at Regional Agricultural Research Station (RARS), Polasa, Jagtial which is situated at an altitude of 243.4 m above mean sea level on 18º49'40" N latitude and 78º56'45"E longitudes in Northern Zone of Telangana State.

2.2 Method of data collection

The experimental material used for the present experiment comprised of four lines *viz.*, JMS 17A, JMS 13A, JMS 18A, CMS 14A, six restorer lines *viz*., JGL 35039, JGL 34450, JGL 34985, JGL 34990, JMBR 44 and IRTON 270 and their 24 hybrids produced by crossing lines and testers in Line X tester fashion along with two hybrid checks (BIO-799 and PA 6129). Four lines and six testers were planted in a crossing block with a spacing of 20 x 15 cm and crossing programme is carried out in a four x six, Line x tester mating design to produce 24 hybrids during *Rabi*, 2018-19. Hybridization and clipping method was followed to obtain hybrids and during *Kharif*, 2019, 30 days old seedlings of 36 entries (four lines, six testers, 24 hybrids and 2 checks) were transplanted in the main field in Randomized Block Design in two replications. Each entry was planted in two rows of four meters length with a spacing of 20 x 15 cm in two replications. Five sample plants were randomly selected from each entry excluding the border plants to minimize error due to the border effect and the following data were recorded: Days to 50% flowering, plant height (cm), panicle length (cm), number of productive tillers per plant, number of grains per panicle, spikelet fertility (%), 1000-grain weight (g), grain yield per plant (g), hulling percentage, milling percentage, head rice recovery (%), kernel length (mm), kernel breadth (mm), L/B ratio, amylose content (%), gelatinization temperature (^{O}C), gel consistency (mm) and alkali spreading value. Collected data were subjected to statistical analysis using line × tester analysis by Kempthorne (1957) [14].

3. Results and Discussion

In the present study, the results pertaining to the estimate of combining ability revealed that mean *sca* variance was relatively greater in magnitude than *gca* variance for all the traits except for number of productive tillers per plant, hulling percentage, amylose content, gel consistency and alkali spreading value indicating that these traits were predominantly under the control of non-additive gene action. Whereas low *sca* variance over *gca* variance indicates that the traits are under the control of additive gene action which can be further used for selecting desirable parents (Table 1), GCA variance and SCA variance are equal for the characters kernel breadth, kernel length and L/B ratio.

Similar results were reported by several workers for days to 50 per cent flowering (Jayasudha and Sharma, 2009, Ghara *et al.*, 2012, Hasan *et al.*, 2013, Santha *et al.*, 2017, Satheesh Kumar *et al.*, 2016 and Archana Devi *et al.*, 2017) [13, 9, 11, 21, 22, 3], plant height (Selvaraj *et al.*, 2011, Hasan *et al.*, 2013, Dorosti and Monajjem, 2014, Ariful islam *et al.*, 2015 and Santha *et al.*, 2017) [23, 11, 7, 4, 21], number of grains per panicle (Satheesh Kumar *et al.*, 2016, Rumanti *et al.*, 2017, Vanave *et al.*, 2018 and Bano and Singh., 2019) [22, 19, 26, 5], grain yield per plant (Hasan *et al.*, 2013, Ariful islam *et al.*, 2015, Santha *et al.*, 2017, Satheesh Kumar *et al.*, 2016 and Bano and Singh, 2019) [11, 4, 21, 22, 5], 1000-grain weight (Vanave *et al.*, 2018, Bano and Singh, 2019) [26, 5], milling percentage (Sreenivas *et al.*, 2014, and Naseer Mohammad *et al.*, 2016) [24, 17], head rice recovery (Thakare *et al.*, 2013, Sreenivas *et al.*, 2014 and Rukmini Devi *et al.*, 2018) [25, 24] and amylose content (Maleki *et al.* 2014) [16].

The broad sense heritability is the relative magnitude of genotypic and phenotypic variances for the traits and have a predictive role in selection procedures (Allard, 1960) [2]. This gives a thought of the entire variation ascribable to genotypic effects, which are exploitable portion of variation. All the 18 parameters were estimated in F_1 hybrids and presented in Table 2.

In the present investigation heritability (broad sense) was observed for all the characters studied and values were high for amylose content (99.65%) followed by gel consistency (99.33%), gelatinization temperature (98.96%), alkali spreading value (98.59%), 1000-grain weight (95.52%), number of grains per panicle (95.36%), grain yield per plant (95.08%), days to 50 per cemt flowering (93.06%), spikelet fertility (92.31%), head rice recovery (90.38%), milling percentage (84.97%), number of productive tillers per plant (84.87%), plant height (84.76%), hulling percentage (83.35%), kernel breadth (68.48%) and panicle length (64.45%). Moderate heritability was observed for L/B ratio (48.92%) and kernel length (41.21%). To arrive at more reliable conclusions estimates of both genetic advance and heritability should be jointly considered.

High heritability coupled with high genetic advance estimates were recorded for number of productive tillers per plant, number of grains per panicle, 1000- grain weight, grain yield per plant, head rice recovery, amylose content, gel consistency and alkali spreading value in the expression of these characters. This type of characters could be improved by mass selection and other breeding methods based on progeny testing. Moderate heritability coupled with low genetic advance for kernel length and L/B ratio while high level of heritability and moderate genetic advance for spikelet fertility, hulling percentage, milling percentage, kernel breadth, gelatinization temperature suggesting greater role of non-additive gene action in their inheritance. Therefore heterosis breeding could be used to improve these traits. However, high level of heritability coupled with low genetic advance estimates were recorded for days to 50% flowering, plant height and panicle length indicated the inheritance was due to non-additive gene effects. (Fig.4.2).

These results are in accordance with findings of Sanjiv kumar *et al.* (2012) [20], Gideon and Dennis *et al.* (2016) [10], Adhikari *et al.* (2018) [1] and Krishna Naik *et al.* (2019) [15].

Table 1: Estimates of general and specific combining ability variance, proportionate gene action and degree of dominance in rice

Source of variation	Days to 50% flowering	Plant height	Panicle length	No. of productive tillers	No. of grains per panicle	Spikelet fertility	1000-Grainweight	Grain yield per plant	Hulling
σ2 gca	3.77	10.15	0.76	2.06	1536.71	35.87	3.62	18.55	23.76
σ2 sca	17.61	20.27	2.61	1.53	2618.88	41.22	10.83	50.25	6.73
σ2 gca / σ2 sca	0.21	0.50	0.29	1.35	0.59	0.87	0.33	0.37	3.53
Degree of Dominance √	2.16	1.41	1.86	0.86	1.31	1.07	1.73	1.65	0.53

σ2 sca/√ σ2 2gca									

Source of variation	Milling	Head rice recovery	Kernel length	Kernel breadth	L/B ratio	Gel consistency	Amylose content	Alkali spreading value	Gelatinization temperature
σ2 gca	6.83	34.72	0.06	0.02	0.01	7.32	13.57	238.91	0.67
σ2 sca	45.38	104.12	0.06	0.02	0.01	2.93	18.82	78.69	0.50
σ2 gca / σ2 sca	0.15	0.33	1.06	0.71	0.63	2.49	0.72	3.04	1.33
Degree of Dominance √ σ2 sca/√ σ2 2gca	2.58	1.73	0.97	1.19	1.26	0.63	1.18	0.57	0.87

Table 2: Heritability and genetic advance for yield, physical and chemical quality traits in rice

S.no	Character	Heritability (%)	Genetic advance as percent mean
1	Days to 50% flowering	93.06	7.11
2	Plant height	84.76	8.18
3	Panicle length	64.45	9.97
4	Number of productive tillers per plant	84.87	33.20
5	Number of grains per panicle	95.36	48.18
6	Spikelet fertility	92.31	17.76
7	1000-grain weight	95.52	53.78
8	Grain yield per plant	95.08	62.97
9	Hulling percentage	83.35	10.38
10	Milling percentage	84.97	15.00
11	Head rice recovery	90.38	35.01
12	Kernel length	41.21	9.16
13	Kernel breadth	68.48	16.48
14	L/B ratio	48.92	7.20
15	Gel consistency	99.65	28.51
16	Amylose content	98.96	14.51
17	Alkali spreading value	99.33	69.23
18	Gelatinization temperature	98.59	40.43

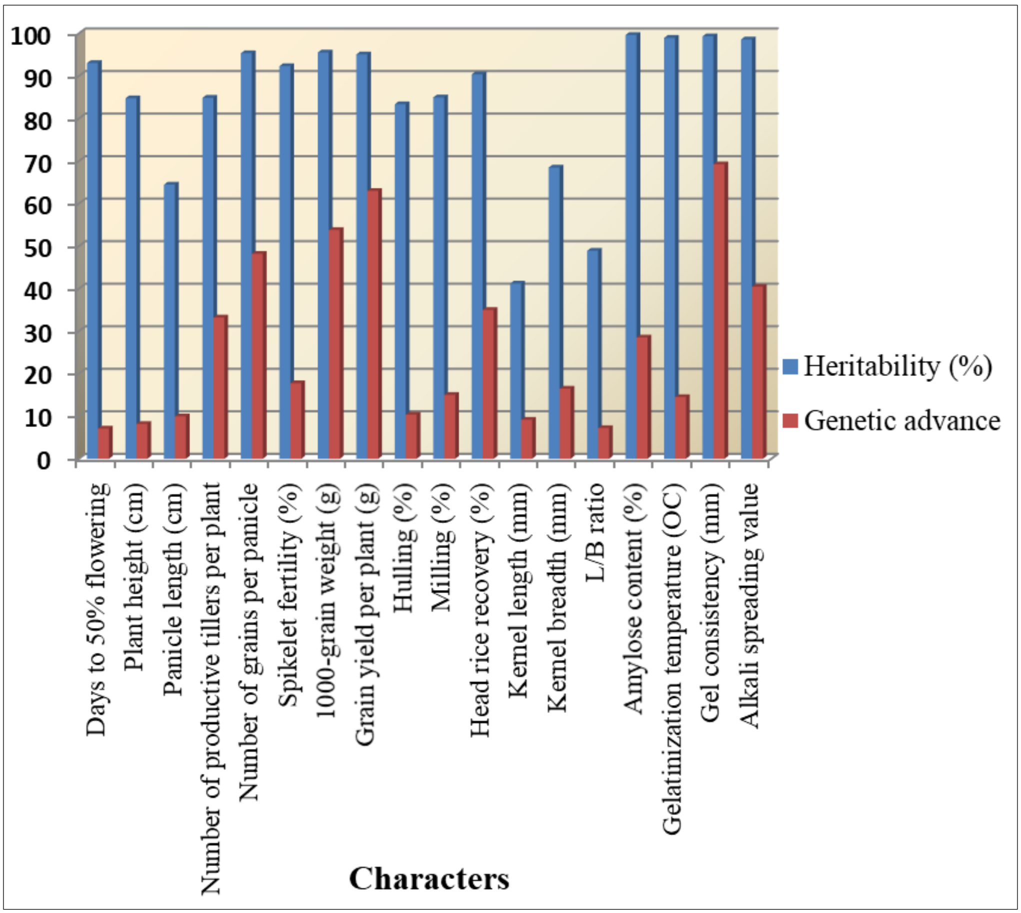

Fig 1: Heritability and genetic advance for grain yield and quality traits in rice hybrids

4. Conclusion

The estimates of variances of GCA and SCA revealed that the nature of gene action was predominantly non-additive and in specific combinations exhibited additive type of gene action for different characters. The predominance of non-additive gene effects representing non-fixable dominance and epistatic components of genetic variance indicated that maintenance of heterozygosity, would be highly fruitful for improving the yield. The overall results indicated that high heritability coupled with high genetic advance was observed for most of the traits under study which indicates that the role of additive gene action was more and selection for these traits is most reliable.

5. Acknowledgement

The authors are very obliged to Agricultural College and Regional Agricultural Research Station, Polasa, Jagtial for providing financial support for conducting the experiment as a part of research work.

6. References

1. Adhikari BN, Joshi BP, Shrestha J, Bhatta NR. Genetic variability, heritability, genetic advance and correlation among yield and yield components of rice (*Oryza sativa* L.). Journal of Agriculture and Natural Resources 2018;1(1):149-160.
2. Allard RW. Principles of Plant Breeding. Publishers by John Wiley and Sons Inc., New York USA 1960, 485.
3. Archana Devi, Preeti Kumari, Ranjan Dwivedi, Saket Dwivedi, Verma OP, Singh PK *et al.* Studies on heterosis and combining ability in rice (*Oryza sativa* L.) for morpho-physiological traits under normal and saline conditions. International Journal of Current Microbiology and Applied Sciences 2017;6(8):1558-1571.
4. Ariful Islam MD, Khaleque Mian MA, Rasul G, Khaliq QA, Mannan Akanda MA. Estimation of gene action and variance components of some reproductive traits of rice (*Oryza sativa* L.) through line x tester analysis. Journal of Rice Research 2015;3(3):1-9.
5. Bano DA, Singh SP. Combining ability studies for yield and quality traits in aromatic genotypes of rice (*Oryza sativa.* L.). Electronic Journal of Plant Breeding 2019;10(2):341-352.
6. Bhadru D, Chandra Mohan Y, Tirumala Rao V, Bharathi D, Krishna L. Correlation and path analysis studies in rice (*Oryza sativa* L.). International Journal of Applied Biology and Pharmaceutical Technology 2012;3(2):l37-140.
7. Dorosti H, Monajjem S. Gene action and combining ability for grain yield and yield related traits in rice (*Oryza sativa* L.). The Journal of Agricultural Sciences 2014;9(3):100-108.
8. Falconer DS, Mackay T. Introduction to quantitative genetics. Fourth edition. Longmans, Essex, England, United Kingdom 1996.
9. Ghara AG, Nematzadeh G, Bagheri N, Ebrahimi A, Oladi M. Evaluation of general and specific combining ability in parental lines of hybrid rice. International Journal of Agriculture Research 2012;2(4):455-460.
10. Gideon I, Dennis U. Genetic variability and heritability of yield and yield components in rice genotypes. Global Journal of Plant Breeding and Genetics 2016;3(6):215-220.
11. Hasan MJ, Kulsum MU, Akter A, Masuduzzaman ASM, Ramesha MS. Genetic variability and character association for agronomic traits in hybrid rice (*Oryza sativa* L.). Bangladesh Journal Plant Breeding and Genetics 2013;24(1):45-51.
12. Indiastat 2018-19. Agriculture production. http: //www.indiastat.com
13. Jayasudha S, Sharma D. Combining ability and gene action analysis for yield and its components in rice (*Oryza sativa* L.). Journal of Rice Research 2009;2:105-110.
14. Kempthorne O. An Introduction to Genetic Statistics. John Wiley and Sons Inc: New York 1957.
15. Krishna Naik R, Ramesh Babu P, Dayal Prasad Babu J, Ashoka Rani Y, Srinivasa Rao V. Study of variability, heritability and genetic advance for grain yield and yield characters in hybrid rice (*Oryza* sativa L.). The Andhra Agricultural Journal 2019;66(1):53-56.
16. Maleki M, Fotokian MH, Kajouri FD, Nouri MZ, Agahi K. Study of combining ability and gene action of cooking quality traits in rice (*Oryza sativa* L.) using line × tester analysis. Journal of Biodiversity and Environmental Sciences 2014;4(3):220-226.
17. Naseer Mohammad, Surendra Singh, Ekhlaque Ahmad, Salil Tewari. Assessment of combining ability for productivity and quality traits in aromatic rice (*Oryza sativa* L). International Journal of Bio-resource and Stress Management 2016;7(4):525-532.
18. Rukmini Devi K, Satish Chandra B, Lingaiah N, Hari Y, Venkanna V. Analysis of variability, correlation and path coefficient studies for yield and quality traits in rice (*Oryza sativa* L.). Agriculture Science Digest 2017;37(1):1-9.
19. Rumanti IA, Purwoko BS, Dewi IS, Aswidinnoor H, Widyastuti Y. Combining ability for yield and agronomic traits in hybrid rice derived from wild abortive, gambiaca and kalinga cytoplasmic male sterile lines. SABRAO Journal of Breeding and Genetics 2017;49(1):69-76.
20. Sanjiv Kumar, Devi Singh, Satyendra, Anil Sirohi, Shashi Kant, Anil Kumar *et al.* Variability, Heritability and Genetic Advance in Rice (*Oryza sativa* L.) Under Aerobic Condition. Environment & Ecology 2012;30(4):1374-1377.
21. Santha S, Vaithilingam R, Karthikeyan A, Jayaraj T. Combining ability analysis and gene action of grain quality traits in rice (*Oryza sativa* L.) using line x tester analysis. Journal of Applied and Natural Science 2017;9(2):1236-1255.
22. Satheesh Kumar P, Saranan K, Sabesan T. Selection of superior genotypes in rice (*Oryza sativa* L.) through combining ability analysis. International Journal of Agriculture and Science 2016;12(1):15-21.
23. Selvaraj I, Nagarajan P, Thiyagarajan, Bharathi M, Rabindran R. Genetic parameters of variability, correlation and pathcoefficient studies for grain yield and other yield attributes among rice blast disease resistant genotypes of rice (*Oryza sativa* L.). African Journal of Biotechnology 2011;10(17):3322-3334.
24. Sreenivas G, Cheralu C, Devi KR, Murthy KG. Combining ability analysis for grain quality traits in rice (*Oryza sativa* L.). Environment and Ecology 2014;33(1):86-191.
25. Thakare IS, Patel AL, Mehta AM. Line × tester analysis using CMS system in rice (*Oryza sativa* L.). The Bioscan 2013;8(4):1379-1381.
26. Vanave PB, Vaidya GB, Jadhav BD. Combining ability of rice genotypes under coastal saline conditions. Electronic Journal of Plant Breeding 2018;9(1):116-123.