Studies on Grain Yield Components in NPT Lines of Rice to Develop Super Rice Hybrid

Shivam Soni[1], Harish Kumar Netam[2]

[1]Indira Gandhi Agriculture University
Department of Genetics and Plant Breeding
Raipur, 492006, Chhattisgarh, India
shivamigkv@gmail.com

[2]Indira Gandhi Agriculture University
Department of Entomology
Raipur, 492006, Chhattisgarh, India
harish.netam15@gmail.com

Abstract: ***Combining ability in NPT lines of rice for Super hybrid rice breeding programme has been carried out in line x tester mating design involving 3 stable CMS lines and well adapted 9 testers of different eco-geographic origin in rice. It revealed presence of predominance of non additive gene action for the characters under study. Among the lines IR 79156A was identified as a good general combiner followed by APMS 6A and IR58025A and within the tester ET 1-13, IRFAN-115, and ET 1-12, was found to be good combiner for grain yield per plant. Promising hybrids based on per se performance, SCA, GCA and Heterosis for grain yield per plant are IR79156A/ET-1-10, APMS6A/ET1-12, IR58025A/IRFAN-115, IR79156A/ET-1-1and IR79156A /TOX 981-11-2-3. These promising hybrids offer greater scope for further exploitation of hybrid vigour commercially.***

Keywords: New plant type, hybrid rice, CMS, Combining ability

1. Introduction

Chhattisgarh is known as the rice bowl of the country and now recognized as potential area for hybrid rice cultivation in India. Increased rice production and productivity is the major goal of rice breeding in this state particularly for rainfed lowland ecosystem. However inspite of considerable breeding efforts, the yield levels have remained almost static, which warrant exploitation and adoption of some innovative approaches. Among the current new approaches super hybrid rice breeding approach seems to have potential as it gives minimum 25% - 40% yield advantage over best commercially cultivated fixed variety.

"New Plant Type" concept including reduced tillering, large panicles, high grain density, longer grain filling period and resistance to major pests semi taller stature, fewer, tough, non lodging, and all effective culms, upright growth habits, fewer, thick, large, but stiff leaves able to maintain erect position, heavy panicles with limited intra plant variation for panicles yield, high fertile spikelet per panicle and a deep extensive root system.

With the increasing interest in exploitation of heterosis in rice, there is an urgent need to subject various cytoplasmic male sterile (CMS) lines and restorer for combining ability tests. The knowledge of combining ability is useful to assess nicking ability in self pollinated crops and at the same time elucidate gene action (additive and non-additive) The average performance of a parents or inbred in a series of cross combinations is known as its 'general combining ability' and the performance of two specific inbreds in a particular cross combination is known as its 'specific combining ability'. General combining ability largely involves additive gene effects, whereas specific combining ability represents only non-additive gene action. The choice of the parents, especially for heterosis breeding, should be based on the combining ability test and their mean performance (Yadav and Murty, 1966). It provides to the breeders an insight into the nature and relative magnitude of fixable and non-fixable genetic variance.

Success of any plant breeding programme depends on the choice of appropriate genotypes as parents in the hybridization programme. The combining ability studies of the parents provide information which helps in the selection of better parents for effective breeding. Accordingly, the present investigation was undertaken to get an idea of the combining ability for yield traits with a view to identify good combiners which may be used to create a population with favorable genes for yield traits in rice.

2. Materials and Methods

The present investigation was conducted at Research Farm, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, during Rabi 2009-2010 and Kharif 2010. In present study it represents an attempt to put the improved New Plant Types lines to test cross with CMS line of WA type cytoplasm and to identify its strength and its short comings.

The experimental material comprised of 27 hybrids obtained from the lines involving three CMS lines (APMS 6A, IR 79156A, IR58025A) and nine testers (ET-1-10, TOX 981-11-2-3, SR-6-SW-8, IR64-SR-6, NPTR-2, ET 1-1, ET 1-12, ET 1-13, IRFAN-115).The set of hybrids were generated in line x tester pattern for the purpose and evaluated along with parents in Randomized Complete Block Design with two

replications. Twenty one days old seedlings of 27 hybrids and 9 parents were transplanted in the field. Single seeding per hill was transplanted. Recommended package of practices were followed. Observations were recorded on five randomly selected plants in both the replications for fifteen traits viz., days to 50% flowering, flag leaf length, flag leaf width, flag leaf area, plant height, productive tillers per plant, pollen fertility (%), sterile spikelet's per panicle, fertile spikelet's per panicle, total number of spikelet's per panicle, spikelet fertility (%), panicle length, thousand seed weight, grain yield per plant and head rice recovery (%).

Statistical analysis: Combining ability analysis was carried out by the method suggested by Kempthorne (1957). Mean sum of squares that arises due to different sources of variation were estimated and their expected genetic values were also calculated.

2.1 Estimation of GCA and SCA effects

$$gcai = \frac{1}{P(P-2)} (Pxi. - 2x..) \quad (1)$$

$$scaij = xij - \frac{1}{P-2}(xi. + x.j) + \frac{2}{(P-1)(P-2)} x.. \quad (2)$$

Where xij is the ith replication for the jth parent (i= 1,...,r; j= 1,…,p),

xi. is the sum of p genotypes for the ith replication, x.j is the sum of r replications for jth genotype and

x.. is the total sum of data (rp observations). The significant tests for GCA and SCA effects were done using the t test with variances of these effects.

$$Var(gcai) = \frac{P-1}{P(P-2)} M'e \quad (1)$$

$$Var(scaij) = \frac{P-3}{P-1} M'e \quad (2)$$

Where M'e is the MSe / r ratio, and MSe and r are the error mean square and the number of replications of randomized complete block design in the analysis of variance.

Table 1: Promising hybrids based on per se performance, SCA, GCA

	Cross combination	*per se* performance (yield per plant in gm)	SCA effects	GCA effects (females)	GCA effects (males)	Heterosis	
						MP	BP
1.	IR79156A /ET-1-10	43.76	15.25**	5.44**	-3.44**	22.61**	-8.85 **
2.	APMS 6A /ET 1-12	42.20	11.30**	-0.75**	5.13**	42.44**	31.65**
3.	IR58025A /IRFAN-115	36.52	9.86**	-4.69**	6.62**	78.89**	60.67
4.	IR79156A /ET 1-1	33.86	6.14**	5.44**	-4.24**	-1.91**	-29.48**
5.	IR79156A /TOX 981-11-2-3	30.80	0.57**	5.44**	-1.73**	-25**	-35.85**

* =significant of p=0.05 level
**=significant of p=0.01 level

3. Results and Discussion

The ANOVA for combining ability on the L x T set revealed that the variances due to lines x testers were significant for all of the characters, indicating that the parents used in this study were significantly differed in terms of general combining ability. The magnitude of specific combining ability (SCA) variance was higher than the GCA variance for all the character. The comparative variances due to general combining ability and specific combining ability revealed the predominance of non-additive gene action for all the characters under study. This was in agreement with the finding of Bobby and Nadarjan (1994) and Ramalingam et al. (1993, 1997)

Estimation of GCA effects of lines revealed that IR 79156A was identified as a good general combiner for grain yield per plant followed by APMS 6A and IR58025A. Among the testers ET 1-13, IRFAN-115, and ET 1-12, was found to be good combiner for grain yield per plant.

Character wise study showed out of lines APMS 6A showed highest negative GCA effect and among the testers ET 1-12, and ET 1-13 negative significant GCA effect was recorded for days to 50% flowering. Among the 27 hybrids APMS 6A /NPTR-2 were earliest to flower followed by APMS 6A /IR64-SR-6 and IR58025A/SR-6-SW-8.The negative GCA effects indicated their usefulness in breeding of early maturing lines.

The SCA effect for plant height ranged from -23.42 to 13.35 among the entire crosses hybrid APMS 6A /TOX 981-11-2-3 showed highest negative significant SCA effects followed by IR79156A /ET-1-10 and IR58025A/IR64-SR-6 as these are less prone to lodging. The result of present investigation is similar to the findings of Sarawgi et al. (1991), Peng and Virmani (1990) and Kumar and Ram (2006).

In rice flag leaf area (length x breadth) had greater contribution for increased grain yield in present study hybrids showing positive significant SCA effects as IR58025A/IR64-SR-6 (flag leaf length and flag leaf width) and IR58025A/IR64-SR-6, APMS 6A /NPTR-2, and IR79156A /ET 1-13for flag leaf area. In case of number of productive tiller per plant cross combination IR58025A/ET 1-13 exhibited highest positive significant SCA effects. Similar results obtained by Manuel and Palanisamy (1989) and Sharma and Mani (1996).

Among the testers highest positive significant GCA effect was shown by ET 1-1 and the cross combinations with positively significant SCA effects are IR58025A/NPTR-2, IR79156A /TOX 981-11-2-3 and APMS 6A /ET-1-10 for pollen fertility similarly for spikelet fertility NPTR-2(tester) and IR79156A /ET 1-13, APMS 6A /ET 1-1,and IR58025A/ET 1-12(hybrids) having positive significant SCA effects . Similar results have been reported by Jayashudha and Sharma (2009).

Crosses with significant desirable SCA effects for various traits such as IR79156A /ET 1-13, IR58025A/ET-1-10 for panicle length; APMS 6A /IR64-SR-6, IR58025A/NPTR-2

for 1000 seed weight; IR58025A/ET 1-12, APMS 6A /SR-6-SW-8 for head rice recovery; However GCA and SCA effects for grain yield per plant revealed that line IR79156A and tester ET 1-13 having highest positive significant GCA effects and cross combinations IR79156A /ET-1-10, APMS 6A /IR64-SR-6 and APMS 6A /ET 1-12 also showed high positive significant SCA effects .Similar finding were recorded by Manomani and Ranganathan (1998), Munhot et al. (2000), Shanthi et al. (2003), Rao and Kulkarni (2004).

4. Conclusion

To conclude the present study it can be clearly stated that CMS line IR 79156A and APMS 6A were found to be the good general combiner and among tester ET 1-13, IRFAN-115, and ET 1-12 were found to be superior general combiners for grain yield per plant and Promising hybrids based on per se performance, SCA, GCA and Heterosis for seed yield per plant are IR79156A /ET-1-10, APMS 6A /ET 1-12, IR58025A /IRFAN-115, IR79156A /ET 1-1 and IR79156A /TOX 981-11-2-3..Therefore the above NPT type hybrids have good potential with respect to grain yield and other related traits.

5. Future Scope

Superior testers ET 1-13, IRFAN-115, and ET 1-12 were identified as good general combiner for most of the traits and may be used for further study to develop good hybrids. The superior identified hybrids viz., IR79156A /ET-1-10, APMS 6A /ET 1-12, IR58025A /IRFAN-115, IR79156A /ET 1-1and IR79156A /TOX 981-11-2-3 will be tested in next year. These promising hybrids offer greater scope for further exploitation of hybrid vigour commercially.

More physiological characters should be involved for further studies. If possible molecular related objective should be under taken for screening and validation of the breeding material and the investigated results looking with the present global rice breeding scenarios.

6. Acknowledgment

With great reverence, I express my deep sense of gratitude to my major advisor Dr. Deepak Sharma, Professor and Liaison officer, Department of Genetics and Plant Breeding , IGKV and chairman of the Advisory Committee for his stead fast inspirations, invaluable guidance, unfailing encouragement, planning of course work and unceasing interest in the research project. It was my privilege to work under his supervision, knowledge and enthusiastic interest, which he provided me throughout my post graduation and research investigation despite of his busy schedule of work. I express my cordial thanks to him for his painstaking efforts, suggestions, scholarly advice and sympathetic attitude throughout the preparation of this manuscript.

References

[1] Khush, G.S. 1995. Breaking the yield frontier of rice. Geo-Journal 35: 329–332. 1957.
[2] Yadav, S.P. and Murty, B.R.. Heterosis and comibinig ability of different height categories in bread wheat. Indian journal of genetics. 36: 184-196. 1966
[3] Manuel, W.W. and Palanisamy, S.. Line x tester analysis of combining ability in rice. Oryza. 26(1):27-32. 1989
[4] Peng, J.Y. and Virmani, S.S.. Combining ability for yield and yield related traits in relation to breeding in rice (Oryza sativa L.). Oryza, 27: 1-10. 1990
[5] Partial diallel cross analysis of yield and its related characters in rice (Oryza sativa L.) under irrigated and rainfed situations. Indian Journal of Genetics, 5(1): 30-36. 1991
[6] Sarawgi, A.K., Shrivastava, M.N. and Chowdhary, B.P.. Partial diallel cross analysis of yield and its related characters in rice (Oryza sativa L.) under irrigated and rainfed situations. Indian Journal of Genetics, 5(1): 30-36. 1991
[7] Ramalingam J, Vivekanandan, P and Vanniarajan C. Combining ability analysis in lowland early rice. Crop research 6 : 228-233. 1993
[8] Bobby TPM and Nadarjan, N. Heterosis and combining ability in rice hybrids involving CMS lines. Journal Oryza 31 pp 5-8 1994.
[9] Ramalingam, J., Nadarjan, N ., Vanniarajan, C., and Rangaswamy P. . Combining ability studies involving CMS line in rice. Oryza 34:4-7.1997
[10] Manonmani, S. and Ranganathan, R.B. Genetic analysis in early lines of indica rice. Oryza, 35(4): 358-360. 1998
[11] Munhot, M.K., Sarawgi, A.K. and Rastogi, N.K.. Gene action and combining ability for yield, grain quality and other related characters in rice. Oryza, 37(1): 1-6. 2000
[12] Gannamani, N. Study of heterosis and combining ability by utilizing cytoplasmic genetic male sterility and fertility restoration system in rice (Oryza sativa L.). M.Sc. (Ag.) Thesis, IGKV, Raipur.2001.
[13] Shanthi, P., Shanmugasundaram, P. and Nagarajan, P.. Combining ability analysis in rice. Oryza, 40(1/2): 11-13. 2003
[14] Rao, S. and Kulkarni, N.. Heterosis and gene effects for gain yield in inter sub-specific crosses of rice (Oryza sativa L.). Extended Summary, 2004
[15] Sharma, R.K. and Mani, S.C.. Combining ability and gene action for quality characters in Basmati rice (Oryza sativa L.). Indian Journal of Genetics and Plant Breeding, 65(2): 123-124. 2005
[16] Kumar,P.S. and Ram, S.R.R. Combining ability studies in rice (Oryza sativa L.). Research on Crops. 7(3): 720-722. 2006.

Author Profile

Shivam Soni received the B.Sc. (Ag) and M.Sc. (Ag) degree in Genetics and Plant Breeding, 2008 and 2011, respectively with outstanding score and merit award. Research work on New Plant Type lines of rice to develop super rice hybrid with 1year (2008-09) work experienced on Bayer Crop Science as project officer for research and development of hybrid rice. He is currently working as Rural Agriculture Extension Officer in Government Agriculture Department, Dhamtari (Chhattisgarh) India.