Electronic Journal of Plant Breeding, 6(2): 389-394 (June 2015)

ISSN 0975-928X

Research Article

Combining ability for quantitative traits in Barnyard millet (*Echinochloa frumentaceae* (Roxb.) Link)

V.G.Renganathan, S. M. Ibrahim and C. Vanniarajan
Department of Plant Breeding and Genetics, Agricultural College and Research Institute, Madurai -625104
Email: cvhariny@gmail.com

(Received: 17 July 2014; Accepted:18 July 2014)

Abstract
In Barnyard millet, combining ability for yield and yield attributing characters were studied through Line x Tester mating design using six lines and four testers. Combining ability analysis exhibited high *sca* effects for all the traits studied indicating the predominant role of non-additive gene action. The lines CO 2 and ACM 110 and the testers ACM 12 and PMK 331 had recorded high *per se* performance and *gca* values for yield and most of the yield contributing characters studied. The cross combination CO 2 x ACM 12 exhibited high *per se* performance and *sca* effect for eight traits. Significant *gca* effects and non significant *sca* effects were recorded in ACM 110 x ACM 11, ACM 110 x ACM 12, CO 2 x ACM 11 and CO 2 x PMK 332 and these could be used for recombination breeding.

Key words
Barnyard millet, Combining ability.

Introduction

Small millets are extraordinarily tolerant of drought and other abiotic stresses, such as high temperature and poor soil. As climates get hotter and drier, small millets and more dominant dry land cereals will become increasingly well suited for production in areas where other crops are now grown. Among small millets, barnyard millet is an important dry land crop in India. It is cultivated over a wide array of environmental conditions. It is cultivated mainly for the nutritious grains and the straw of good fodder value. It is one of the important minor millets and it is rich in minerals and fat as compared to rice. It has the highest content of amylose (30.47%) amongst minor millets, contains all types of essential amino acids, excellent for people suffering from acidity, indigestion and allergenic to gluten and has hypoglycemic effect, hence recommended for diabetic patient.

Recently threatening of modern life style disease like diabetes, degenerative disease like heart attack and cancer tunes the food habit of adding more amount of millet based foods especially Barnyard millet. To get maximum grain yield associated with best grain quality is the aim of the breeding program. Hence exploiting of local varieties for nutritive value in addition yield is foremost important to the breeder. The goal of a plant breeder in self-pollinated crop is to develop a true breeding (homozygous) population among various desirable characteristics contributing to the yield of that crop with great genetic potential. The accomplishment of this objective would be based on the selection of suitable parents and nature of the gene action controlling the various traits in plants. The nature of gene action helps in the identification of suitable breeding strategy in barnyard millet.

Materials and method

Six lines were crossed to four testers in a line x tester mating design to generate 24 cross combinations in rabi, 2012. Emasculation was done through hot water treatment and pollination was through contact method during 6.30 to 8.30 a.m. Crossed seeds along with their parents (10 parents + 24 cross combinations) were evaluated during kharif, 2013. The male parents used had pink colouration on stem, leaf and inflorescence that were used as morphological markers. Each genotype was grown in a single row of 3 m length with a spacing of 40 cm between rows and 10 cm between plant to plant in a randomized block design with three replication. At flowering and maturity, the following quantitative traits like days to flowering, plant height, number of tillers per plant, ear head length, ear head breadth, number of rachis, stem girth, flag leaf length, flag leaf breadth, single ear head weight, grain yield per plant, fodder yield per plant and test weight were studied and observations were recorded individually on five randomly selected competitive plants of the cross combinations and parents in each replication. The combining ability analysis was done according to Kempthorne (1957).

Result and discussion

The analysis of variance revealed significant variation among the parents and cross combination for all the traits. High level of significance in the variance of parents vs hybrids for all the characters clearly indicated the existence of significant level of average heterosis in the hybrids. The variance due to lines, testers and line x tester interaction was significant for all the characters studied (Table 1). This indicated that there was a good level of genetic difference present among lines and testers. The additive and dominance genetic variances and their relative proportions for all the 13 quantitative traits are presented in Table 2. The estimate of genetic variance revealed that the dominance genetic variance (σ^2_D) was higher in magnitude than the additive genetic variance (σ^2_A) for all the traits *viz*., days to flowering, plant height, number of tillers per plant, ear head length, ear head breadth, number of rachis, stem girth, flag leaf length, flag leaf breadth, ear head weight, grain yield per plant, fodder yield per plant, test weight. The similar result was supported by the findings of Sivagurunathan *et al.* (2006 b), Shailaja *et al.* (2010) and Savitha *et al.* (2013) in finger millet.

The *per se* performance of parents was considered as the first important criterion for selection and second most important criteria is *gca* effects of parents. Because, the parents with high mean values may not necessarily be able to transmit their superior traits to their progenies. Hence combination of *per se* performance and *gca* effects will result in the selection of parents with good reservoir of superior genes. The high *gca* effects indicate additive gene effects. The comparison of *per se* and *gca* effects revealed that most of the parents with high *per se* performance also had high *gca* effects indicating that *per se* is an indicator for *gca* effects (Munhot *et al*., 2000). On this basis, the lines CO 2 and ACM 110 and the testers ACM 12 and PMK 331 had highly significant mean values and *gca* effects for most of the traits along with grain yield per plant (Table 2). The line CO 2 showed high *per se* and *gca* effects for six traits namely days to flowering, number of tillers per plant, ear head length, ear head breadth, ear head weight and grain yield per plant. The line ACM 110 recorded high *per se* performance and *gca* effects for three traits *viz.*, plant height, number of rachis and grain yield per plant. The tester ACM 12 and PMK 331 were recorded high *per se* and *gca* effects for grain yield per plant. Hence these parents can be utilized in the hybridization programme and the segregants can be screened for superior genotypes.

The basic idea behind hybridization is to combine the favourable genes present in different parents into a single genotype. The cross combinations obtained through hybridization are can be utilized in two different ways *viz.*, one way is directly use of F_1 cross combinations to exploit commercially valuable one (heterosis breeding) or forwarding to further generations and selecting superior segregants and releasing the best recombinants after attaining homozygosity (recombination breeding).

The criterion for selection of cross combinations for recombination breeding depends on the parents should have significant *gca* effects and corresponding cross combinations with non significant *sca* effects (Table 3). The segregation of such cross combinations are likely to throw desirable recombinants possessing favourable additive genes from both the parents and they can be selected very easily in the early segregating generation in the absence of dominance (Khorgade *et al.*, 1989). In the present study four cross combinations *viz*., ACM 110 x ACM 12, CO 2 x PMK 332, CO 2 x ACM 11 and ACM 110 x ACM 11 are the promising cross combinations that can be recommended for recombination breeding to get desirable segregants in early segregating generations for yield. Hence from this present study, it is inferred that though the crossing procedure is difficult, heterosis is realized more in Barnyard millet. Hence, search for male sterile source should be initiated as reported in foxtail millet.

References

Kempthorne, O. 1957. An introduction to genetic statistics, John Wiley and sons, New York.

Khorgade, P.W., A.V. Deshmukh, M.N. Narkhede and S.K. Rant. 1989. Combining ability for yield and its components in sesame**.** *J. Maharashtra Agric. Univ.*, 14(2): 164-166.

Munhot, M.K., A.K. Sarawagi and N.K. Rastogi. 2000. Gene action and combining ability for yield, grain quality and other related characters in rice. *Oryza*, 37(1): 1-6.

Nirmalakumari and Vetriventhan. 2009. Phenotypic analysis of anther and pollen in diversified genotype of Barnyard millet (*Echinochloa frumentacea*) floral characters. The *ICFAI University J. Genetics & Evolution,* 2(3).

Parashuram, D. Patroti , Jayarame Gowda., 2011. Heterosis and Combining Ability Studies for Yield and Yield attributing characters in Finger millet (Eleusine coracana (L.) Geartn.) *Electron. J. Plant Breed.*, 2(4): 494-500.

Rahimi, M., B. Rabiei, H. Samizadeh and A. Kafi Ghasemi. 2010. Combining ability and heterosis in rice (*Oryza sativa* L.) cultivars. *J. Agric. Sci. Tech*., 12: 223-231.

Savitha, P., A. Nirmala kumari and T. Raguchander. 2013. Combining ability analysis for yield and yield attributing traits in Finger Millet (Eleusine coracana (L.) Gaertn.) Hybrids. *Electron. J. Plant Breed.,* 4(2): 1133-1136.

Shailaja, H. B., S. Thirumeni, K. Paramasivam and T. Ramana. 2010. Combining ability analysis in finger millet (*Eleusine coracana* (L).Gaertn.) under Salinity. *Electron. J. Plant Breed.,* 1 (2): 129-139.

Sivagurunathan, M., P. Veerabadhiran and N. Senthil. 2006 b. Heterosis studies in finger millet (*Eleusine coracana* (L).Gaertn.) for yield and qualitative traits. *Crop Res.,* 31(2): 267-270.

Table 1. Analysis of variance for combining ability for all traits

Source	Df	Mean sum of squares												
		DF	**PH**	**PT**	**EL**	**EB**	**NR**	**SG**	**FLL**	**FLB**	**EW**	**GYP**	**FYP**	**TW**
Crosses	23	102.56*	238.52*	6.31*	22.22*	0.77*	37.49*	0.52*	30.65*	0.22*	4.69*	112.19*	1166.67*	0.04*
Lines	5	397.94*	385.83*	8.58*	58.25*	1.30*	42.53*	0.47*	57.89*	0.22*	8.45*	40.80*	1611.84*	0.02*
Testers	3	33.75*	129.40*	10.88*	8.44*	0.42*	92.98*	0.19*	13.95*	0.07*	1.74*	95.32*	1185.59*	0.03*
L x T inter action	15	17.86*	211.24*	4.64*	17.30*	0.65*	24.71*	0.60*	9.18*	0.24*	4.02*	139.37*	1014.50*	0.05*
Error	46	0.34	27.69	0.41	2.47	0.17	10.43	0.15	9.19	0.09	1.32	2.95	780.03	0.01
σ^2_A		4.27	1.37	0.08	0.24	0.005	0.64	-0.00	0.28	-0.00	0.03	-1.37	7.68	-0.00
σ^2_D		5.84	61.18	1.40	4.61	0.16	4.76	0.15	5.24	0.05	0.90	42.06	78.16	0.02
σ^2_A / σ^2_D		0.73	0.02	0.06	0.05	0.03	0.13	0.00	0.05	0.00	0.03	-0.03	0.10	0.00

*** Significant at 5% level**

DF : Days to flowering
PH : Plant height
PT : Number of tillers per plant
EL : Ear head length
EB : Ear head Breadth
NR : Number of Rachis
SG : Stem girth
FLL : Flag leaf Breadth
FLB : Flag leaf Breadth
EW : Single ear head weight
GYP : Grain yield per plant
FYP : Fodder yield per plant
TW : Test weight

Electronic Journal of Plant Breeding, 6(2): 389-394 (June 2015)

ISSN 0975-928X

Table 2. The *gca* effects of parents for all traits

Parents	DF	PH	PT	EL	EB	NR	SG	FLL	FLB	EW (g)	GYP	FYP	TW
							Lines						
CO1	-3.82 *	-0.78	0.88*	1.60*	-0.07	-1.53	-0.11	-1.30	-0.15	-0.48	-2.57*	-14.18	0.05
CO2	-8.99 *	0.91	0.82*	2.81*	0.64*	-2.00*	-0.23 *	-2.64*	0.23*	0.92 *	2.83*	8.29	0.02
ACM 82	4.43 *	3.79*	-0.87*	-0.81	-0.10	-1.13	0.14	3.58*	-0.01	0.51	-0.82	-11.40	-0.01
ACM 110	5.01 *	8.35*	-0.71*	-0.33	-0.19	2.07*	0.17	0.19	-0.02	-0.18	1.21*	13.45	0.00
ACM 145	4.85 *	-6.27*	0.60*	-0.96*	-0.00	2.40*	-0.18	1.61*	0.06	-1.35*	-0.32	1.99	-0.06
ACM 161	-1.49 *	-6.00*	-0.71*	-2.30*	-0.29*	0.18	0.21	-1.45*	-0.11	0.57	-0.32	1.84	-0.02
SE	0.17	1.52	0.18	0.45	0.12	0.96	0.11	0.88	0.09	0.33	0.49	8.06	0.02
							Testers						
ACM 11	-1.90 *	-3.53*	-1.10*	1.02*	0.19	2.72*	0.02	0.91	-0.02	-0.12	-1.40*	-11.46	-0.05
ACM 12	-0.07	2.99*	0.49*	-0.74	0.05	-2.35*	0.13	0.47	0.06	0.30	2.56*	2.40	0.04
PMK 331	1.15 *	0.25	0.21*	-0.14	-0.13	-1.31	-0.04	-1.18*	0.04	-0.38	2.40*	4.10	-0.02
PMK 332	0.82 *	0.30	0.61*	-0.14	-0.12	0.94	-0.11	-0.20	-0.08	0.20	1.24*	4.96	0.03
SE	0.14	1.24	0.16	0.37	0.09	0.78	0.09	0.72	0.07	0.24	0.41	6.58	0.02

*** Significant at 5% level**

Table 3. The *sca* effects of crosses for all traits

Crosses	DF	PH (cm)	PT	EL (cm)	EB (cm)	NR	SG (cm)	FLL (cm)	FLB (cm)	EW (g)	GYP (g)	FYP (g)	TW (g)
CO 1 x ACM 11	-1.85 *	-2.16	0.54	6.56 *	0.76 *	3.36	0.33	-0.33	0.02	2.13 *	8.27 *	22.49	-0.10
CO 1 **x** ACM 12	-1.35 *	4.70	-1.55 *	-2.31 *	-0.49 *	-0.60	0.11	-2.67	-0.16	0.08	-6.03 *	-2.94	0.30 *
CO 1 **x** PMK 331	1.10 *	-9.80 *	0.31	-1.99 *	0.05	-3.50	-0.35	3.62 *	0.05	-1.39 *	0.70	-16.12	-0.04
CO 1 **x** PMK 332	2.10 *	7.26*	0.70	-2.26 *	-0.32	0.74	-0.09	-0.62	0.09	-0.82	-2.95*	-3.43	-0.16 *
CO 2 **x** ACM 11	1.99 *	-1.84	-0.78*	-0.70	-0.36	-0.69	-0.38	-0.65	-0.45 *	-0.43	-5.33 *	-3.73	-0.08
CO 2 **x** ACM 12	-0.18	1.89	-1.23 *	2.11*	0.84 *	1.13	0.29	4.69 *	0.38 *	0.72	5.93 *	17.74	0.15 *
CO 2 **x** PMK 331	-1.40 *	-2.37	2.45 *	0.19	0.04	-2.28	0.60 *	-1.61	0.13	-1.56 *	6.43 *	-7.11	-0.02
CO 2 **x** PMK 332	-0.40	2.33	-0.86*	-0.98	-0.53 *	1.84	-0.51 *	-2.43	-0.07	1.27	-7.04 *	- 6.90	-0.05
ACM 82 **x** ACM 11	-5.10 *	6.16 *	-0.34	-1.30	-0.12	2.81	0.25	1.74	0.17	-0.53	1.27	13.17	-0.05
ACM 82 **x** ACM 12	3.07 *	5.89	1.08*	0.54	-0.10	-1.00	-0.28	1.34	0.12	0.10	4.35 *	-0.50	-0.07
ACM 82 **x** PMK 331	2.85 *	-6.00	-1.07*	1.41	-0.03	-1.03	0.34	-1.72	-0.10	-0.44	-7.77 *	-5.50	0.00
ACM 82 **x** PMK 332	-0.82	-6.05	0.33	-0.65	0.26	-0.78	-0.31	-1.36	-0.19	0.86	2.16*	-7.18	0.12
ACM 110 **x** ACM 11	0.65	-15.03 *	-0.74	-2.39 *	0.43	-1.01	0.40	0.94	0.56 *	-1.06	-3.38*	-24.64	0.13 *
ACM 110 **x** ACM 12	-1.51 *	1.70	0.17	-0.06	-0.33	-2.33	-0.73 *	-3.96*	-0.39 *	0.04	4.10*	6.73	-0.14*
ACM 110 **x** PMK 331	0.60	9.94 *	0.65	0.10	-0.10	2.35	0.02	1.07	-0.25	0.94	-5.68 *	5.13	0.01
ACM 110 **x** PMK 332	0.26	3.39	-0.08	2.35 *	-0.00	0.99	0.31	1.95	0.08	0.08	4.96 *	12.78	-0.00
ACM 145 x ACM 11	3.82 *	13.42 *	0.07	-0.94	-0.54 *	-1.34	-0.19	-3.91	-0.08	-0.09	-2.32*	-9.71	-0.01
ACM 145 x ACM 12	0.32	-10.22 *	1.11*	-0.57	-0.06	3.34	0.26	2.64	0.12	-0.86	-11.37 *	-29.22	-0.14 *
ACM 145 x PMK 331	-2.24 *	1.06	-2.20 *	-0.09	-0.07	3.06	-0.34	-1.55	-0.14	1.57 *	6.65 *	19.87	0.07
ACM 145 x PMK332	-1.90 *	-4.25	0.99*	1.60	0.68 *	-5.06 *	0.27	2.82	0.11	-0.62	7.05 *	19.05	0.08
ACM 161x ACM 11	0.49	-0.55	1.21 *	-1.22	-0.17	-3.12	-0.42	2.21	-0.23	-0.03	1.49	2.41	0.12
ACM 161 x ACM 12	-0.35	-3.95	-0.08	0.91	0.14	-0.56	0.35	-2.05	-0.06	-0.08	3.02*	8.19	-0.10
ACM 161 x PMK 331	-0.90 *	7.17*	-0.02	0.38	0.11	1.41	-0.27	0.19	0.31	0.88	-0.32	3.72	-0.04
ACM 161 x PMK332	0.76*	-2.68	-1.12 *	-0.07	-0.08	2.28	0.33	-0.35	-0.01	-0.77	-4.19*	-14.32	0.02
SE	0.34	3.04	0.39	0.91	0.24	1.92	0.22	1.75	0.17	0.66	0.99	16.13	0.04

***Significant at 5% level**

DF : Days to flowering
PH : Plant height
PT : Number of tillers per plant
EL : Ear head length
EB : Ear head Breadth
NR : Number of Rachis
SG : Stem girth
FLL : Flag leaf Breadth
FLB : Flag leaf Breadth
EW : Single ear head weight
GYP : Grain yield per plant
FYP : Fodder yield per plant
TW : Test weight