Int.J.Curr.Microbiol.App.Sci (2021) *10*(08): 459-470

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 10 Number 08 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1008.057

Heterosis and Combining Ability Studies for Predicting F_1 Hybrid Performance using Diallel Mating Design in Inbred Lines of Maize (*Zea mays* L.)

Anil Kumar Hota[*] and S. K. Sinha

RMD College of Agriculture and Research Station, IGKV Ambikapur- 497001, C.G., India

**Corresponding author*

Keywords

Combining Ability, Heterosis, GCV, Diallel Mating Design, Maize, Inbred, Yield

Article Info

Accepted:
20 July 2021
Available Online:
10 August 2021

A B S T R A C T

General and specific combining ability effects along with the magnitude of heterosis of the inbred lines and hybrids of the maize were estimated using diallel mating design during *2019-20* cropping season at Research-cum-Instructional farm, Ajirma, RMD CARS, Ambikapur with Randomized Complete Block Design (RCBD). The analysis of variance revealed that the sufficient variability was present in the material studied. A comparatively higher estimate of GCV was obtained for traits *viz.*, grain yield qha^{-1}, cob weight in g $plot^{-1}$. High heritability coupled with high genetic advance for the traits like grain yield qha^{-1}, cob weight (g $plot^{-1}$), ear height (cm), plant height (cm) and 100 grain weight (g) were recorded. Mean sum of squares was highly significant for all the traits studied except anthesis silking interval. The mean sum of squares due to inbreds, hybrids and inbred x hybrids were significant for all the characters. This implies both the additive and non-additive gene actions were playing significant role in the expression of these characters. Variance due to sca was greater than gca variance for almost all the traits except for number of kernel rows cob^{-1}, days to 50% tasseling and days to 50% silking. Results of combining ability revealed that the parental lines VL18941, VL18579, KL156018, VL171511, VL175894 and VL172428 are identified as good general combiners for grain yield and other important traits under study. The hybrids VL18579 x VL18452, VL175894 x VL18941, VL171511 x VL172428, VL171511 x VL18579 and VL18932 x VL18579 were found to be as desirable specific combiners for grain yield and other related important traits and showed significant standard heterosis for grain yield over checks.

Introduction

Maize (*Zea mays* L.; 2n = 20) is an important summer cereal crop which is believed to be originated in Southern Mexico or Northern Guatemala (Weatherwax and Paul 1955) cultivated commonly throughout the world with a remarkable productive potential among cereals. Maize ranks first in the total production followed by wheat and rice

(Begum *et al.,* 2016). Hence it is called Queen of cereals (Ali *et al.,* 2007). Maize is used as staple food in many countries and is also used in animal feed and has many industrial applications.

Maize is the third most important crop among the cereal crops grown in India. India produced over 281 MT food grains in 2018-19, out of which cereals share the major part. Rice and wheat constitute 44% and 39% of cereal production, respectively while maize represents little over 9% of cereal production (Rakshit *et al.,* 2017). Presently it occupies 8.69 million hectare area and produces around 28.75 MT of maize (Sujay and Chikkappa 2018). In Chhattisagarh, it occupies area of 193 thousand hectare and production and productivity are 489.48 MT and 2536 kg/ha respectively (Anonymous, 2018). It has high nutritive value and contains starch 72 %, protein 10 %, oil 4.80 %, fiber 9.50 %, sugar 3.0 %, ash 1.70%, endosperm 82 %, embryo 12 %, bran testa 5% and tip cap 1% (Ali *et al.,* 2014). Due to demanding in poultry feed and other related industry maize grain is very popular in India. It is very necessary to introduce hybrid varieties of maize to increase the yield potential to satisfied the need of human and industrial purpose.

Knowledge of genetic variability, heritability and genetic advance is most helpful tools for breeders to the selection of desirable lines or parents in a crop improvement programme. (Bello *et al.*, 2012). Enhance in the production and development of a suitable hybrid variety. It is important to know the nature of association between yield and related components Selection of suitable parents along with knowledge of gene action is an important tool for the success of any breeding programme (Venkatesh *et al.,* 2001). Combining ability is an efficient tool for selection of suitable parents for hybridization from a large number of parental lines. The most potential lines are to be identified on the basis of their ability to give superior hybrids (Adelardo *et al.,* 2006). Heterosis exploitation is very useful for the development and identification of high per se performing parental lines and evaluate their combining ability in cross combinations (Kabdal *et al.,* 2003). Recently developed inbreds are available at the AICRP on Maize, Raj Mohini Devi College of Agriculture and Research Station, Ambikapur, Chhattisgarh whose combining ability has not yet been studied. Thus, the present investigation was carried out to unravel the genetics of yield and other important trait, nature and magnitude of gene action lines and crosses of maize for yield and other important traits and to study the magnitude of heterosis in maize.

Materials and Methods

The experimental/biological materials used in the research work comprised of ten maize inbred lines viz., VL1033, VL18352, KL156018, VL171511, VL175894, VL18941, VL18902, VL172428, VL18579 and VL18452. Total forty five crosses were made by adopting diallel mating design. Three checks viz., NK-30, JK-502 and Pro 4212 were also included to evaluate the standard heterosis. The parents were grown in different sowing dates to raise good crop during Kharif 2019, in such a way so as to ensure synchronization in flowering for the purpose of hybridization. The above crosses and their parents were sown in a RCBD (Randomized Complete Block Design) with three replications at Research field of Ajirma farm, RMD, CARS, Ambikapur, which is located at a $20^0$8'N, longitude of $83^0$15'E and altitude of 592.62 m MSL (mean sea level). Each genotype was sown as four rows of 4 meter lengths with row-to-row and plant-to-plant distance of 60 cm and 20 cm respectively. Recommended agronomical packages and practices were followed during the crop growth period. Observations were recorded on traits namely plant height, ear height, ear length, ear girth, cobs per plot, day to 50% pollen shed, day to 50% silking, day to 80% maturity, anthesis silking intervals, cob yield per plot, number of kernel rows per cob, number of kernels per rows, grain yield per plot, final plant stand, shelling percentage and 100-grain weight. The data so obtained were analyzed and genetic parameters (GCV, PCV, heritability and genetic advance), combining ability effects (GCA & SCA) and all kinds of heterosis were worked out.

Results and Discussion

The results of the various analyses are summarized in [Table–1-3]. Genotypic coefficient of the variation's (GCV's) were not much differ with their respective phenotypic coefficient of the variation's (PCV's), indicating the less influence of the environment on the expression of the traits. Reasonably higher estimates of GCV for grain yield/plot, cob weight g/plot, ear height and plant height suggest that the selection can be effective for these traits. High heritability estimates for almost all the traits indicates the preponderance of additive gene action. High heritability along with high genetic advance was recorded for the traits plant height, 100 grain weight, ear height, cob weight and grain yield that describes the additive gene effects. Thus, such characters should be improved through selection. Most of these findings are in harmony with those obtained by (Devi *et al.,* 2001), (Sofi and Rather 2007), (Rafiq *et al.,* 2010) and (Wannows *et al.,* 2010).

Analysis of variance for parents, crosses and parents vs. crosses were highly significant for all the traits [Table-2]. This indicated the presences of sufficient variability among parents and hybrids. The mean sum of squares were found highly significant for the all the traits considering hybrids which indicate that hybrids showed diverse performance of different cross combinations for these traits and hence, selection is possible to identify the most desirable crosses. The parents versus hybrids mean sum of squares were highly significant for all traits revealing the presence of average heterosis due to the significant differences in the mean performances of hybrids and parents.

GCA mean squares of the Inberd Lines were found highly significant for most of the traits viz., 100 grain weight, days to pollen shed and silking, plant and ear height, grain yield, cob yield [Table-3]. Estimates of GCA effects for grain yield revealed that inbred lines VL18941, VL18579 and VL175894 are good general combiners for grain yield (Table3). Inbred line VL18579 found to be a good general combiner for days to 50% tasseling, days to 50% silking and days to 80% maturity. These lines are desirable for earliness. For plant height line VL1033 and VL18932 were found to be good general combiners. In maize, shorter plant height is desirable for lodging resistance. For ear height line VL1033 and VL18932 were good general combiners for final plant stand, line VL18941 and line VL18352 showed highest significant GCA effects. For number of cobs plot^{-1}, number of kernels row^{-1} and cob weight line VL18579 showed highest positive and significant GCA effects. This line could be a good general combiner for these traits. For number of kernel rows cob^{-1} and shelling percentage line VL18941 showed positive and significant GCA values. For ear length line VL18452 showed maximum GCA effects. For ear girth line VL18932 showed highest positive significant GCA effects. For 100 grain weight line VL171511 showed highest positive and significant GCA value. No any lines were good general combiners for anthesis- silking intervals.

Table.1 Genetic Parameters for Different characters of Maize

Characters	Range		GCV %	PCV %	h^2 %	GA as % of Mean
	Min.	Max.				
Final plant stand	36.00	43.00	2.70	4.73	57.00	11.62
Days to 50% tasseling	74.00	91.00	4.24	4.78	96.52	11.19
Days to 50% silking	77.00	93.00	3.97	4.01	98.10	10.39
Days to 80% maturity	115.00	125.00	1.91	2.00	91.20	4.81
Ear height	74.00	142.90	12.69	13.91	83.20	30.56
Plant height	172.00	384.80	10.08	11.10	92.50	24.18
Number of cobs/plot	35.00	42.00	4.94	6.08	73.40	13.76
Length of cobs	12.10	16.30	5.08	8.19	67.10	11.92
Ear girth	12.20	15.80	3.00	5.89	46.00	7.16
Number of kernel rows/cob	12.70	17.80	5.98	8.43	72.30	14.96
Number of kernals/row	23.90	36.00	7.75	8.89	76.10	17.86
100 Grain Wt	26.00	40.50	9.56	10.30	86.10	23.43
Cob Wt (g)	1800.00	7233.00	20.08	22.91	79.40	41.97
Anthesis silking interval	2.00	3.00	1.99	2.13	86.20	1.52
Shelling %	69.23	75.44	2.95	3.44	73.40	6.67
Grain yield q/ ha	67.36	114.58	20.79	4.07	74.60	47.40

Table.2 ANOVA for diallel analysis and Combining Ability

Characters	Replications	Genotypes	Parents	Hybrids	Parents Vs. Hybrids	Error	GCA	SCA	Error	GCA Variance	SCA Variance	GCA/SCA Variance Ratio
Degree of freedom	2	57	9	44	1	114	9	44	114			
Final plant stand	3.05*	5.26**	6.25**	5.00**	3.91**	3.52	1.66*	1.77*	1.2	0.09	0.36	0.26
Days to 50% tasseling	14.67**	31.53**	32.23**	32.05**	7.58*	0.007	12.52**	10.06**	0	4.03	3.49	1.15
Days to 50% silking	16.36**	29.39**	31.08**	29.64**	6.89*	0.22	11.97**	9.31**	0.1	3.66	3.35	1.09
Days to 80% maturity	0.05*	16.99**	25.33**	15.57**	0.24*	0.49	4.70*	5.87*	0.2	0.84	4.33	0.19
Ear height	74.41*	686.95**	1115.29**	608.07**	21.44*	44.39	175.44**	240.88**	15	6.42	286.01	0.02
Plant height	104.80*	2008.52**	3978.28**	1606.57**	318.62**	161.03	911.15**	615.80**	54	66.75	707.49	0.09
Number of cobs/plot	1.08*	8.15 **	10.53**	7.77 **	2.67*	4.95	2.40*	2.78 *	1.7	0.10	0.41	0.25
Length of cobs	10.00**	2.01*	2.39 *	1.95*	1.19*	0.65	1.31*	0.53*	0.2	0.38	0.77	0.49
Girth of cob	0.85*	1.03**	1.14 **	1.02**	0.12*	0.39	0.31 *	0.34	0.1	0.07	0.16	0.45
Number of kernel rows/cob	0.24*	2.15 **	0.98*	2.31 **	5.93 **	1.21	0.44*	0.77 **	0.4	0.10	0.08	1.23
Number of kernals/row	24.41**	13.87**	17.13**	13.50**	0.48*	1.52	4.28*	4.69*	0.5	0.86	3.14	0.27
100 grain weight	5.63*	31.6**	50.92**	27.98**	3.88*	1.95	6.25*	11.48**	0.7	1.46	10.78	0.13
Cob Wt g/plot	0.18*	2.39**	5.44**	1.75*	0.45*	0.39	0.70*	0.81*	0.1	0.06	0.89	0.07
Anthesis silking interval	0.05*	0.22**	0.28**	0	0.01*	0.21	0.06*	0.07*	0.1	0.007	0.01	0.70
Shelling %	1.07*	17.12**	9.12**	19.39**	1.85*	2.03	3.37*	6.22**	0.7	0.02	6.31	0.003
Grain yield q/ ha	55.58*	708.52**	1465.49**	553.26**	86.86**	92.3	177.85**	249.13**	31	14.85	281.73	0.05

Significance levels *=<.05, **=<.01

Table.3 General Combining Ability Effects of Maize Inbred Lines for Different Characters.

PARENTS	Final plant stand	Days to 50% tasseling	Days to 50% silking	Days to to 80% maturity	Ear height	Plant height	Number of cobs / plot	Length of cobs	Girth of cob	Number of kernel rows/cob	Number of kernals/row	100 grain wt	Anthesis silking intervals	Shelling%	Cob wt g/plot	Grain yield q/ ha
VL1033	-0.01	-0.10	-0.09	-0.23 *	-8.16 **	-19.61**	0.02	-0.54*	0.05	-0.13	-1.21	-0.52 *	0.01	0.37	-0.46 **	-6.70 **
VL18352	0.43**	-1.56	-1.45	-0.26*	1.32	0.67	0.53	-0.46	-0.12	0.04	-0.71	-1.04**	0.10	0.04	-0.05	-0.83
KL156018	0.07	-1.01	-1.12	0.45	2.91	7.36*	0.26	-0.16	-0.27*	0.26	0.29	0.19	-0.10	-0.63*	0.06	0.30
VL171511	0.10	-0.59	-0.48	-0.20	1.45	8.43 *	0.23	0.22	-0.15	0.01	0.33	1.05 **	0.10	-0.07	0.08	1.24
VL175894	-0.56**	-0.65	-0.70	-0.66	-0.55	2.30	0.05	0.20	0.16	0.10	0.47 *	0.77	-0.04	-0.42	0.23 *	3.39 *
VL18941	0.58**	0.80	0.78	-0.54	5.77 **	9.34 *	0.50	0.05	0.06	0.40*	0.50 *	0.88	-0.01	1.08**	0.41	7.43 **
VL18932	-0.38	1.43	1.45	1.00	-3.78*	-7.41*	-0.50	0.23	0.25 *	0.12	0.14	-0.34	0.01	-0.56 *	-0.19	-3.54 *
VL172428	0.16	0.25*	0.30*	-0.54	0.68	0.80	0.22	-0.05	0.11	0.35*	0.19	0.60 *	0.04	-0.22	0.04	0.30
VL18579	0.16	-1.30**	-1.33**	-1.52**	-0.42	0.00	1.44**	0.10	-0.60	0.26	0.94**	0.26	-0.02	0.22	0.43**	7.03 **
VL18452	-0.41**	1.43	1.33**	1.00	0.34	-1.89	-0.88 *	0.50 *	-0.09	-0.25	0.77 *	0.86	-0.10	0.40	-0.12	-1.59
CD at 95%	0.71	0.03	1.00	0.26	2.52	0.80	0.84	0.30	0.21	0.37	0.46	0.49	0.16	0.49	0.16	3.45

Significance levels *=<.05, **=<.01

Table.4 Specific Combining Ability Effects of Maize Hybrids for Different Characters.

CROSSES	FPS	DT	DS	DM	EH	PH	NCPP	LC	GC	NKRPC	NKPR	100 G Wt.(g)	ASI	Shelling%	cob wt in g/plot	GY q/ha
VL1033xVL18352	0.79	-2.44	-2.21	-1.18	0.91	-2.89	0.20	-0.26	0.31	0.36	-0.65	1.30	0.22	0.50	0.81*	12.90*
VL1033xKL156018	1.49	2.00	2.11	-1.91	7.05	8.28	0.80	0.99	-0.25	-0.30	1.68*	4.46	0.08	1.75*	0.65	11.97*
VL1033xVL171511	-0.53	-2.41	-2.18	-1.24	6.98	10.88	-0.83	-0.05	0.03	-0.17	-0.02	4.30	0.19	2.01**	-0.03	0.81
VL1033xVL175894	0.12	2.64	2.35	-0.79	7.69 *	3.27	-0.64	0.20	0.39	0.50*	1.43*	-1.62*	-0.24	1.45	1.00**	16.90**
VL1033xVL18941	-0.02	1.18	1.20	0.08	5.73	12.89	-0.43	-0.41	0.27	-0.16	-0.61	-0.08	0.00	1.17	0.43	7.69
VL1033xVL18932	0.94	-0.44	-0.79	-1.46	9.56 *	15.89 *	1.23	0.60	0.69*	0.32	1.28	4.41	-0.10	0.23	0.86*	13.59*
VL1033xVL172428	-0.93	-4.26*	-3.97	0.41	17.75	32.71	-1.37	0.22	0.41	0.77	0.28	0.60	0.19	1.92*	0.51	9.66
VL1033xVL18579	-0.86	0.29	0.65	0.84	17.10	25.98	-1.34	0.77	0.34	0.31	3.60	2.97	0.36	1.23	0.13	3.01
VL1033xVL18452	-0.35	-2.44	-2.00	-3.46	13.62	30.14	0.95	0.33	0.09	0.23	0.40	1.21	0.00	-0.47	0.00	-0.63
VL18352xKL156018	-0.29	-2.53	-2.18	2.11	-35.33	-59.01	0.95	-1.88	0.36	0.12	1.72*	1.59*	0.00	1.98**	0.46	9.37
VL18352xVL171511	0.00	2.03	1.84	0.78	2.09	4.29	-0.67	1.26**	0.85*	0.25	1.94**	1.05	-0.22	0.77	-0.05	-0.40
VL18352xVL175894	0.67	-1.90	-1.94	-0.76	13.40	20.38 **	-0.49	0.21	0.44	0.20	-0.12	-2.83	0.33	1.32	0.16	3.18
VL18352xVL18941	-0.33	0.64	0.90	-0.88	2.94	2.67	0.38	-0.10	0.55	0.06	-0.17	3.81	0.25	0.57	0.60	9.95
VL18352xVL18932	-0.41	1.00	1.23	1.90	7.60 *	19.84 **	0.38	0.52	0.31	0.05	3.02	1.06	0.14	1.76*	0.64	11.69*
VL18352xVL172428	0.27	2.18	2.05	1.11	7.59 *	11.15	1.10	0.80	-0.40	0.03	-0.81	-3.93	-0.55*	1.61*	0.19	4.28
VL18352xVL18579	0.41	-2.12	-2.51	-2.23	11.75	21.99	-1.17	-0.70	0.09	-0.58	0.01	6.00	-0.38	-0.63	0.44	5.96
VL18352xVL18452	2.18 *	-4.99*	-5.30**	-1.43	7.27 *	15.79 *	0.77	-0.32	-0.05	-0.23	1.18	0.87	-0.08	1.33	0.28	5.78
KL156018xVL171511	-1.29	-2.50	-2.49	2.05	11.37 **	13.29	-0.07	-0.10	0.14	0.05	1.21	- 2.51**	-0.02	1.71*	0.55	10.47*
KL156018xVL175894	0.37	2.55	2.38	4.50*	-22.68	-20.11 **	1.10	0.48	0.50	0.20	1.01	-3.64	0.19	1.15	0.12	2.95
KL156018xVL18941	0.21	-0.90	-0.76	-0.61	8.92 *	12.78	0.32	0.82	0.18	0.09	-1.5*	1.73*	-0.22	1.36	-0.08	-0.02
KL156018xVL18932	-1.47	3.46	3.57	-1.15	9.58 **	29.08	-2.67 *	0.11	-0.05	0.29	0.25	-1.07	0.03	1.70*	-0.54	-7.29
KL156018xVL172428	0.97	2.64	2.38	0.38	5.80	-5.27	0.04	-0.16	-0.06	-0.39	0.99	-1.54*	0.64*	-0.03	0.40	6.13
KL156018xVL18579	-0.36	1.18	0.99	-3.86	3.62	9.97	-0.40	-0.50	-0.31	-0.15	-0.75	- 2.40**	-0.19	1.25	0.05	2.25
KL156018xVL18452	-0.11	3.46	3.35	3.84	2.51	3.82	-1.61	0.04	-0.29	0.23	-0.34	3.29	-0.22	1.59*	0.06	2.77

VL171511xVL175894	0.33	2.12	1.75	-3.82	4.24	9.49	0.80	0.19	-0.66*	2.99	-1.39*	1.95*	-0.35	0.02	-0.23	-4.05
VL171511xVL18941	-2.81 **	2.67	2.26	2.05	-4.08	0.71	-2.64 *	0.67	0.11	-0.47	0.25	-1.66*	-0.10	1.54*	-0.04	1.33
VL171511xVL18932	0.82	0.03	0.26	1.50	-33.09	-47.71	3.35 **	-1.06	0.53	-0.24	-0.08	-1.17	0.11	1.00	1.10**	18.34
VL171511xVL172428	0.27	1.21	0.75	-0.27	0.46	-5.80	-0.92	-0.11	0.05	-0.50*	0.35	-0.01	-0.24	1.25	1.28*	21.35
VL171511xVL18579	0.05	-3.20	-2.95	-2.53	5.38	5.60	1.04	1.05*	0.34	-0.19	2.10**	-1.74*	0.25	2.06**	0.56	11.22*
VL171511xVL18452	0.52	0.03	0.05	-0.49	-1.25	-6.96	-0.25	-1.41**	0.63	0.13	2.21**	1.26	0.22	0.99	-0.05	-0.75
VL175894xVL18941	1.18	-6.26**	-6.18**	0.50	7.92 *	5.24	1.53	-0.07	-0.06	-0.62	0.92	0.14	0.11	2.50**	1.73	29.22
VL175894xVL18932	1.15	-6.90**	-6.52**	-5.03**	8.01 *	11.20	3.53 **	0.72	-0.10	0.20	-0.05	-0.56	-0.65**	1.95*	0.53	10.12
VL175894xVL172428	-3.72	-2.72	-2.37	0.50	-0.05	15.18 *	-3.07 *	0.13	-0.82*	-0.68	-0.32	-3.34	-0.02	0.69	0.11	2.02
VL175894xVL18579	1.88	-1.29	-1.14	-0.48	12.70	18.40	1.37	1.08*	-0.06	-0.77	1.07	-1.43	0.14	0.87	-0.23	-32.41
VL175894xVL18452	-2.14 *	6.09**	5.93**	4.96 *	-31.71	-45.77	-2.73 *	-0.72*	0.72*	-0.38	-0.06	-0.56	0.11	0.33	-0.22	-3.41
VL18941xVL18932	0.06	1.64	1.32	-0.49	3.72	1.16	-0.25	-0.56	0.13	0.66	1.63*	4.31	-0.08	0.95	0.31	-11.57*
VL18941xVL172428	0.79	-1.17	-1.18	-0.27	-8.78 *	-11.98	-1.19	-0.28	-0.24	0.01	-0.03	-1.36	-0.10	0.05	-0.72*	4.63
VL18941xVL18579	-0.33	-0.12	0.26	0.93	5.48	6.70	5.48	-2.91	-0.08	-0.40	1.15	-0.12	0.39	0.70	0.09	2.14
VL18941xVL18452	1.37	-2.35	-2.21	-1.82	4.15	7.44	2.13	0.65	-0.32	-0.72	0.26	2.31**	-0.30	1.85*	0.30	6.82
VL18932xVL172428	1.43	4.18	4.14	1.84	-36.75	-63.55	1.80	-1.32	0.14	-0.26	1.99**	5.16	-0.22	0.17	0.76*	11.92*
VL18932xVL18579	-0.80	-3.37	-3.42	2.21	6.75	1.82	0.32	-0.37	0.50	-0.65	1.91**	3.00	-0.05	0.80	0.76*	12.90*
VL18932xVL18452	0.67	-0.99	-1.21	-1.70	2.98	2.61	-0.19	1.14*	-0.60	-0.76	-0.74	-4.09*	-0.08	1.53*	-0.16	-1.15
VL172428xVL18579	-0.69	-1.40	-1.48	-0.17	5.25	9.22	-0.01	-0.07	0.82	0.46	-0.01	2.62*	-0.08	1.05	0.54	9.66
VL172428xVL18452	0.46	-0.81	-0.4	-0.49	0.97	-3.54	1.20	0.39	0.58	0.58	0.25	1.5*	0.22	0.30	0.45	7.40
VL18579xVL18452	0.38	1.12	1.18	1.60	-0.71	7.63	1.71	0.48	-0.02	0.09	1.14	-0.494	0.05	-0.04	1.77	27.83
CD at 95%	2.01	0.09	0.51	0.75	7.14	13.60	2.38	0.86	0.65	1.12	1.39	1.479	0.48	1.47	0.68	10.34

Significance levels *=<.05, **=<.01

Table.5 Standard Heterosis for Grain Yield

CROSSES	NK 30	Pro 4212	JK 502
P1XP2	-10.31**	0.00	-17.24**
P1XP3	-7.32**	3.34**	-14.48**
P1XP4	-21.53**	-12.50**	-27.59**
P1XP5	-12.55**	-2.50**	-19.31**
P1XP6	-12.56**	-2.51**	-19.32**
P1XP7	-9.57**	0.83*	-16.56**
P1XP8	-14.05**	-4.16**	-20.69**
P1XP9	-12.55**	-2.50**	-19.31**
P1XP10	-21.53**	-12.50**	-27.59**
P2XP3	-4.33**	6.67**	-11.72**
P2XP4	-17.04**	-7.50**	-23.45**
P2XP5	-21.53**	-12.50**	-27.59**
P2XP6	-4.33**	6.67**	-11.72**
P2XP7	-5.82**	5.00**	-13.10**
P2XP8	-14.05**	-4.16**	-20.69**
P2XP9	-3.58**	7.50**	-11.03**
P2XP10	-8.81**	1.67**	-15.86**
P3XP4	-1.35**	10.00**	-8.97**
P3XP5	-17.78**	-8.33**	-24.13
P3XP6	-11.06**	-0.84**	-17.94**
P3XP7	-22.27**	-13.33**	-28.27**
P3XP8	-8.07**	2.50**	-15.18**
P3XP9	-3.58**	7.50**	-11.03**
P3XP10	-8.07**	2.50**	-15.18**
P4XP5	-27.50**	-19.16**	-33.10**
P4XP6	-11.81**	-1.67**	-18.62**
P4XP7	3.14**	15.00**	-4.83**
P4XP8	6.13**	18.34**	-2.07**
P4XP9	3.90**	15.84**	-4.13**
P4XP10	-14.05**	-4.16**	-20.69**
P5XP6	9.87**	22.50**	1.38**
P5XP7	-14.05**	-4.16**	-20.69**
P5XP8	-23.01**	-14.16**	-28.96**
P5XP9	-20.03**	-10.84**	-26.21**
P5XP10	-25.26**	-16.67**	-31.04**
P6XP7	-27.50**	-19.16**	-33.10**
P6XP8	-10.31**	0.00	-17.24**
P6XP9	-4.33**	6.67**	-11.72**
P6XP10	-4.34**	6.66**	-11.73**
P7XP8	-5.82**	5.00**	-13.10**
P7XP9	3.89**	15.83**	-4.14**
P7XP10	-16.28**	-6.66**	-22.75**
P8XP9	0.15	11.66**	-7.59**
P8XP10	-7.32**	3.34**	-14.48**
P9XP10	23.32**	37.50**	13.79**

Significance Levels *** = <.05, ** = <.01**

P_1 - VL1033, **P_2 -** VL18352, **P_3 -** KL156018, **P_4 -** VL171511, **P_5 –** VL175894,
P_6 – VL18941, **P_7 -** VL18932, **P_8 - V**L172428, **P_9 -** VL18579, **P_{10} –** VL18452

Analysis of variance for SCA also showed highly significant differences for grain yield, 1000grain weight, plant height and ear height, days to pollen shed, silking, maturity. Both positive and negative and significant estimates of SCA effects were observed among the crosses for grain yield [Table-4]. Crosses VL1033 x VL175894, VL1033 x VL18932 VL1033 x VL18352, VL18932 x VL18579, VL1033 x KL156018, VL18932 x VL172428, VL18352 x VL18932 and VL171511 x VL18579 were good showed positive significant SCA effects for grain yield. Highly significant SCA effects of the crosses indicate that significant deviation from what would have been predicted based on their parental performances. These crosses with highly positive and significant estimates of SCA effect could be selected for their specific combining ability to use in maize improvement program. Estimates of SCA effects [Table-4] of hybrids revealed that highest significant level of SCA effects in most of the crosses they studied for grain yield in maize. With respect to days to 50% tasseling, days to 50% silking and days to 80% maturity cross VL175894 x VL18932 showed the best SCA effects.

Cross VL1033 x VL175894 showed highest positive significant SCA effects for number of kernel rows cob^{-1}. Cross VL175894 x VL18932 showed significant SCA effects for number of cobs plot^{-1}. Cross VL18352 x VL171511 showed positive significant effects for ear length and ear girth. VL18941 x VL172428 showed significant SCA effects for number of kernels row^{-1}. Cross VL18941 x VL18452 showed significant SCA effects for 100 grain weight (g). Cross VL175894 x VL18941 showed significant SCA effects for shelling percentage. Cross VL171511 x VL172428 showed significant SCA effects for cob weight plot^{-1}. No crosses have showed significant SCA effects for anthesis-silking intervals.

The results of analysis of combining abilities obtained from this study indicated the importance of both additive and non-additive gene actions in controlling in these agronomical important traits such as 100 grain weight, days to pollen shed and silking, plant and ear height, grain yield. Therefore, both additive and non-additive variances are important in determining for the exploitation breeding behaviour of the genetic potential of the inbred lines in variety development program. (Pal *et al.*, 1986), (Satyanarayana *et al.*, 1994), (Prasad and Kumar 2003), (Vijayabharathi *et al.*, 2009), (Kanagarasu *et al.*, 2010), (Abrha *et al.*, 2013), (Gowda *et al.*, 2013) and (Alamine *et al.*, 2006). The standard heterosis (over NK-30) ranged from -27.50% (VL171511 x VL175894 and VL18941 x VL18932) to 23.32% (VL18579 x VL18452). Over NK-30, almost all hybrids have shown significant standerd heterosis effects, among them only five hybrids have shown the positive significant effects. Standard heterosis over Pro 4212 ranged from -22.50% (VL18941 x VL18932) to 37.50 (VL18579 x VL18452). Twenty two hybrids have shown significant positive standard heterosis effects against Pro 4212. Standard heterosis over JK-502 ranged from -33.10 % (VL18941 x VL18932 and VL171511 x VL175894) to 13.79% (VL18579 x VL18452). Only two hybrids have shown significant positive standard heterosis effects. Hybrid VL18579 x VL18452 has shown highest and posistive significant heterosis against all checks. [Table-5]. These findings are in confirmatory with the results. (Hussain *et al.*, 2011), (Mohammed 2005) and (Muraya *et al.*, 2006).

References

Abrha, Shushay, W., Zeleke Habtamu, Z. and Gissa, Dagne, W. 2013. Line x tester analysis of maize inbred lines for grain yield and yield related traits. *Asian*

Journal of Plant Science and Research, 3(5):12-19.

Adelardo, J., De la Vega. and Scott, C. C. 2006. Multivariate analysis to display interactions between environment and general or specific combining ability in hybrid crops. *Crop Sci.*, 46: 957-967.

Alamnie, A., Nayakar, Y., Wali, M C., 2003. Combinig ability, heterosis and per se performance of height characters in maize. *J. Agric. Sci.* Karnataka., 16(1), 131-133.

Ali, Q., M. Ahsan, M. H. N., Tahir and S.M.A.. Basra. 2014. Gene action and Correlation Studies for Various Grain and its Contributing Traits in Maize (*Zea mays L*). *Bothalia*, 44(2): 80-91.

Ali, W., Rehman, U. H., Ahmad, K., Munir, I., Khan, A.. 2007. Genetic variability among maize hybrids for yield and yield components. *Sarhad J. Agric*, 23(1).

Anonymous, 2018.

Begum, S., Ahmed, A., Omy, S. H., Rohman, M. M., Amiruzzaman, M., 2016. Genetic variability, character association and path analysis in maize (*Zea mays L.*). *Bangladesh J. Agri. Res. 41*(1):173-182.

Bello, O. B., Ige, S. A., Azeez, M. A., Afolabi, M.S., Abdulmaliq, S. Y., Mahamood, J. 2012. Heritability and genetic advance for grain yield and its component characters in maize (*Zea mays L.*). *Int. J. Plant. Res.* 2, 138–145.

Devi, I. S., Muhammad, and S., Muhammad. 2001. Character association and path co-efficient analysis of grain yield and yield components in double crosses of maize. *Crop Res.* Hisar, 21, 355-359.

Gowda, K., Kage, U. K., Lohithasa, H. C., Shekara, B. G. and Shobha, D. 2013. Combining ability studies in maize (*Zea mays L.) Molecular Plant Breeding*, 4(14), 116-127

Hussain, Ali, M. and Ibraheem, S. R., 2011. Estimation of some parameters, heterosis and heritability for yield and morphological traits in inbred line of maize (*Zea mays L*) using line x tester method. *Journal of Tikrit University for Agricultural Sciences,* 11(2): 359-383.

Kabdal, M. K., Verma, S. S., Kumar, A., Panwar, U. B. S. 2003. Combining ability and heterosis analysis for grain yield and its components in maize (*Zea mays L.) Indian J. Agr. Res.*, 37(1): 3943.

Kanagarasu, S., Nallathambi, G. and Ganesan, K. N. 2010. Combining ability analysis for yield and its component traits in maize (*Zea mays L.). Electronic Journal of plant Breeding.* 1(4): 915-920.

Mohammed, A. S. A. 2005. A study of characters contributing to yield in some genotypes of maize. *J. of Tik. Unvi. Agri.* 2(5):1-9.

Muraya, A. B. M. M; C. M. Ndirangu A and E. O. Omolo A. 2006. Heterosis and combining ability in diallel crosses involving maize (*Zea mays L.*) S_1 lines. *Aust. J. of Exp.Agri.*46 (3) : 387–394.

Pal, S. S., Khera, A. S. and Dhillon, B. S., 1986, Genetic analysis and selection advance in maize population. *Maydica.*, 31: 153-162

Prasad S. K. and Kumar P. (2003). Line x tester analysis for combining ability in maize. RAU *J Res.*, 13(1&2): 68-72.

Rafiq, M., Rafiq, M., Hussain, A. and Altaf, M. 2010. Studies on heritability, correlation and path analysis in maize *(Zea mays). Journal Agric.Res.,* 48(1), 35-38.

Rakshit, S., Chikkappa, G K., Jat S L, Dhillon, B S and Singh, N. N. 2017. Scaling-up of Proven Technology for Maize Improvement through Participatory Approach in India. In

Best Practices of Maize Production Technologies in South Asia. *SAARC Agriculture Centre*, *Dhaka*, *Bangladesh*, 36-60.

Satyanarayana, E., Kumar, R. S. and Sharma, M. Y. (1994). Inheritance studies of maturity components and yield in selected hybrids of maize *(Zea mays L.). Mysore J. Agric. Sci.*, 28(1): 25-30.

Sofi, P. A. and Rather, A. G. 2007. *Maize genetics Cooperation Newsletter*. 81.

Sujay, R. and Chikkappa, G. K. 2018. Perspective of maize scenario in India. *Maize Journal* 7 (2): 49-55.

Venkatesh, S., Singh, N. N. and Gupta, N. P. 2001. Early generation identification and utilization of potential inbred lines in modified single cross hybrids of maize (*Zea mays L.*). *Indian J. Genet*., 61(3): 213-217.

Vijayabharathi, A., Anandkumar, C. R. and Gnanamalar, R. P. 2009. Combining ability analysis for yield and its components in popcorn *(Zea mays var. evertasturt.). Electronic J. Plant Breeding*.1: 28-32.

Wannows, A., A., Azzam, H., K. and Ahmad S. A. AL. 2010. Genetic variances, heritability, correlation and path coefficient analysis in yellow maize crosses *(Zea mays L.). Agric. Biol. J. N. Am.*, 1(4), 630-637.

Weatherwax, Paul 1955. History and origin of corn. In G. F. Spragne (Ed.). Corn and corn improvement, Academic Press. New York. 1-16.

How to cite this article:

Anil Kumar Hota and Sinha, S. K. 2021. Heterosis and Combining Ability Studies for Predicting F1 Hybrid Performance using Diallel Mating Design in Inbred Lines of Maize (*Zea mays* L.). *Int.J.Curr.Microbiol.App.Sci.* 10(08): 459-470.
doi: https://doi.org/10.20546/ijcmas.2021.1008.057