Journal of Genetics, Genomics & Plant Breeding 9(3) 64-73 (July, 2025)
ISSN (Online): 2581-3293 DOI: 10.63551/jggpb.vol.9.issue03.001

RESEARCH ARTICLE

Heterosis and combining ability in full diallel crosses for yield and yield component traits in pepper (*Capsicum spp.*)

N.M. Akpan, E. E. Bassey, G.I. Harry, I.I. Dominic

Department of crop Science, Faculty of Agriculture, University of Uyo, Uyo, P.M.B 1017 Akwa Ibom State, Nigeria

Corresponding authors email: akpandueso@gmail.com

Manuscript received: June 2, 2025; Decision on manuscript, June 30, 2025; Manuscript accepted: July 10, 2025

Abstract

The present investigation was conducted to evaluate mid parent heterosis (MPH), better parent heterosis (BPH), general combining ability(GCA) and specific combining ability (SCA) for yield and it related traits in pepper. Experimental materials consisted of seven parental genotypes and their forty two F_1's developed by full diallel mating design. Significant differences were observed among the pepper genotypes in all the characters studied as the hybrid, Scotch bonnet♀ x Anitillias♂ was significantly higher in fruit weight per plant (429.80g) and fruit yield per hectare (17.19t/ha) when compared to other genotypes. All the hybrids were found to show a significant ($p< 0.05$) positive MPH for all the traits. BPH which is important to breeders was highest in the hybrid Ntuen okpo♀ x Tatse♂ for fruit weight per plant (53.28%) and fruit yield per hectare (53.29%). Significant GCA and SCA effect were obtained for all characters analyzed, indicating the importance of both additive and non-additive genetic components. The genotype Scotch bonnet was the best general combiner for fruit weight per plant and fruit yield per hectare while the hybrid Tatse♀ x Ntuen okpo♂ was the best specific combiner for fruit weight per plant and fruit yield per hectare. Therefore application of hybridization breeding method may result in improved productivity of pepper.

Keywords: Combining ability, diallel crosses, heterosis, yield, yield component

Introduction

Pepper is an important commercial vegetable and condiment species that is grown all over the world. Pepper is used in many forms, such as fresh or cooked vegetables, herbs or spices, and various kinds of processed products. It is a vital component of many foods, contributing taste, colour, vitamins A and C, and pungency (Akpan *et al.,* 2024). The fruits contain combinations of antioxidants, including carotenoids, ascorbic acid, flavanoids, and polyphenols, in addition to vitamins A and C. It can be used medically for the treatment of fevers, colds, indigestion, and constipation and as a pain killer (Dagnoko *et al.,* 2013). Heterosis is expressed as an agricultural phenomenon, in which growth, productivity, earliness, quality and other features of hybrid genotypes are superior compared to their parents. Advancement in the exploitation of heterosis has help in difference ways to develop hybrids with increased yield and the required goals of increasing productivity in the quickest possible time can be achieved by utilizing heterosis breeding (Rao *et al.,* 2017). Combining ability of genotype is the ultimate factor determining future usefulness of the lines for hybrid development. It provides the breeders an insight into nature and relative magnitude of fixable and non-fixable genetic variances. Such studies provide a guideline for selecting elite parents or combiners which may later be hybridized either to exploit heterosis or to accumulate fixable genes through selection (Akpan *et al.,* 2017). Comparatively, pepper yield in the developing countries like Nigeria is about 10 – 30% of that in developed countries (Grubben and Tahir, 2004; Akpan, and Dominic, 2024), and the demand for pepper is increasing consistently due to increasing population, the nutritional and health importance of the crop while there is a decrease in productivity mainly due to the use of unimproved genotypes for yield and other important agronomic characteristics. Therefore, the present investigation was undertaken to estimate the magnitude of heterosis in the hybrids and to elucidate information on combining ability of pepper genotypes in order to obtain superior hybrids, of excellent high yields.

Materials and methods

The experiment was conducted at the Crop Science Department teaching and research farm, University of Uyo, Uyo Akwa Ibom State, Nigeria. Uyo has coordinates of latitudes 4030'N and 5027'N, and longitudes 7050'E and 8025'E and altitude 38.1m above sea level. It is characterized by two seasons, the wet rainy season and the dry season. The rainfall pattern of Uyo is bimodal. Rain usually starts in March and ends in November with a short period of relative moisture stress in August sometimes referred to as August break (Udo-Inyang and Edem, 2012). Planting materials consisting of seven (7) parent genotypes of pepper, namely, [Piquante yellow (A), Scotch bonnet (B), Antillais (C), Big sun (D), Tatse (E), Ntuen okpo (F), and Efia (G)], obtained from different seed company across the country while Ntuen okpo a local pepper genotype used as a check was obtained from a local farm in Uyo, Akwa Ibom State.

The seven (7) parent genotypes of pepper were used to generate twenty one (21) straight hybrids and twenty one (21) reciprocal hybrids using Griffing (1956) model 1 method 1 (parents, F_1's and reciprocal) of full diallel crosses. The experiment was laid out in a randomized complete block design with three replications. Planting was other agronomic practices done manually on the field as when due. The data collected comprised: number of fruits per plant, fruit length (cm), fruit circumference (cm), fruit weight per plant (g) and fruit yield per hectare (tonnes). The data obtained were subjected to analysis:

Analysis of variance (ANOVA) and means which showed significant differences were separated using least significance (LSD) at 5% probability level. The performance of the F_1's and their parents were used to determined heterosis according to Bassey (2020) as follows:

Heterosis over the mid parent (%) = $(F_1\text{-MP}) / MP \times 100/1$

Heterosis over better parent (%) = $(F_1\text{-BP}) / BP \times 100/1$

Where MP is mean of mid parent and is obtained by P1+P2 / 2, P1 and P2 are both parents. BP is mean of better parent; and F_1 is mean of F_1's. Test of significance was also done as described by following formula-

Journal of Genetics, Genomics & Plant Breeding 9(3) 64-73 (July, 2025)
ISSN (Online): 2581-3293 DOI: 10.63551/jggpb.vol.9.issue03.001

$$CD = \sqrt{\frac{2me}{r}} X t$$

Where CD = Critical Difference; t = t tabulated at 5% probability; r = number replications; me = error mean square; 2 = a constant.

Using the Griffings (1956) model 1 method 1 (Parents, F_1s and reciprocal), the genetic components attributable to general combining ability (GCA), specific combining ability (SCA), and reciprocal were used to divide the variations among the hybrids obtained in the experiment as elucidated by Chaudhary and Singh (1985).

Results and discussion

Mean performance of parental genotypes and their hybrids on yield and yield component traits

The analysis of variance shows significant differences ($p \le 0.05$) among the parental genotypes and their F_1 hybrids for all the traits measured. The highest number of fruits per plant were produced by F_1 hybrids of Piquante yellow x Antillias (A♀× C♂) with (84.00 fruits), for fruit length, the F_1 hybrids of Tatse x Piquante yellow (E♀× A♂) with 10.40 cm produced the longest fruits, the F_1 hybrids of Tatse x Big sun (E♀ × D♂) produced fruits with the biggest circumference of 12.88 cm, while the F_1 hybrid of Scotch bonnet x Anitillias (B♀× C♂) produced the highest fruit weight per plant and fruit yield per hectare of 429.80 g and 17.19 t/ha respectively (Table 1 and 2). Estimation of variability is an important prerequisite for realizing response to selection as the progress in the breeding depends upon its amount, nature and magnitude (Kumar *et al.*, 2013). Significant differences for all characters studied shows the existence of substantial amount of variability among the genotypes tested which indicating the possibility to select best genotypes and exploit them for variety development. Several researcher have reported significant differences for traits among pepper genotypes (Birhanu and Tiegist, 2020; Deresa *et al.*, 2023).

Mid-parent and better parent heterosis (%) in straight crosses and their reciprocals for yield and yield component trait in pepper

Mid-parent and better parent heterosis for straight crosses and their reciprocals for fruit length showed significant difference ($p<0.05$) (Table 3). The highest positive mid-parent heterosis of 38.66 % was recorded by the F1 hybrids of Big sun x Piquante yellow (D♀× A♂) while the highest positive better parent heterosis of 25.14 % was obtained from the F_1 hybrids of Efia x Ntuen okpo (G♀× F♂). The highest positive mid-parent heterosis of 32 48 % was obtained from the F_1 hybrids of Efia x Piquante

Table 1: Mean performance of parental genotypes on yield and yield component traits of pepper

Genotypes	Number of fruits per plant	Fruit length (cm)	Fruit circumference (cm)	Fruit weight per plant (g)	Fruit yield per hectare (t/ha)
A (Piquante yellow)	58.0	6.1	7.9	264.4	10.5
B (Scotch bonnet)	45.6	6.6	11.1	315.8	12.6
C (Antillais)	50.0	4.4	8.0	273.7	10.9
D (Big sun)	43.6	8.1	11.6	269.8	10.7
E(Tatse)	39.3	9.3	12.7	244.7	9.7
F (Ntuen okpo)	48.6	5.3	8.2	246.3	9.8

Journal of Genetics, Genomics & Plant Breeding 9(3) 64-73 (July, 2025)
ISSN (Online): 2581-3293 DOI: 10.63551/jggpb.vol.9.issue03.001

yellow (G♀× A♂) and the highest positive better parent heterosis of 29.45 % was given by the F1 hybrids of Piquante yellow x Antillias (A♀ × C♂) for fruit Circumference. The highest positive mid-parent heterosis of 55.55 % was obtained from the F1 hybrids of Piquante yellow x Antillias (A♀×C♂) and the highest positive better parent heterosis (52.52 %) was recorded by the hybrids of Efia x Scotch bonnet (G♀×B♂) for number of fruits per plant.

Table 2: Mean performance of hybrids on yield and yield component traits of pepper

Genotypes	Number of fruits per plant	Fruit length (cm)	Fruit circumference (cm)	Fruit weight per plant (g)	Fruit yield per hectare (t/ha)
A♀ × B♂	75.0	8.0	10.8	419.3	16.7
A♀ × C♂	84.0	5.6	10.4	387.1	15.4
A♀ × D♂	69.3	9.6	11.8	362.3	14.4
A♀ × E♂	69.0	9.9	12.8	337.8	13.5
A♀ × F♂	76.0	7.1	9.1	369.7	14.7
A♀ × G♂	69.0	7.0	9.5	406.4	16.2
B♀ × A♂	75.3	8.1	11.4	414.1	16.5
B♀ × C♂	61.6	6.1	10.6	429.8	17.1
B♀ × D♂	55.6	9.6	12.7	394.1	15.7
B♀ × E♂	51.0	10.0	12.8	361.0	14.4
B♀ × F♂	66.6	7.1	10.4	417.0	16.6
B♀ × G♂	68.3	6.9	10.1	427.3	17.0
C♀ × A♂	79.6	5.3	10.1	373.3	14.9
C♀ × B♂	64.6	5.8	9.3	416.7	16.6
C♀ × D♂	64.0	7.4	11.5	393.0	15.7
C♀ × E♂	51.6	9.0	11.7	330.0	13.1
C♀ × F♂	69.3	6.1	9.6	394.4	15.7
C♀ × G♂	70.3	5.9	9.1	415.9	16.6
D♀ × A♂	63.0	9.9	11.8	358.5	14.3
D♀ × B♂	59.8	10.0	12.4	394.2	15.7
D♀ × C♂	56.6	7.6	11.7	374.9	14.9
D♀ × E♂	46.6	10.1	12.7	338.3	13.5
D♀ × F♂	55.3	8.1	11.1	376.0	15.0
D♀ × G♂	64.0	7.6	11.2	400.6	16.0
E♀ × A♂	69.0	10.4	12.2	333.3	13.3
E♀ × B♂	44.0	10.1	12.7	360.5	14.4
E♀ × C♂	45.5	9.0	12.2	314.4	12.5
E♀ × D♂	50.0	10.3	12.8	343.1	13.7
E♀ × F♂	46.6	8.5	11.5	362.3	14.4
E♀ × G♂	46.3	8.6	11.5	396.2	15.8
F♀ × A♂	71.5	6.8	9.4	344.6	13.7
F♀ × B♂	64.5	6.8	10.1	403.9	16.1
F♀ × C♂	65.6	6.1	9.3	382.9	15.3
F♀ × D♂	62.3	7.8	11.5	383.2	15.3
F♀ × E♂	54.1	7.8	11.8	377.6	15.1
F♀ × G♂	66.6	6.0	9.4	404.5	16.1
G♀ × A♂	62.6	7.1	10.4	410.1	16.4
G♀ × B♂	70.1	7.1	10.6	416.1	16.6
G♀ × C♂	64.8	6.1	9.1	396.2	15.8
G♀ × D♂	58.5	8.0	11.2	393.9	15.7
G♀ × E♂	45.8	8.3	11.7	387.2	15.3
G♀ × F♂	59.1	6.6	10.1	392.6	15.7
X	60.1	7.6	10.8	367.4	14.6
LSD (0.05)	1.9	0.6	0.4	5.26	0.2

Table 3: Mid-parent heterosis (MPH) and better parent heterosis (BPH) (%) in straight crosses and their reciprocals for yield and yield component trait in pepper

	Number of fruits per plant		Fruit length (cm)		Fruit circumference (cm)		Fruit weight per plant (g)		Fruit yield per hectare (t/ha)	
Genotypes	**MPH**	**BPH**	**MPH**	**BPH**	**MPH**	**BPH**	**MPH**	**BPH**	**MPH**	**BPH**
A♀ × B♂	25.9	21.1	13.5	-2.60	44.7	29.3	44.5	32.7	44.5	32.7
A♀ × C♂	8.0	-7.0	30.2	29.45	55.5	44.8	43.8	41.4	44.0	41.4
A♀ × D♂	35.4	18.3	20.6	1.54	36.3	19.5	35.6	34.3	35.8	34.4
A♀ × E♂	28.2	6.1	23.7	0.46	41.8	18.9	32.4	27.7	32.8	27.8
A♀ × F♂	18.7	17.5	12.0	10.16	42.5	31.0	44.7	39.8	44.7	39.8
A♀ × G♂	24.1	14.7	20.9	19.42	32.6	18.9	45.4	38.0	45.4	30.0
B♀ × A♂	28.6	23.7	20.2	3.14	45.3	29.8	42.7	31.1	42.7	31.1
B♀ × C♂	12.1	-6.5	10.4	-4.76	28.9	23.3	45.7	36.0	45.9	36.1
B♀ × D♂	30.8	18.3	12.1	9.50	24.6	22.0	34.5	24.7	34.7	24.7
B♀ × E♂	25.4	7.1	7.4	0.54	20.0	11.6	28.7	14.3	28.8	14.2
B♀ × F♂	20.1	8.6	7.4	-6.46	41.3	36.9	48.3	32.0	48.3	31.9
B♀ × G♂	17.1	4.5	7.1	-8.89	49.0	48.5	40.0	35.3	40.0	35.3
C♀ × A♂	1.9	-12.6	25.9	25.12	47.5	37.3	38.7	36.3	38.7	36.3
C♀ × B♂	6.0	-11.7	7.2	-7.45	35.1	29.3	41.3	31.9	41.4	31.9
C♀ × D♂	18.1	-9.0	16.3	-1.54	36.6	28.0	44.6	43.5	44.7	43.6
C♀ × E♂	31.0	-3.5	12.9	-7.83	15.6	3.3	27.2	20.5	27.3	20.5
C♀ × F♂	26.6	15.7	18.2	16.94	40.5	38.6	51.6	42.9	51.7	44.1
C♀ × G♂	23.8	14.7	15.1	14.41	46.5	40.6	46.4	41.2	46.5	41.2
D♀ × A♂	38.6	21.1	20.9	1.71	23.9	8.6	34.2	32.8	34.3	33.0
D♀ × B♂	35.3	22.4	9.2	6.67	33.9	31.0	34.6	24.8	34.7	24.7
D♀ × C♂	12.2	-6.1	18.8	0.51	20.9	13.3	37.9	36.9	38.0	37.0
D♀ × E♂	16.2	9.0	4.0	-0.46	12.4	6.8	31.5	25.4	31.6	25.5
D♀ × F♂	21.0	0.0	11.9	-4.45	19.8	13.7	45.7	39.3	45.8	39.5
D♀ × G♂	13.9	-6.9	16.0	-3.33	42.7	39.1	41.9	36.0	42.1	36.1
E♀ × A♂	34.7	11.4	17.7	-4.38	41.8	18.9	30.9	26.6	30.9	26.0
E♀ × B♂	27.6	9.0	7.0	0.15	3.5	-3.6	28.6	14.1	28.6	14.0
E♀ × C♂	31.0	-3.5	17.5	-4.07	1.8	-0.1	21.2	14.8	21.3	14.8
E♀ × D♂	18.0	10.7	5.4	0.86	20.5	14.5	33.3	27.1	33.3	27.1
E♀ × F♂	15.9	-8.9	9.5	-9.86	6.0	-4.1	47.5	47.0	47.7	47.1
E♀ × G♂	19.5	-7.0	12.1	-9.71	8.6	0.7	46.9	34.5	47.0	34.5
F♀ × A♂	19.4	11.9	16.0	14.04	34.0	23.2	34.9	30.3	34.9	30.3
F♀ × B♂	14.4	3.4	4.7	-8.80	36.7	32.5	43.7	27.9	43.6	27.8
F♀ × C♂	23.0	12.5	13.9	12.71	33.1	31.3	47.2	39.8	47.3	39.9
F♀ × D♂	16.0	-4.1	15.7	-1.19	35.0	28.0	48.4	42.0	48.5	42.1
F♀ × E♂	6.4	-16.4	12.9	-7.04	23.1	11.3	53.7	53.2	53.9	53.2
F♀ × G♂	14.2	12.5	18.2	14.76	40.8	36.9	49.5	37.3	49.5	37.3
G♀ × A♂	27.1	17.5	32.4	30.82	20.5	8.03	46.7	39.2	46.8	39.3
G♀ × B♂	21.7	8.6	13.0	-3.95	53.0	52.5	36.3	31.7	36.3	31.7
G♀ × C♂	28.8	19.3	15.6	13.49	35.0	29.6	39.4	34.5	39.6	34.6
G♀ × D♂	19.9	-2.0	16.0	-3.33	30.4	27.1	39.6	33.7	39.7	33.8
G♀ × E♂	14.9	-10.7	14.4	-7.83	7.4	-0.3	43.6	31.5	43.7	31.5
G♀ × F♂	27.0	25.1	26.8	23.12	24.9	21.5	45.2	33.3	45.2	33.3
S.E	0.3	0.3	0.2	0.21	0.9	0.9	2.6	2.6	0.1	0.1
CD ($p<0.05$)	0.6	0.6	0.4	0.4	1.9	1.9	5.3	5.3	0.2	0.2

Journal of Genetics, Genomics & Plant Breeding 9(3) 64-73 (July, 2025)
ISSN (Online): 2581-3293 DOI: 10.63551/jggpb.vol.9.issue03.001

For fruit weight per plant, the highest positive mid-parent and better parent heterosis of 53.79 % and 53.28 % respectively, was obtained from the F_1 hybrids of Ntuen okpo x Tatse (F♀×E♂). Also, Ntuen okpo x Tatse (F♀×E♂) recorded the highest positive mid-parent and better parent heterois of 53.92 % and 53.29 % respectively, for fruit yield per hectare. The foundation for increasing crop yield is heterosis, it displays the extent to which the F1 mean surpasses the mean of its better parent or mid parent. (Bassey, 2022). High positive mid parent heterosis (MPH) observed in all the crop attributes suggest that all the hybrids performed better than their mid parent value. This result is in accordance with the findings of Murat-Dogru *et al.*, (2022) who observed that all the hybrids exhibited mid parent heterosis in fruit yield of pepper, Chakrabarty *et al.*, (2019) who observed that 10 out of 15 hybrids shows positive MPH in fresh fruit yield per plant and 9 out of 15 hybrids exhibit positive MPH for number of fruits per plant. Fruit weight per plant and fruit yield per hectare shows that all the hybrids exhibit positive BPH, this result is in accordance with Chakrabarty *et al.*, (2019) who reported that 6 out of 15 hybrids shows positive BPH for fresh fruit yield per plant, Ganefianti and Fahrurrozi (2018) who reported 36 bout of 42 hybrids combination shows positive BPH in fruit weight per plant. Rao *et al.*, (2017) reported that 9 out of 12 hybrids exhibit positive BPH in fruit yield per plant.

Variance components of general combining ability (gca), specific combining ability (sca) and reciprocal of pepper yield and yield component traits

Combining ability analysis of variances for yield and yield component traits of pepper presented in Table 4 showed highly significant ($p<0.01$) GCA and SCA effect in all the traits measured. The GCA/SCA ratio which indicate the relative important of additive gene effect showed a GCA/SCA ratio less than one in number of fruits per plant, fruit yield per plant and fruit yield per hectare while a GCA/SCA ratio above one was obtained in fruit diameter (1.12) and fruit circumference (4.71). The highly significant mean squares for both General Combining Ability (GCA) and Specific Combining Ability (SCA) variance for all the attributes measured and Reciprocal mean square for some of the traits indicate the important of both additive and non-additive gene action for these traits. This is in agreement with the findings of Chakrabarty *et al.*, (2019), Ganefianti and Fahrurrozi (2018), and Adday (2017) who all observed a highly significant GCA and SCA mean square in pepper. However, all the traits measured exhibit GCA/SCA ratio that is less than one (unity) except fruit length and fruit circumference suggesting that non-additive gene action has been more important source of variation for the traits than the additive gene action.

Table 4: Analysis of variance for combining ability on yield and yield component traits of pepper genotypes

SOV	d.f	Number of fruits per plant	Fruit length (cm)	Fruit circumference (cm)	FW/P= Fruit weight per plant (g)	Fruit yield per hectare (t/ha)
GCA	6	254.68**	16.58**	34.52**	2168.72**	3.46**
SCA	21	4588.31**	1.11**	0.71**	16282.62**	1.83**
RECIP	21	4.12**	0.06ns	0.10ns	14.90ns	0.023**
Error	96	0.56	0.06	0.19	109.47	0.005
GCA/SCA Ratio	0.004	1.12	4.71	0.01	0.005	

*, **= 5 and 1% probability level

This result is in line with Rego *et al.,* (2009) and who observed that all the traits exhibited GCA/SCA ratio less than one except for fruit length.

General combining ability (GCA) estimate of the pepper genotypes

The result presented in Table 5 showed the GCA effect estimate for yield and yield component traits of pepper used as parents. A significant ($p<0.05$) high GCA effect was obtained in Big sun (1.10) and Tatse (1.68) genotypes and a significant low GCA effect in Antillais (-1.30), Ntuen okpo (-0.82) and Efia (-0.82) genotypes for fruit length. A significant high GCA effect was obtained in Scotch bonnet (0.57), Big sun (1.16) and Tatse (2.29) genotypes while Piquante yellow (-0.73), Antillais (-1.05), Ntuen okpo (-1.25) and Efia (-1.62) genotypes all showed a significant low GCA effect for fruit circumference. For number of fruits per plant, Piquante yellow and Antillais genotypes gave a significant high GCA effect of 7.15 and 2.00 respectively, while Big sun and Tatse genotypes showed a significant low GCA effect of -2.75 and -6.78 respectively. A significant high GCA effect was observed in Scotch bonnet (13.97) and Efia (10.99) genotypes while a significant low GCA effect of -8.11 and -22.68 was obtained in Big sun and Tatse genotypes respectively for fruit weight per plant. However, for fruit yield per hectare, the genotypes Piquante yellow, Scotch bonnet, Antillais and Efia all showed a significant ($p<0.05$) high GCA effect of 0.15, 0.56, 0.15 and 0.43 respectively while Big sun, Tatse and Ntuen okpo genotypes showed a significant low GCA effect of -0.32, -0.90 and -0.08 respectively. A high positive GCA value means that the parental lines have high potential for generating superior offspring (Akpan *et al.,* 2016). Piquante yellow (A) parent was a good general combiner for number of fruits per plant while Scotch bonnet (B) was a good general combiner for fruit weight per plant and fruit yield per hectare. The GCA effect together with relative performance is useful for selecting desirable parent with favourable genes for different component traits of yield. The performance of the parent and their GCA effects for all the traits were in close agreement indicating that the performance of the parents for these traits could possibly be taken as criteria for selecting parents. GCA effects represent additive and additive x additive interaction effects. Similar result have been reported by Chakrabarty *et al.,* (2019), Ganefianti and Fahrurrozi (2018), Adday (2017), that different parents were good general combiner for different plant characters.

Specific combining ability (SCA) estimate for the F_1 hybrids of pepper

The result presented in Table 6 showed the SCA effect estimate for yield and yield component traits of the generated pepper hybrids. For number of fruits per plant, there was a significant ($p<0.05$) high SCA effect in all the hybrids with exceptions of Piquante yellow x Big sun (A♀×D♂) (-0.64), Piquante yellow x Efia (A♀×G♂) (-3.16), Scotch bonnet x Tatse (B♀×E♂) (-1.73), Antillais x Tatse (C♀×E♂) (-2.37) and Tatse x Efia (E♀×G♂) (-1.49) that showed a significant low SCA effect. The hybrids Piquante yellow x Big sun (A♀×D♂) (1.01), Piquante yellow x Tatse (A♀×E♂) (0.79), Scotch bonnet x Big sun (B♀×D♂) (0.93), Scotch bonnet x Tatse (B♀×E♂) (0.60) and Antillais x Tatse (C♀×E♂) (0.95) all showed a significant high SCA effect while Piquante yellow x Anillais (A♀×C♂) hybrid showed a significant low SCA effect of -0.87 for fruit length. For fruit circumference, all the hybrids showed a non-significant high and low SCA effect with exception of the hybrid Ntuen okpo x Efia (F♀×G♂) (1.17) that produced a significant high SCA effect. For fruit weight per plant, all the hybrids showed a non-significant high SCA effect with exceptions of Piquante yellow x Ntuen okpo (A♀×F♂) (-1.36), Scotch bonnet x Tatse (B♀×E♂) (-2.33) and Antillais x Tatse (C♀×E♂) (-10.05) that showed a non-significant low SCA effect.

ISSN (Online): 2581-3293 DOI: 10.63551/jggpb.vol.9.issue03.001

Table 5: General combining ability estimate on yield and yield component traits of pepper genotypes used as parent

Genotypes	Number of fruits per plant	Fruit length (cm)	Fruit circumference (cm)	FW/P= Fruit weight per plant (g)	Fruit yield per hectare (t/ha)
Piquante yellow	0.0	-0.7	7.1	4.0	0.1
Scotch bonnet	0.1	0.5	0.2	13.9	0.5
Antillais	-1.3	-1.0	2.0	3.6	0.1
Big sun	1.1	1.6	-2.7	-8.1	-0.3
Tatse	1.6	2.4	-6.7	-22.6	-0.9
Ntuen okpo	-0.8	-1.2	0.5	-1.8	0.0
Efia	-0.8	-1.6	-0.4	10.9	0.4
S.E	0.1	0.1	0.2	3.9	0.0
C.D(p<0.05)	0.2	0.3	0.5	7.7	0.0

Table 6: Specific combining ability estimate on yield and yield component traits of F1 hybrids pepper genotypes

Genotypes	Number of fruits per plant	Fruit length (cm)	Fruit circumference (cm)	FW/P= Fruit weight per plant (g)	Fruit yield per hectare (t/ha)
A♀×B♂	2.8	0.2	0.5	19.0	0.7
A♀×C♂	5.2	-0.8	0.6	9.0	0.3
A♀×D♂	-0.6	1.0	0.4	1.8	0.0
A♀×E♂	4.8	0.7	0.9	2.2	0.1
A♀×F♂	1.3	0.1	-0.3	-1.3	0.0
A♀×G♂	-3.1	0.2	-0.1	12.1	0.4
B♀×C♂	-0.3	-0.5	-0.2	16.0	0.6
B♀×D♂	0.5	0.9	0.7	5.9	0.2
B♀×E♂	-1.7	0.6	0.6	-2.3	0.0
B♀×F♂	2.0	0.0	-0.4	11.4	0.4
B♀×G♂	5.6	0.0	0.0	9.0	0.3
C♀×D♂	0.1	0.0	0.3	9.1	0.3
C♀×E♂	-2.3	0.9	0.9	-10.0	-0.4
C♀×F♂	2.2	0.5	0.3	14.4	0.5
C♀×G♂	3.2	0.5	0.3	12.4	0.5
D♀×E♂	2.1	0.5	-0.2	11.4	0.4
D♀×F♂	0.6	0.0	0.0	11.1	0.4
D♀×G♂	2.8	-0.1	-0.0	7.8	0.3
E♀×F♂	0.0	-0.3	-0.3	20.7	0.8
E♀×G♂	-1.4	0.0	-0.4	20.2	0.8
F♀×G♂	0.3	0.3	1.1	3.04	0.1
S.E	0.2	0.2	0.5	12.5	0.0
C.D(p<0.05)	0.5	0.5	1.0	24.5	0.1

References

1. Adday, H. A. 2017. Estimation of Heterosis, Combining Ability and Some Genetic Parameters in Sweet Peper. J. Plant Product., 8(5): 629-63.
2. Akpan, N. M., Ogbonna, P. E., Onyia, V. N, Okechukwu, E. C., Dominic, I. I and Atugwu, I. A. 2017. Genetic control and heterosis of quantitative traits in several local eggplant genotypes. Notulae Scientia Biologi., 9(4):520-524.
3. Akpan, N. M., Ogbonna, P. E., Onyia, V. N, Okechukwu, E. C., Atugwu, I. A and Dominic, I. I. 2016. Studies on the variability and combining ability for improved growth and yield of local eggplant genotypes (*Solanum melongena* L.). Notulae Scientia Biologic., 8(2):226-231. DOI: 10.15835/nsb.8.2.9783.
4. Akpan, N. M. and Dominic, I. I. 2024. Gene action and pattern of inheritance for quantitative characters of peppers (*Capsicum spp*). J. Genet. Genom. Plant Breedi., 8 (4):110-117.
5. Akpan, N. M., Bassey, E.E. Harry, G.I. and Dominic, I.I. 2024. Study on genetic variability, heritability and genetic advance among genotypes of pepper in Uyo Nigeria J. Genet. Genom. Plant Breedi., 8 (2):50-60.
6. Bassey, E. E. 2020. Fundamentals of Genetices. Wilonek Publishers Uyo, Akwa Ibom State. Nigeria. 149p.
7. Birhanu, H and Tiegist, D. 2020. multivariate analysis and traits association in hot pepper (*Capsicum annum*) landraces of Ethiopia. Int. J. Res. Studies in Agril. Sci.. 6(10): 42-52.
8. Chakrabarty, S., Aminul Islam. A. K. M., Khaleque Mian, M. A and Tofayel Ahamed, T. 2019. Combining ability and heterosis for yield and Related Traits in Chili (*Capsicum annuum* L.). The Open Agril.J., 13: 34-43.
9. Dagnoko, S., Yaro-Diarisso, N., Sanogo, P., Adetula, O., Dolo-Nantoume, A., GambyToure, K and Diallo-Ba, D. 2013.Overview of pepper (*Capsicum spp*.) breeding in West Africa. African J. Agril. Res., 8(13): 1108-1114.
10. Deresa, D., Girma, S and Assefa, G. 2023. Genetic variability, heritability, genetic Advance, and Association of characters in Small Pod Hot pepper (*Capsicum annuum* L.) landraces in West Hararghe, Eastern Ethiopia, Res. Square, 1-14.
11. Ganefianti, D. W and Fahrurrozi, F. 2018. Heterosis and combining ability in complete diallel cross of seven chili pepper genotypes grown in ultisol. Agrivita J. Agril. Sci., 40(2): 360-370.
12. Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing systems. Australian J. Biolog.l Sci., 9:463-493.
13. Grubben, G. J. H and El-Tahir, I. M. 2004. *Capsicum annuum* L. In: Grubben, G. J. H and Denton, O. A. (eds.). PROTA 2: Vegetables/legumes. (CD-Rom). PROTA, Wageningen, Netherlands.
14. Kumar, A., Mishra, V. K., Vyas, R. P and Singh, V. 2011. Heterosis and combining ability analysis in Bread Wheat (*Triticum aestivum*). J. Plant Breed. Crop Sci., 3:209-217.
15. Kumar, S. R., Arumugam, T., Anandakumar, C. R and Premalakshmi, V. 2013. Genetic variability for quantitative and qualitative characters in Brinjal (*Solanum melongena* L.). African J. Agril. Res.. 8(39):4956-4959.
16. Murat-Doğru, S., Kar, H., Özer, M. O and Bekar, N. K. 2022. Heterosis, heterobeltiosis and dominance effect on yield, total soluble solid and dry matter of red pepper [*Capsicum annuum* L. var. conoides (Mill.) Irish] hybrids. Mustafa Kemal University. J. Agril. Sci. 27 (2):365-373.
17. Rao, P. G., Reddy, K. M., Naresh, P and Chalapathi, V. 2017. Heterosis in Bell Pepper (*Capsicum annuum* L.) For yield and yield attributing traits. Bangladesh J. Botany, 46(2): 745-750.

18. Rêgo, E. R., Rêgo, M. M., Cruz, C. D and Finger, F. L. 2009. A diallel study of yield components and fruit quality in Chilli pepper (*Capsicum baccatum*). Euphytica, 168: 275-287.
19. Singh, R. K and Chaudhary, B. D. 1985. Biometrical methods in quantitative genetic analysis. Kalyani Publishers, New Delhi-Ludhiana, India, 3978p.
20. Udo-Inyang, U. C and Edem, I. D. 2012. Analysis of rainfall trends in Akwa Ibom State, Nigeria J. Enviro. Earth Sci. ,2(8): 60-70.