Zagazig J. Agric. Res., Vol. 51 No. (1) 2024 19-29

Plant Production Science

Available online at http://zjar.journals.ekb.eg
http:/www.journals.zu.edu.eg/journalDisplay.aspx?Journalld=1&queryType=Master

ASSESSING COMBINING ABILITY OF DIVERSE CHILI PEPPER GENOTYPES TO DEVELOP HIGH YIELD AND QUALITY ADOPTED HYBRIDS UNDER EGYPTIAN CONDITIONS

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Received: 25/12/2023; Accepted: 17/01/2024

ABSTRACT: Developing adapted chili pepper genotypes to Egyptian conditions offering both high yield and quality is crucial particularly under the current fast-growing population and abrupt climate change. Thereupon, this study aimed to investigate the general (GCA) and specific (SCA) combining abilities for yield and quality traits, develop hybrids adapted to Egyptian conditions with high yield and quality, and elucidate the type of gene action governing these traits in chili pepper. This study was carried out at a private farm in DakahlyiaGovernorate, Egypt during the two successive autumn seasons 2021 and 2022 applying half-diallel mating scheme (5×5) without reciprocals. Five diverse parental genotypes of chili pepper were used for this study; *i.e.*, P_4, P_5, P_7, $P_{8,}$ and P_{11}. The results reflected highly significant variation among the tested parental genotypes and crosses in all studied traits. The best combiner based on GCA was P_8 for most tested traits. It recorded significant positive GCA values all studied traits except for number of fruits per plant and fruit wall thickness showed insignificant medium GCA effect. In addition, all evaluated parental genotypes were good for improving fruit length and fruit diameter. The results reflected the role of non-additive gene action on offspring for total yield was confirmed. The relationship among the tested characters could provide useful information for screening pepper genotypes and breeding programs.

Keywords: Diallel cross, gca, sca, yield traits, genotypes, *Capsicum annuum*, chili pepper.

INTRODUCTION

Pepper (*Capsicum annuum* L.) is a self-pollinated diploid species with twelve pairs of chromosomes (2n=24) which belongs to family *Solanaceae***(Wang and Bosland, 2006)**. It is an important vegetable crop that is widely grown in Egypt. Five *Capsicum* species including *annuum*, *chinensis*, *frutescence*, *baccatum* and *pubescens*) were domesticated all over the world (**Park and Choi, 2013**). The sweet types (bell pepper) and many pungent cultivars belong to the genus *Capsicum*. *Capsicum* fruits are rich in vitamins including pro-vitamin A, vitamin C and vitamin E. Among the secondary metabolites, capsaicin which is responsible for the pungency (hotness) of Capsicum fruits, is the most important and is utilized in medicinal formulations, chemotherapyand radiation therapy to reduce pain. Capsicum fruits also contain antimicrobial and anti-inflammatory properties (**Zimmer *et al.*, 2012**). Recently, it was reported that Capsicum may have anti-cancerous properties by reducing the chance of organelle cancer (**Gaur *et al.*, 2016**). Capsicum fruits are also utilized to make natural food colors. Therefore, it has become an important commercial crop so far as the area, production, industrial value, medical uses, and contribution to human nutrition is concerned.

Pepper breeders mainly look for specific characters; *i.e.*, fruit pungency, fruit color, short and compact plant, high yield, short cropping time and stress tolerance. There are different ways to improve pepper or chili production, among them, is hybridization followed by

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pedigreeselection which produces new cultivars that often have higher crop indices than older outmoded ones (**Karim*et al.*, 2021**). Furthermore,use of hybrid seeds may be applied to increase chili production per unit area. Production of F1 hybrids requires superior parental lines(**Do Rêgo and do Rêgo, 2016**).

Wild and ornamental peppers own desirable traits including easy seed propagation, relatively short cropping time, and heat and drought tolerance. Cross of some pure lines with ornamental peppers is favorable and should be result in hybrid with high yield, high quality, hybrid vigor, diseases and pests' resistance. The chili hybrids have generated increased interest of the breeders for last few years all over the world (**Bosland and Votava, 2012**). However, there are no Egyptian breeders interested in production of vegetable hybrids. The hybrids cultivated in Egypt come from seeds imported from other countries. Therefore, the objectives of the currentwork were to analyze the combining abilities for vegetative, yield, and quality traits in chili pepper(*C. annuum*),identify genotypes suitable for use as parents in Capsicum genetic breeding program. Elucidate the type of gene action governing the studied traits and produce Egyptian hybrids suitable for local conditions with high yield and quality as well as low cost. Moreover,

MATERIALS AND METHODS

Experimental Site

A field experiment was conducted at a private farm (at Meet Al faramawy village, Meet Ghamr) in Dakahlyia governorate, Egypt during the two successive autumn seasons 2021 and 2022. The soil was loamy and all agricultural practices were used according to ministry of agricultures recommendations. This work was initiated to study the performance of some chili pepper genotypes through 5×5 half-diallel mating scheme without reciprocals.

Plant Materials

The genetic materials used in this experiment were obtained from Prof. Gong Zheng Hui, pepper breeding department, College of Horticulture, Northwest Agriculture and forest university, Yangling, China. All the inbred lines were grown under Egyptian conditions for seven years with selection of suitable characters every year.

Hybridization

In the season of 2021, five breed lines of chili (*Capsicum annuum*); *viz.*, P_4, P_5, P_7, P_8 and P_{11}were used in 5×5 half-diallel cross mating design to obtain seeds of their 10 F_1 hybrids (Table 1). Seedlings were transplanted under protected greenhouse on the 15th of February and the crossing was made among the five parents to obtain the required 10 F_1 hybrids' seeds.

Hybrids Evaluation

In the two autumn seasons of 2021 and 2022, the obtained 10 hybrids and their parental lines with the commercial F_1 hybrid Al Battal as control (standard cultivar) were evaluated. Seedling were transplanted at the last week of August and the hybrids were distributed in a randomized complete block design with three replicates. The plot area was 10 m^2 with three replicates for each hybrid and each replicate contains 10 plants. Drip irrigation system was used with distance of 1.2 m between each two dripper lines and 35 cm between plants in the same line. Routine agricultural practices were done according to the recommendation of the Ministry of Agriculture, Egypt.

Data Recorded

Vegetative growth

After 60 days of transplanting, two plants from each replicate were randomly taken to determine the following traits

1- Plant height (cm)
2- Number of branches
3- Number of leaves per plant
4- Fruit set percentage

Fruit characteristics

1- Fruit length (cm)
2- Fruit diameter (cm)
3- Average Fruit weight (g)
4- Number of fruits/ plants

Fruit yield

1- Total yield (g)
2- Early yield/ plant

Table 1. Name, p-degree and origin of the five chili verities used as parents in this study

Codes	Genotype	Source	P-degree	Fruit shape	Toxonomy
P_4	T.P-9	Prof. Dr. Gong Zhen Hui, Northwest A&F University China	Thai-dragon × Thai-sun	Thai	*C. annuum*
P_5	Zunla-1		-	Serrano	*C. annuum*
P_7	Jalapeno		Jalapeno selfing	Jalapeno	*C. annuum*
P_8	GZH-11		-	Cayenne	*C. annuum*
P_{11}	GZH-4		-	Cayenne	*C. annuum*

Statistical Analysis

Analysis of variation among different genotypes (5 parents and the produced 10 crosses), using the methods described for completely randomized block design, by **Snedecor and Cochran (1967)**. Differentiation among means performances of the studied genotypes (15 genotypes), using LSD at 5% level of probability. Estimation of general and specific combining ability and their effects was performed using Griffing's approach; Method II Model II (random effect), reported in (**Griffing, 1956**) for all the suggested traits of this study.

RESULTS

Analysis of Variance

The results of the analyses of variance for 5×5 diallel cross system were run for some growth traits of chili pepper on the bias of individual plant data.

The analysis of variance for the evaluated traits including yield and its component, fruit characters, number of days to flowering and plant height are shown in Table 2. The investigated genotypes showed highly significant differences among all studied traits. In addition, classifying the genotypic variance into parents, crosses, and parents' *vs* crosses clarified highly significant variance due to parents and crosses for all investigated traits. The obtained results indicated that there is genetic variability among the used parental lines. Besides the traits followed different patterns in each genotype. Therefore, these parental lines and their crosses can be used for further chili breeding programs to improve yield, earliness, plant height and fruit characters.

The variance of GCA and SCA was highly significant for all recorded traits and the selection of transgressive genotypes through chili breeding programs. However, for most traits, the variance due to SCA was greater than that due to GCA. Furthermore, the GCA/SCA was less than unit, indicating the importance of non-additive gene action in the inheritance of these traits.

Mean Performance of Parents and F_1 Crosses

The mean performance of the used parental capsicum genotypes and their 10 crosses for the investigated traits are presented in Table 3. The parents and their hybrids showed significant differences in total yield, earliness, number of fruits and fruit weight. Notably, the parent P8 surpassed the other parents giving the highest values of total yield, early yield, number of fruits/plants, fruit weight and fruit wall thickness. Furthermore, the same parental genotype gave 73% of it yield as an early yield. For the plant height, the parents (P11 and P4) showed the tallest plant followed by P8 and P5, while P7 showed the shortest plants. The genotype encoded P7 showed the lowest number of days to flowering, on the contrary the genotype P4 showed the highest number of days to flowering.

Among the F_1 crosses, the combination (P5 × P11) with Thai fruit type recorded the highest values for total yield/ plant, number of fruits per plant and plant height. Furthermore, this hybrid showed average values for early yield, fruit length, fruit wall thickness and number of days to flowering. On the other hand, this combination showed lower fruit weight and fruit diameter. The combination (P5 × P8) came in the second rank for the yield amount and fruit length. Furthermore, it showed average performance for other characters and recorded the longest period till 50% flower anthesis. The cross (P7 × P11) came in the third rank for yield amount showing the second rank for early yield and fruit wall

Table 2. Mean squares of evaluated traits, namely, earliness traits and yield and its component traits for the five chili genotypes and their F1 crosses

Source of Variation	d. f.	Yield and its component				Fruit characters			Plant Characters	
		Total yield/ Plant (g)	Early yield/ plant (g)	No. of fruits/ plant	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit wall thickness (cm)	No. of days to flowering	Plant height (cm)
Replications	2	54811.04^{ns}	3839.63^{ns}	1678.08^{ns}	00.27^{ns}	0.22^{ns}	0.03^{ns}	0.0123^{ns}	9.15^{ns}	2.64^{ns}
Genotypes	14	1618907.41**	210574.28**	51766.86**	33.48**	20.51**	0.13**	0.0101**	23.88**	778.14**
Parents (P)	4	1667156.76**	654632.25**	15815.91**	108.56**	107.62**	3.88**	0.0387**	1662.03**	5960.87**
Crosses (C)	9	6163302.91**	251456.46**	187105.67**	130.00**	153.13**	5.06**	0.0530**	2425.40**	11539.49**
P $_{VS}$ C	1	7078042.64**	19011.78**	203036.87**	6.91**	15.10**	0.12**	0.0024**	3.19**	2035.38**
GCA	4	4729032.34**	3823889.61**	110523.04**	72.39**	80.17**	1.57**	0.0191**	828.44**	5813.67**
SCA	9	4832885.06**	3885398.00**	120465.57**	127.60**	144.47**	5.74**	0.0576**	2595.68**	10064.10**
Error	28	125412.86	4004.37	2745.39	0.13	0.19	0.01	0.0044	2.24	24.11
Total	44	597406.50	69723.68	18294.62	10.74	6.65	0.05	0.0066	9.44	263.05
δ^2GCA/δ^2SCA		0.98	0.43	0.92	0.57	0.55	0.27	0.33	0.32	0.58

Table 3.Mean performance of evaluated traits for the five chili genotypes and their F1 crosses

Source of Variation	Yield and its component				Fruit characters			Plant Characters	
	Total yield/ Plant (g)	Early yield/ plant (g)	No. of fruits/ plant	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit wall thickness (cm)	No. of days to flowering	Plant height (cm)
P4	373.00	35.64	106.29	3.48	4.87	1.38	0.09	37.33	70.67
P5	405.39	50.35	94.34	4.30	4.39	1.68	0.13	33.25	48.50
P7	420.18	65.07	82.38	5.12	3.90	1.98	0.18	29.17	26.33
P8	1720.46	1025.00	126.14	13.77	12.54	1.57	0.21	33.83	66.00
P11	429.22	52.05	107.53	3.93	8.73	1.54	0.16	36.67	77.33
P4xP5	1062.20	137.12	219.00	4.85	7.24	1.23	0.08	35.67	72.00
P4xP7	1240.07	301.40	215.21	5.77	5.64	1.62	0.07	31.53	59.00
P4xP8	840.93	179.00	103.53	8.15	7.78	1.57	0.18	33.33	81.33
P4xP11	738.63	103.50	152.77	4.83	6.74	1.48	0.06	33.27	81.00
P5xP7	1546.54	190.63	303.99	5.08	6.84	1.52	0.05	35.10	65.33
P5xP8	2205.73	316.67	343.60	6.49	10.50	1.30	0.17	37.51	70.00
P5xP11	2652.15	378.88	531.75	4.99	8.08	1.29	0.16	34.67	95.67
P7xP8	1601.10	246.10	111.84	14.42	8.22	1.78	0.19	28.70	54.33
P7xP11	2193.70	418.75	359.75	6.08	7.55	1.82	0.20	29.83	70.00
P8xP11	1028.54	620.19	116.83	8.85	12.54	1.57	0.21	35.25	71.67
LSD 0.05	**592.30**	**105.84**	**87.63**	**0.59**	**0.72**	**0.17**	**0.11**	**2.50**	**8.21**
LSD 0.01	**799.00**	**142.77**	**118.22**	**0.80**	**0.98**	**0.22**	**0.15**	**3.38**	**11.08**

thickness. It showed the highest fruit diameter with the lowest number of days to flowering. The f1 hybrid (P8 × P11) recorded a moderate yield amount, plant height and fruit weight with the highest early yield (66% of total yield). On the contrary, the combination (P4×P11) showed the lowest yield amount, early yield, fruit weight and fruit wall thickness.

Genotypic Classification According to Performance

The parents and their F_1 crosses were classified by using hierarchical clustering into three groups on the basis of yield components, fruit characters, number of days to flowering and plant height (Fig. 1). Group A included two hybrids (P5 × P8 and P5 × P11) presented the best performance among all hybrids for all tested traits. Accordingly, these two hybrids could be characterized as high yield hybrids with earliness and suitable fruit characters with better vegetative growth. Group B comprised threeparents (P4, P5 and P11) and five F1 hybrids that displayed intermediate values and consequently could be characterized as intermediate in yield and its component besides to earliness. Group C contained one parental genotype (P8) which showed the best performance as compared to the other parental genotypes. In addition, the same group included P8 × P11 hybrid which showed the highest early yield, fruit length and fruit wall thickness with an average yield amount and fruit weight. Group D contained one parental genotype(P7) and two F1 hybrids (P7 × P8 and P7 × P11). The parental genotype (P7) showed low performance among all recorded traits. Furthermore, the two hybrids at the same group recorded average values for all measured characters.

General and Specific Combining Ability Effects

The estimated GCA effect for yield, fruit and growth characters (Table 4) showed that P8 was the best combiner among all tested traits. It recorded significant GCA values among all yield characters, fruit characters and plant height except for number of fruits per plants and fruit wall thickness showed medium GCA effect. It was clear from Table 4 that P5 and P8 were considered as good combiner parents for yield improvement. Furthermore, P8 and P11 were the best combiners for improving earliness and fruit weight per plant characters. For number of fruits per plants, the genotypes P5 and P11 were the best combiners. In addition, the whole selected parental genotypes were good for improving fruit length and fruit diameter. All parental genotypes showed medium GCA effect for fruit wall thickness. On the other hand, all parents showed high GCA effect for increasing the number of days to flowering which is not desired.

Estimated SCA effect was shown in Table 5 for yield characters, fruit characters and plant height. The results reflected the role of non-additive gene action on offspring for total yield was confirmed. A number of three F_1 hybrids recorded a positive SCA with significant sign values. Furthermore, the remains crosses showed non-significant effect. The three hybrids with significant SCA values including P5 × P8, P5 × P11, P7 × P11 with values ranged between 1089.03 to 1570.89 which considered very consistent in specific combining ability for improvement of total yield. These crosses involved parents with high × high, high × medium and medium × medium general combining ability effect. Indicating that all types of GCA effects could produce high SCA effects and the relationship between GCA effects of parental lines and their SCA effects of the crosses are not fixed. In addition, these three F_1 crosses also showed high SCA for all tested characters.

Interrelationship among Evaluated Traits

The relationship among the tested characters including total yield, early yield, number of fruits per plant, fruit weight, fruit length, fruit diameter, fruit wall thickness, number of days to flowering and plant height were estimated by using principal component analysis (PCA) (Fig. 2). This interrelationship could provide useful information for screening pepper genotypes and its breeding programs. The biplot of PCA is an appropriate statistical tool for presenting the interrelationship among evaluated traits. The first two principal components presented most variability of approximately 75.67% (51.41% by PC1 and 24.26% by PC2). Consequently, they were used to construct the biplot (Fig. 3). The

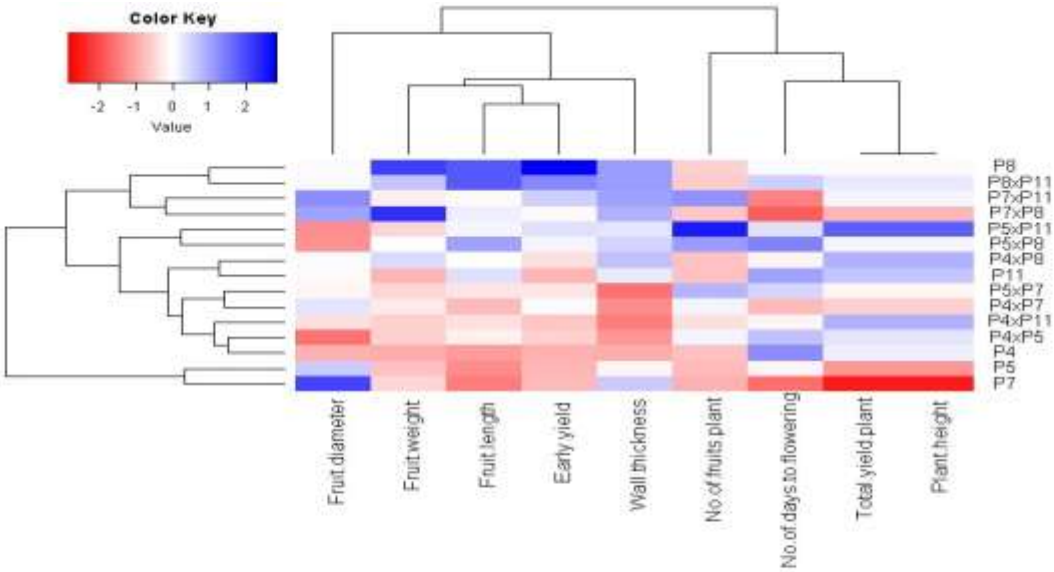

Fig. 1. Heat map for the mean performance of the evaluated traits of the five parental genotypes and ten F1 hybrids

Table 4. Estimates of the general combining ability (GCA) effects of the five chili genotypes for the investigated traits

	Yield and its component				Fruit characters			Plant Characters	
Source of Variation	**Total yield/ Plant (g)**	**Early yield/ plant (g)**	**No. of fruits/ plant**	**Fruit weight (g)**	**Fruit length (cm)**	**Fruit diameter (cm)**	**Fruit wall thickness (cm)**	**No. of days to flowering**	**Plant height (cm)**
P4	-35.963^{ns}	-27.344^{ns}	5.305^{ns}	0.205^{ns}	0.339**	0.145**	-0.006^{ns}	4.48**	11.17**
P5	325.756**	4.357^{ns}	74.895**	0.069^{ns}	0.816**	0.118**	0.006^{ns}	4.99**	9.92**
P7	238.713^{ns}	19.187^{ns}	32.944^{ns}	1.144^{ns}	0.326**	0.288**	0.016^{ns}	2.80**	2.27^{ns}
P8	278.229**	135.687**	5.820^{ns}	2.665**	2.269**	0.196**	0.043^{ns}	4.23**	9.10**
P11	242.778^{ns}	54.329**	52.489**	0.366**	1.476**	0.187**	0.025^{ns}	4.34**	14.33**

Table 5. Estimates of the specific combining ability (SCA) effects of the ten crosses for the investigated traits

	Yield and its component				Fruit characters			Plant Characters	
Source of Variation	**Total yield/ Plant (g)**	**Early yield/ plant (g)**	**No. of fruits/ plant**	**Fruit weight (g)**	**Fruit length (cm)**	**Fruit diameter (cm)**	**Fruit wall thickness (cm)**	**No. of days to flowering**	**Plant height (cm)**
P4xP5	259.68^{ns}	45.650^{ns}	56.160^{ns}	1.795**	2.875**	0.316**	0.017^{ns}	12.15**	22.87**
P4xP7	524.60 ^{ns}	195.103**	94.320**	1.637**	1.768**	0.542**	-0.002^{ns}	10.20**	17.52**
P4xP8	85.94^{ns}	-43.800^{ns}	9.763^{ns}	2.499**	1.965**	0.584**	0.087^{ns}	10.58**	33.02 **
P4xP11	19.09^{ns}	-37.942^{ns}	12.335^{ns}	1.475**	1.718**	0.503**	-0.021^{ns}	10.41**	27.45**
P5xP7	469.35^{ns}	52.636**	113.519**	1.090**	2.488**	0.466**	-0.029**	13.27**	25.10**
P5xP8	1089.03**	62.169**	180.249**	0.979**	4.205**	0.338**	0.064**	14.25**	22.94**
P5xP11	1570.89 **	205.744**	321.731**	1.775**	2.582**	0.334**	0.071^{ns}	11.30**	43.37**
P7xP8	571.43 ns	-23.228*	-9.560^{ns}	7.827**	2.414**	0.644**	0.074*	07.62**	14.92**
P7xP11	1199.49**	230.781**	191.678**	1.793**	2.541**	0.693**	0.103**	08.65**	25.35**
P8xP11	-5.18^{ns}	315.722**	-24.114^{ns}	3.039**	5.585**	0.542**	0.079**	12.64**	20.19**

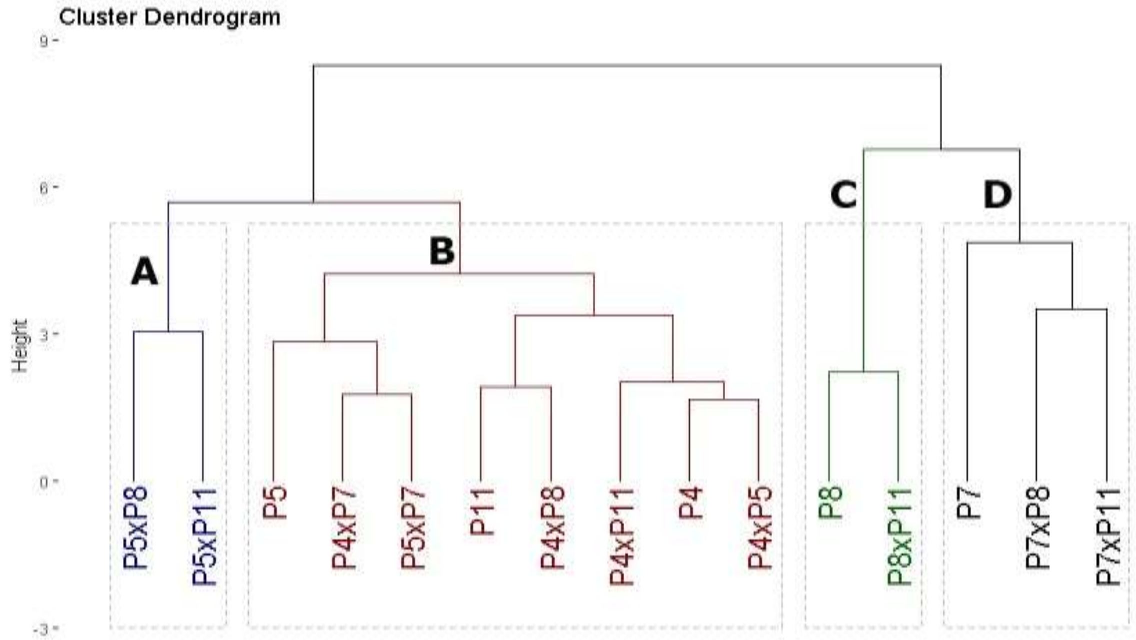

Fig. 2. Dendrogram of phylogenic distance among 15 genotypes (5 parents and 10 F1 hybrids) based on yield components, fruit characters, number of days to flowering and plant height

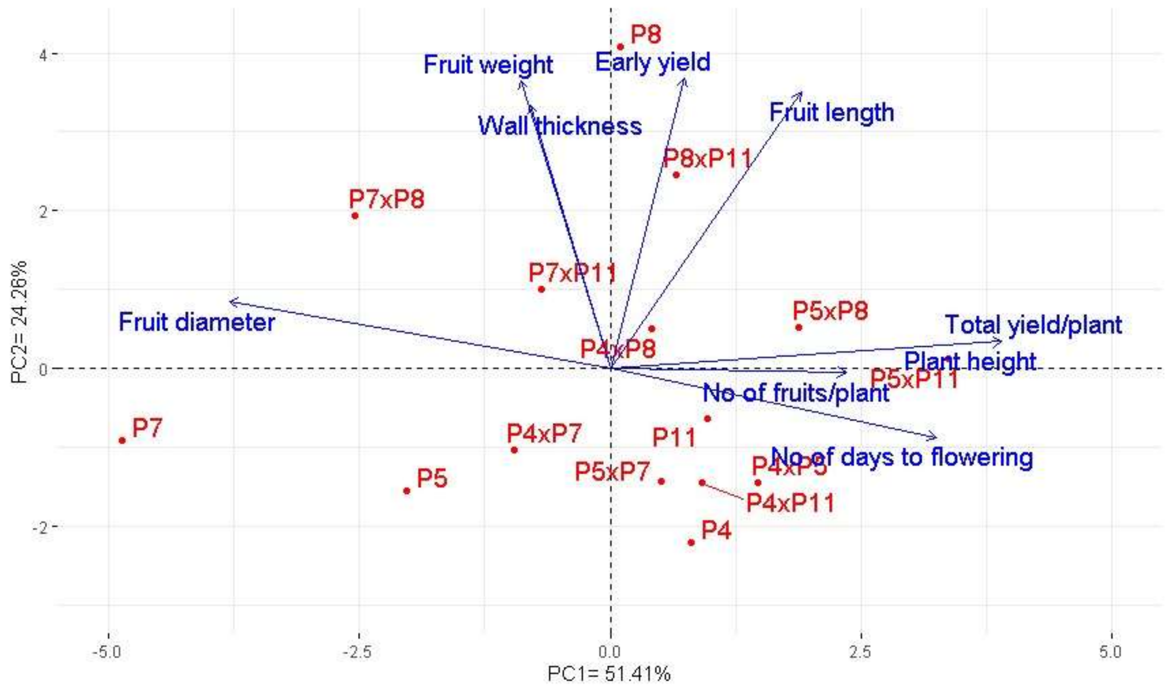

Fig. 3.Biplot of pepper genotypes (Parents and hybrids) and evaluated characters

traits characterized by parallel or adjacent vectors present strong positive relationships. Whereas, vectors that are positioned closely opposite (at 180°) exhibit highly negative relationships. The evaluated traits can be divided into three groups. The first group included pepper fruit characters (weight, fruit diameter and fruit wall thickness). The second group comprised early yield, total yield, plant height and fruit length. The third group contained number of fruits per plant and number of days to flowering. The PC2 was observed to be associated with the parental genotypes and their crosses. It divided the genotypes into positive and negative sides of PC2, indicating that genotypes on the positive side exhibited high yield and quality performance, particularly P8, P8×P11, P7×P8, and P7×P11. Conversely, those on the negative side of PC2 demonstrated lower performance, especially P4, P5, P7, P5×P7, and P4×P5. Additionally, the heatmap and hierarchical clustering based on the evaluated yield and quality traits divided the evaluated parental genotypes and crosses into distinct clusters (Fig. 3). Genotypes such as P8 and its cross P8×P11, along with P7×P11 and P7×P8, exhibited superior values for most yield and quality traits (indicated in blue), whereas parental genotypes P7, P5, and P4 exhibited comparatively lower values (highlighted in red).

DISCUSSION

From the analysis of 5×5 diallelcrossing system in chili pepper for generating useful information on general and specific combining ability, heritability and gene action for the important traits in chili including fruit characters, yield and its components. This could help in the selection process in breeding programs under Egyptian conditions

According to the current study analysis of variance showed highly significant differences among growth characters, fruit characteristics, yield and its components. Furthermore, the obtained results showed genetic variability among the used parental line which is considered an important factor suggesting that these parental lines can be used for improving yield, earliness, plant growth and fruit quality of chili. Similar findings were obtained by **Sreenivas *et al.*(2020), Verma *et al.*(2022) and Ajjappalavara (2023)** who found significant differences among parents and hybrids for 9 out of 16 traits. Furthermore, they reported that the significant effect of genotype was found for most of the traits in all parents. That's may be due to using diverse genotypes from different sources creates genetically strong hybrids (**Szwarc *et al.*, 2022**). If some hybrid genotypes are fitter than one or both parents, at least in some environments, then hybridization could make a positive contribution (**De Oliveira *et al.*, 2023**).

In the present investigation for all evaluated traits the variance due to specific combining ability was greater than the general combining ability which explain the importance of non-additive gene action in the inheritance of all studied characters. It also reveals the importance of non-additive gene actions in selecting superior genotypes through chili breeding programs at the later generations (**Rani *et al.*, 2023**). That's maybe due to all of these characters are qualitative traits (**Díaz-Valenzuela *et al.*, 2023**). In agree with the current research work (**Thilak *et al.*, 2019**) revealed that parents and crosses differed significantly for general and specific combining ability effects. The relative magnitude of SCA variances was higher than the GCA variance, indicates the role of non-additive gene action component in the expression of all the traits.

According to the main performance of all studied characteristics, the results of the current research the parent (P-8) was the superior for total yield, early yield, number of fruits per plants, fruit weight and fruit wall thickness. For crosses the cross (P5×P11) showed the highest yield amount followed by (P5×P8) and (P7×P11). In agree with the mean performance, the genotypic classification showed that the crosses (P5×P8) and (P5×P11) showed the best overall performance among all crosses. It means that these three crosses with high performance and the parents formed the best combiners (**Ajjappalavara, 2023**).

GCA values showed that the best combiner was P8 among all tested traits. Furthermore, P5 and P8 were better for yield improvement, P8 and P11 were better for improving earliness and average fruit weight, P5 and 11 were the best to improve number of fruits per plant and all parental genotypes were good to improve fruit length and fruit diameter characters. Hence, these genotypes can be further used in developing segregating populations of chili (hot pepper) breeding programs especially P5, P8, P11 and P7 under Egyptian conditions. On the other hand, the ability of improving fruit wall thickness through the current breeding program was moderate. That's maybe due to the selection of the prenatal genotypes was depending on the characters of yield, earliness, and fruit characters(**Rathva *et al.*,; Bayati *et al.*, 2022**). In accordance with the current investigation (**Thilak *et al.*, 2019**) reported that the parents were found to be the best general combiner. In addition, two crosses were the best specific crosses for green fruit yield and its contributing traits. That's mean these superior GCA genotypes in the current results can be further utilized commercially in crop breeding programs for the improvement of yield characters in chili (**Verma *et al.*, 2022**).

Concerning estimated SCA, the current study indicated the prevalence of the non-additive effect for all determined traits. That's because all of the recorded traits are quantitative traits and don't show dominance and recessive action (**Srivastava *et al.*, 2019; Lopez-Moreno *et al.*, 2023**). In addition, in the current experiment three crosses (P5×P8, P5×P11 and P7×P11) showed high specific combining ability which considered very consistent for yield and its component improvement. The current results also clarified that all types of GCA effects can be resulted in high SCA effects. The cross combinations participated in at least one f the good general combiner parent. Different crosses registered desirable SCA effects when studied by other authors (**Chakrabarty *et al.*, 2019; Sahid *et al.*, 2020; Jawarkar *et al.*, 2023; Lata *et al.*, 2023; Rodríguez-Llanes *et al.*, 2023**).

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تقدير القدرة على التآلف لتراكيب وراثية متنوعة من الفلفل الحريف لتحسين إنتاجية وجودة وتأقلم الهجن تحت الظروف المصرية

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يمثل تطوير تراكيب وراثية للفلفل الحريف متأقلمة مع الظروف المصرية بإنتاجية وجودة عالية أهمية بالغة تحت ظروف النمو السكاني والتغيرات المناخية، لذلك فإن هذه الدراسة هدفت لاختبار القدرة العامة والخاصة علي التآلف لصفات المحصول والجودة، تطوير هجن متأقلمة مع الظروف المصرية ذات إنتاجية وجودة عالية، والتعرف علي طبيعة الفعل الجيني المتحكم في هذه الصفات في الفلفل الحريف. أجريت هذه الدراسة في مزرعة خاصة بمحافظة الدقهلية – مصر، خلال موسمي خريف 2021 و2022 لدراسة القدرة علي التآلف والأداء الذاتي لبعض صفات الفلفل الحريف باستخدام نظام التهجين داي أليل 5×5 (بدون الهجن العكسية)، أستخدم خمسة أباء مختلفة التراكيب الوراثية لهذه الدراسة هي: P_4, P_5, P_7, P_8 and P_{11}. عكست نتائج هذه الدراسة التباين المعنوي المرتفع بين التراكيب الوراثية الأبوية المختبرة والهجن في كل صفات هذه الدراسة،ان أفضل التوليفات بناءً علي القدرة العامة علي التآلف لمعظم الصفات كانتP_8، حيث أنها سجلت معنوية موجبة لقيم القدرة العامة علي التآلف لكل الصفات تحت الدراسة عدا صفات عدد الثمار لكل نبات وسمك جدار الثمرة أظهرت تأثير معنوي متوسط للقدرة العامة علي التآلف. علاوة علي ذلك، كل التراكيب الوراثية الأبوية المقيمة كانت جيدة في تحسين صفتي طول وقطر الثمرة. أظهرت النتائج دوراً للفعل الجيني غير المضيف للنسل لصفة المحصول الكلي.العلاقة ما بين الصفات المدروسة يمكن أن تمدنا بمعلومات مفيدة للتعرف علي التراكيب الوراثية للفلفل وبرامج التربية للفلفل.

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