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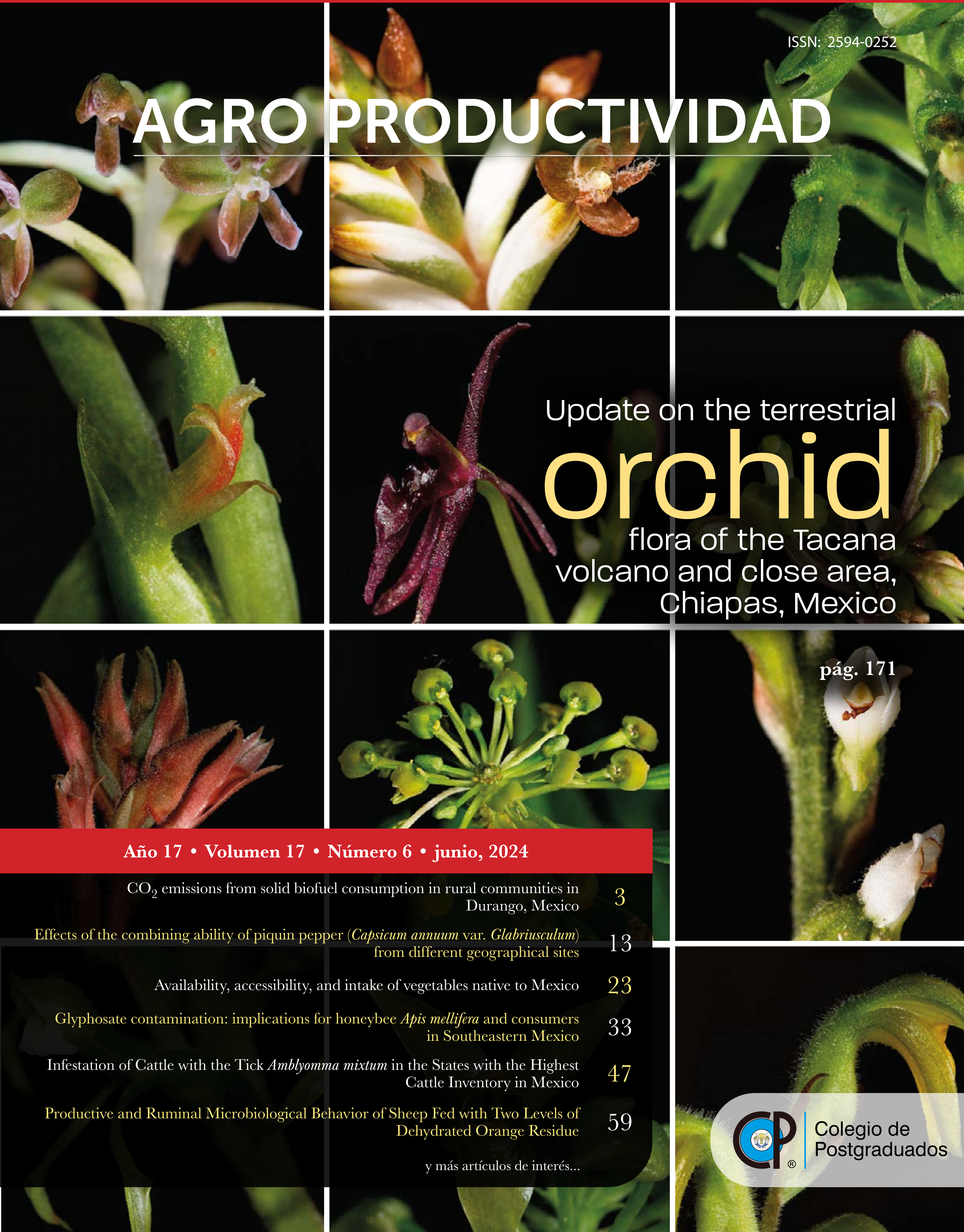

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Effects of the combining ability of piquin pepper (*Capsicum annuum* var. *Glabriusculum*) from different geographical sites

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ABSTRACT
Objective: To evaluate the effects of the general combining ability (GCA) and the specific combining ability (SCA) on the agronomic variables of piquin pepper (*Capsicum annuum* var. *Glabriusculum*) genotypes.
Methodology: A total of 36 F1 and nine parental crosses were used as plant material. The genotypes were distributed in a completely randomized block design with three replications. Ten agronomic variables were evaluated.
Results: Differences ($P \leq 0.01$) were found in all the evaluated variables, both in the genotypes and in GCA and SCA. Additive gene action influenced heritability, where following variables stood out: days to harvest (DTH), chlorophyll (CHL), plant height (PH), average fruit weight (AFW), fruit equatorial diameter (FED), and fruit polar diameter (FPD). One the one hand, genotypes G6 and G7 recorded the highest positive yield values for GCA, with 143.96 and 66.97 kg ha^{-1}, respectively. On the other hand, 58% of the SCA crosses obtained favorable yield results. Meanwhile, the highest positive values were obtained by the G6×G7, G8×G9, G5×G9, G3×G4, G4×G8, and G1×G8 crosses, which recorded 427.1, 190.5, 167.4, 146.8, 129.7, and 125.7 kg ha^{-1}, respectively.
Conclusions: According to the effects of GCA and SCA on the agronomic variables of piquin pepper, the genotypes G6 and G7 can be used to develop varieties, while the G6×G7, G8×G9, and G5×G9 crosses are recommended for hybrid formation within breeding programs.

Keywords: Diallelic, genetic variance, yield, GCA, SCA.

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INTRODUCTION

Genus *Capsicum* is grown all over the world. In the Americas, it can be found from the southern USA to Peru and northern Brazil (Perry *et al.*, 2007). It consists of approximately 38 species, of which, six species are the most widely cultivated: *C. annuum*, *C. frutescens*, *C. chinense*, *C. baccatum*, *C. pubescens*, and *C. assamicum* (Ramchiary and Kole, 2019). Mexico is the main center of domestication and diversification of the *Capsicum annuum*

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species (Aguilar-Melendez *et al.*, 2009; Pickersgill, 2007). Its ancestor, *Capsicum annuum* var. *Glabriusculum* —commonly known as piquin pepper, chiltepín, quipín, timpinchile, mountain pepper, and wild pepper— is distributed throughout the country (Medina-Martínez *et al.*, 2010). The piquin pepper is a wild perennial shrub that develops under the shade of trees. It is a highly valuable phytogenetic resource of importance for the economy of rural households. As a result of its pungency and flavor, the price of piquin pepper is 40 times higher than serrano or jalapeño chillis. Piquin pepper is an important ingredient of Mexican cuisine (Alcalá-Rico *et al.*, 2019; González-Cortés *et al.*, 2015; Pedraza and Omez, 2008). Currently, the domestication and establishment of this species as a commercial crop has been the subject of some interest (Alcalá-Rico *et al.*, 2019). Genetic improvement is an alternative for its domestication and production increase. Consequently, determining the actions and the expression of its characteristics is fundamental. Genetic improvement of the desirable characteristics of a species depends on nature —the genetic variability of the interactions involved in the inheritance of characteristics, which can be estimated using diallel crosses (Zeinab and Helal, 2014). In this regard, diallelic analysis has been used as a tool to explore genetic effects (Huang *et al.*, 2015; Mendoza *et al.*, 2021). The general combining ability (GCA) is the average behavior of a genotype in hybrid combinations, while the specific combining ability (SCA) is the deviation of each cross on the average behavior of the parents involved in the crosses (Sprague and Tatum, 1942). As a result of the lack of information about the genetic effects of GCA and SCA on piquin pepper, the objective of this study was to determine the effects of the general combining ability (GCA) and the specific combining ability (SCA) on the agronomic variables of piquin pepper (*Capsicum annuum* var. *Glabriusculum*) genotypes.

MATERIALS AND METHODS

Location of the experimental site

The crosses and self-pollination of the genotypes of piquin pepper were carried out in the greenhouse of the plant breeding department of the Universidad Autónoma Agraria Antonio Narro. The evaluation of the F1 and the parental crosses was carried out under a 30% shade mesh, in the Forest Department of the said university, located at coordinates 25° 21’ 12” N and 101° 01’ 51” W, with an altitude of 1,779 m.a.s.l. According to the Köppen-Geiger climate classification, the climate of the area is temperate warm (Cfb), with a mean temperature of 16.4 °C and an average precipitation of 610 mm.

Plant material

Nine genotypes from different states: three from Nuevo León, two from Tamaulipas, two from Veracruz, one from Coahuila, and one from San Luis Potosí, Mexico, were used in the experiment. Genotypes were provided by the Las Huastecas experimental field of INIFAP (Table 1).

Pre-germination treatment and sowing

Before the sowing, the seeds were immersed in 5,000 mg kg^{-1} of gibberellic acid for 24 h, at room temperature. The aim was to break their physiological dormancy (Alcalá-

Table 1. Identification of the parental genotypes that were involved in the diallel crosses.

ID	Location	Municipality	State	Group
G1	Estación Álamo	Villaldama	N.L.	Piquin
G2	Ej. Potrero de Zamora	Aramberri	N.L.	Piquin
G3	Ej. Lázaro Cárdenas	Burgos	Tam.	Piquin
G4	Barranco Azul	San Carlos	Tam.	Piquin
G5	Castaños	Castaños	Coah.	Piquin
G6	Colatlán	IXMA	Ver.	PIHU
G7	Tiopancahuatl	IXMA	Ver.	PIHU
G8	Los Rincón	Linares	N.L.	Piquin
G9	La Labor	Rioverde	S.L.P.	Piquin

N.L.: Nuevo León, Tam.: Tamaulipas, Coah.: Coahuila, Ver.: Veracruz, S.L.P.: San Luis Potosí, IXMA: Ixhuatlán de Madero, PIHU: Piquin Huasteco.

Rico *et al.*, 2019). Afterwards, two seeds were sown per cavity in the greenhouse, using 200-cavities polystyrene trays. Peat moss was used as substrate. Subsequently, the trays were piled-up and covered with black plastic to provide favorable conditions for the seeds and to speed up the germination process. When the apex of the seedlings emerged, the trays were separated and distributed all around the greenhouse. Two months after the sowing, the seedlings were transplanted to 30×30 polystyrene bags; vermicompost was used as substrate.

Parental crosses

Direct crosses and self-pollination of the parents were carried out during the flowering phenological stage, using Griffing's experimental method II (Griffing, 1956). In order to guarantee an effective cross or self-pollination, the pollinated flowers were covered and labelled. The seeds obtained from the F1, and the parentals were extracted from the ripe fruits. Subsequently, the seeds were sown using the same methodology mentioned in the section pre-germinative treatment and sowing. Subsequently, F1 and parental seedlings were placed on 1 m high metal structures to facilitate evaluation and agronomic management.

Experimental design

The F1 and parental crosses were distributed using a completely randomized block design, with three replicates. The useful plot had four plants per replication. There was a 0.5 m separation between plants, 0.9 m between rows, and 1.0 m between alleys.

Evaluated variables

Ten variables were evaluated: days to flowering (DTF), days to harvest (DTH), chlorophyll (CHL; SPAD units), plant height (PH; cm), production per plant (PPP; g), fruits harvested per plant (FHPP), average fruit weight (AFW; g), fruit equatorial diameter (FED; mm), fruit polar diameter (FPD; mm), and yield (YIE; kg ha^{-1}).

Analysis

The analysis of variance and the genetic effects of the general combining ability (GCA) and the specific combining ability (SCA) were performed according to the Griffing's experimental method II, model 1, using the DIALLEL-SAS05 computational routine, proposed by Zhang *et al.* (2005) with the SAS software version 9.4. The components of the genetic variance and the heritability were estimated using an expected mean square.

RESULTS AND DISCUSSION

Table 2 shows the effects of the combining ability obtained from the mean squares of the analysis of variance. The sources of variation of the genotypes, GCA and SCA recorded highly significant differences ($P \leq 0.01$) for the 10 variables. These results indicate that the expression of the characteristics of the piquin pepper genotypes is influenced by both the additive and non-additive effects, providing a different ability to pass on its characteristics to its descendants, in addition to presenting a diverse performance in specific hybrid combinations. These results match the findings of Sing *et al.* (2014), who determined that both the additive and non-additive variances were fundamental to control the expression of the characteristics of *Capsicum annuum* L. crosses.

In a genetic improvement program, the GCA and SCA variances enable the deduction of the type of the gene action and the importance of the expression of the characteristics (Rohini *et al.*, 2017). Table 3 shows that the CHL, PH, FED, and FPD variables recorded a higher GCA than SCA variance. Meanwhile, the rest of the variables recorded opposite results —SCA obtained the highest values. Rohini *et al.* (2017) pointed out that the characteristics with the highest SCA variations are controlled by the non-additive genes action. In addition, the GCA:SCA ratio recorded <1 values with a lower GCA variance and a higher SCA variance. When the values are >1, the results are the opposite. The variables

Table 2. Mean squares of the analysis of variance of diallel crosses, using Griffing's experimental method II.

SV	Rep	Genotype	GCA	SCA	Error	R^2
DF	2	44	8	36	88	
DTF	20.99	152.41 **	88.16 **	42.50 **	2.27	0.92
DTH	306.90 *	378.25 **	378.82 **	69.92 **	22.49	0.74
CHL	11.10 *	99.28 **	165.95 **	3.57 **	0.93	0.95
PH	94.61	1581.13 **	2600.12 **	66.36 **	19.18	0.93
PPP	25.83	161.71 **	107.80 **	41.93 **	9.64	0.74
FHPP	2278.10	4645.00 **	3098.74 **	1203.81 **	436.96	0.64
AFW	0.31 **	0.09 **	0.09 **	0.02 **	0.01	0.73
FED	0.48 **	0.63 **	0.95 **	0.04 **	0.02	0.88
FPD	0.31	10.95 **	19.21 **	0.19 **	0.05	0.97
YIE	12726.0	79693.0 **	53119.0 **	20663.0 **	4752.0	0.74

*, ** Significant at the ≤0.05 and ≤0.0.1 probability levels; SV: source of variation; Rep: repetition; GCA: general combining ability; SCA: specific combining ability; R^2: coefficient of determination; DF: degrees of freedom; DTF: days to flowering; DTH : days to harvest; CHL: chlorophyl; PH: plant height; PPP: production per plant; FHPP: fruits harvested per plant, AFW: average fruit weight; FED: fruit equatorial diameter; FPD: fruit polar diameter; YIE: yield.

that stood out in the additive variance included: DTH, CHL, PH, AFW, FED, and FPD. These results indicated that these characteristics can be inherited to the descendants. The dominance variance was related to the DTF, PPP, FHPP, and YIE variables. At the same time, this variance is associated with the dominance degree, registering the highest values in the same variables. Regarding the narrow-sense heritability estimations, the results fluctuated between 0.28 (DTF) and 0.96 (FPD). In addition, heritability was classified as high (>50%), medium (30-50%), and low (<30%) (Bhateria *et al.*, 2006). In this regard, 60% of the variables showed a high heritability, while 40% recorded a low to medium heritability. Additionally, the additive gene action influenced heritability. The information about these components of the variance is fundamental to determine the appropriate focus for the genetic improvement of the crop (Meena *et al.*, 2020).

Table 4 includes specific GCA data. Genotypes G6 and G7 recorded the highest positive and significant ($P \leq 0.01$) yield values, contributing 143.96 and 66.97 kg ha^{-1} above the mean for the different combinations. These genotypes likewise recorded the highest positive and significant values ($P \leq 0.01$) for the following variables: CHL (6.81 and 6.32 units SPAD), PH (32.09 and 12.24 cm), PPP (6.49 and 3.02 g), AFW (0.08 and 0.13 g), and FPD (2.04 and 2.41 mm). However, FED recorded significant negative values ($P \leq 0.01$), showing a 0.48 mm reduction in the different crosses.

Meanwhile, genotypes G1, G2, G5 and G9 recorded negative yield values with different levels of significance ($P \leq 0.05$ or 0.01) contributing a reduction of 39.76 - 81 kg ha^{-1} in combination with other genotypes. Likewise, these genotypes presented different negative values for CHL (1.56 - 3.19 SPAD), PPP (1.79 - 3.65 g) and FPD (0.28 - 1.21 mm).

On the other hand, genotypes G3, G4, and G8 showed no yield significance. Although genotype G3 recorded significantly negative ($P \leq 0.01$) for DTF (1.19 days), PH (14.47 cm), and FPD (0.48 mm) values. However, it also it obtained significantly positive ($P \leq 0.01$) FED (0.21 mm) values. With respect to the G4 genotype, showed significantly negative

Table 3. Variance and heritability components of the agronomic variables of piquin pepper.

Variables	σ^2_{GCA}	σ^2_{SCA}	GCA/SCA	σ^2_{A}	σ^2_{D}	ADD	h^2
DTF	7.81	40.23	0.19	15.61	40.23	2.27	0.28
DTH	32.39	47.43	0.68	64.79	47.43	1.21	0.54
CHL	15	2.64	5.69	30	2.64	0.42	0.91
PH	234.63	47.18	4.97	469.26	47.18	0.45	0.9
PPP	8.92	32.28	0.28	17.85	32.28	1.9	0.33
FHPP	241.98	766.85	0.32	483.96	766.85	1.78	0.35
AFW	0.01	0.01	0.76	0.02	0.01	1.15	0.56
FED	0.08	0.03	2.95	0.17	0.03	0.58	0.83
FPD	1.74	0.14	12.14	3.48	0.14	0.29	0.96
YIE	4397.01	15911.15	0.28	8794.02	15911.15	1.9	0.33

σ^2: variance; GCA: general combining ability; SCA: specific combining ability; A: additive; D: dominance; ADD: average degree of dominance; h^2: narrow-sense heritability; DTF: days to flowering; DTH: days to harvest; CHL: chlorophyll; PH: plant height; PPP: production per plant; FHPP: fruits harvested per plant; AFW: average fruit weight; FED: fruit equatorial diameter; FPD: fruit polar diameter; YIE: yield.

(P≤0.05) DTF (0.97 days) values and significantly negative (P≤0.01) CHL (1.29 SPAD) and PH (15.68 cm) values. In addition, it recorded significantly positive (P≤0.01) FED (0.22 mm) values. Finally, genotype G8 obtained significantly positive (P≤0.01) DTF (3.72 days), PH (5.64 cm), and FED (0.12 mm) values. Although it recorded significantly negative (P≤0.01) CHL (2.34 SPAD) and FPD (0.63 mm) values. Therefore, the genotypes have a different capacity to inherit their characteristics to their descendants. In this regard, determining the combination capacity of the genotypes that will be included in any genetic improvement program is fundamental for the effective transfer of desirable genes to the resulting progeny (Singh *et al.*, 2014).

Regarding the effects of the specific combing ability (Table 5), 58% of the crosses recorded favorable yield results (*i.e.*, positive values). In addition, the highest significantly positive (P≤0.01) values of this variables were obtained by the G6×G7, G8×G9, and G5×G9 crosses, which recorded 427.1, 190.5, and 167.4 kg ha^{-1}, respectively. Meanwhile, the G3×G4, G4×G8, and G1×G8 crosses also recorded significantly positive (P≤0.05) values, obtaining an increase of 146.8, 129.7, and 125.7 kg ha^{-1}, respectively. Fifty percent of these crosses recorded negative GCA values for both parents, 33.3% obtained positive GCA values, and 16.7% showed one parent with negative GCA values and one

Table 4. Effects of the general combining ability (GCA) of nine genotypes of piquin pepper from different geographical sites.

Genotype	DTF	DTH	CHL	PH	PPP
G1	2.78 **	5.42 **	−3.16 **	1.68	−3.65 **
G2	0.39	3.42 *	−1.56 **	−0.46	−1.79 *
G3	−1.19 **	−1.40	0.49	−14.47 **	0.40
G4	−0.97 *	1.69	−1.29 **	−15.68 **	0.77
G5	−1.58 *	−5.79 **	−2.09 **	−10.69 **	−1.98 *
G6	1.51 **	−0.34	6.81 **	32.09 **	6.49 **
G7	−5.82 **	−12.12 **	6.32 **	12.24 **	3.02 **
G8	3.72 **	2.63	−2.34 **	5.64 **	−1.02
G9	1.15 *	6.48 **	−3.19 **	−10.35 **	−2.24 *
Genotype	**FHPP**	**AFW**	**FED**	**FPD**	**YIE**
G1	−15.43 *	−0.10 **	0.08 *	−1.01 **	−81.00 **
G2	8.25	−0.17 **	−0.13 **	−1.21 **	−39.76 *
G3	3.68	0.04	0.21 **	−0.48 **	8.87
G4	−1.26	0.04	0.22 **	0.06	17.13
G5	−18.51 **	0.04	0.22 **	−0.28 **	−43.86 *
G6	35.80 **	0.08 **	−0.43 **	2.04 **	143.96 **
G7	7.33	0.13 **	−0.52 **	2.41 **	66.97 **
G8	−4.56	−0.04	0.12 **	−0.63 **	−22.54
G9	−15.30 *	−0.02	0.23 **	−0.89 **	−49.78 **

*, ** Significant at the ≤0.05 and ≤0.0.1 probability levels; DTF: days to flowering, DTH: days to harvest; CHL: chlorophyll; PH: plant height; PPP: production per plant; FHPP: fruits harvested per plant; AFW: average fruit weight; FED: fruit equatorial diameter; FPD: fruit polar diameter; YIE: yield.

Table 5. Effects of the specific combining ability (SCA) of 36 F1 crosses of piquin pepper.

Crosses	DTF	DTH	CHL	PH	PPP
G1×G2	2.85 *	0.39	3.18 **	−4.15	−0.37
G1×G3	4.76 *	2.87	0.79	4.28	3.66
G1×G4	−8.78 **	−7.22	0.03	−2.85	5.19
G1×G5	−5.18 **	−12.73 **	0.66	5.92	0.28
G1×G6	3.07	2.15	−2.13 *	−3.12	−5.95 *
G1×G7	−0.60	2.93	1.40	3.82	−1.15
G1×G8	2.52	0.51	−0.07	−0.58	5.66 *
G1×G9	−6.90 **	−9.01 *	1.03	−1.25	3.31
G2×G3	−1.51	−2.13	−0.13	−2.51	1.30
G2×G4	−0.72	2.78	0.82	−1.47	5.43
G2×G5	0.88	8.27	0.51	3.34	4.91
G2×G6	−4.87 **	6.81	−1.14	1.35	−7.60 **
G2×G7	−4.87 **	−9.07 *	−0.09	14.95 **	−3.92
G2×G8	−1.75	−1.49	2.51 **	2.31	0.32
G2×G9	−6.51 **	0.99	2.10 *	−4.79	3.44
G3×G4	−2.81 *	−0.40	−0.08	−0.95	6.61 *
G3×G5	−8.21 **	−17.25 **	1.01	1.73	1.59
G3×G6	−6.96 **	−16.04 **	−1.15	−10.31 *	−4.12
G3×G7	−3.30 *	−4.25	0.65	6.88	0.85
G3×G8	0.16	−0.34	0.84	5.48	1.30
G3×G9	5.07 **	−0.52	1.20	−2.44	4.64
G4×G5	2.25	1.66	0.38	−2.44	2.69
G4×G6	−1.51	−2.13	−0.32	−2.01	−3.38
G4×G7	−4.18 **	−7.34	1.27	6.01	−7.11 *
G4×G8	−3.72 **	−3.10	1.56	−6.14	5.84 *
G4×G9	0.19	−2.61	−0.07	4.02	−1.01
G5×G6	−4.90 **	−9.31 *	2.65 **	−8.83 *	−3.11
G5×G7	−4.24 **	−2.19	2.10 *	−2.31	−3.20
G5×G8	−0.12	0.05	0.00	0.01	2.79
G5×G9	−0.87	−2.13	1.73	7.20	7.54 **
G6×G7	4.34 **	1.69	−0.82	−13.43 **	19.24 **
G6×G8	−5.21 **	3.60	−0.57	26.84 **	−5.30
G6×G9	−6.63 **	0.75	−1.03	7.25	−6.67 *
G7×G8	−6.21 *	−8.28	0.18	3.20	−6.55 *
G7×G9	−6.96 **	−0.46	−0.27	8.69 *	−7.19 *
G8×G9	−0.84	−2.22	0.63	−0.71	8.58 **
Crosses	**FHPP**	**AFW**	**FED**	**FPD**	**YIE**
G1×G2	−5.30	0.02	−0.03	0.01	−8.26
G1×G3	21.96	0.04	0.05	0.02	81.34

Table 1. continues...

Crosses	FHPP	AFW	FED	FPD	YIE
G1×G4	17.16	0.17 *	0.13	0.36	115.08
G1×G5	−1.18	0.07	0.14	0.70 **	6.24
G1×G6	−25.49	−0.03	0.02	−0.26	−132.00 *
G1×G7	11.65	−0.13	0.01	−0.59 **	−25.60
G1×G8	31.20	0.12	0.23	0.45 *	125.70 *
G1×G9	20.03	0.10	0.12	0.49 *	73.39
G2×G3	10.28	−0.05	−0.20	−0.05	28.82
G2×G4	50.40 *	0.01	−0.13	0.01	120.65
G2×G5	38.84 *	−0.03	0.03	0.06	108.90
G2×G6	−50.91 **	0.01	0.00	−0.03	−168.79 **
G2×G7	−30.11	0.01	0.06	0.03	−87.00
G2×G8	0.02	0.00	0.16	−0.09	7.13
G2×G9	29.85	−0.01	0.00	0.10	76.37
G3×G4	36.38	0.12	0.31 *	0.60 **	146.76 *
G3×G5	−3.96	0.20 *	0.20	0.36	35.33
G3×G6	−42.01 *	0.14	0.25 *	0.30	−91.39
G3×G7	5.29	0.06	0.02	0.20	18.84
G3×G8	10.17	−0.02	−0.03	0.05	28.80
G3×G9	30.84	0.03	0.10	0.30	103.03
G4×G5	2.82	0.17	0.23	0.48 *	59.64
G4×G6	2.85	−0.14	−0.24	−0.50 *	−74.91
G4×G7	−38.84 *	−0.01	−0.23	0.07	−157.95 *
G4×G8	23.29	0.18 *	0.30 *	0.21	129.70 *
G4×G9	−34.55	−0.25 **	0.11	−0.01	−22.51
G5×G6	−14.82	0.04	−0.14	−0.03	−69.04
G5×G7	−5.69	−0.10	−0.16	−0.35	−71.06
G5×G8	0.00	0.00	−0.04	−0.02	61.89
G5×G9	37.86	0.16	0.44 **	0.49 *	167.42 **
G6×G7	79.35 **	0.15	0.20	0.80 **	427.10 **
G6×G8	−16.61	−0.13	−0.13	−0.15	−117.57
G6×G9	−33.94	−0.06	−0.14	−0.48 *	−148.05 *
G7×G8	−35.22	0.05	−0.11	−0.06	−145.48 *
G7×G9	−32.39	−0.09	−0.07	−0.58 **	−159.68
G8×G9	52.66 **	0.09	0.06	0.32	190.50 **

*, ** Significant at the ≤0.05 and ≤0.0.1 probability levels; DTF: days to flowering, DTH: days to harvest; CHL: chlorophyll; PH: plant height; PPP: production per plant; FHPP: fruits harvested per plant; AFW: average fruit weight; FED: fruit equatorial diameter; FPD: fruit polar diameter; YIE: yield.

with positive GCA values. The second and the third cases match the results of Escorcia-Gutiérrez *et al.* (2010), who pointed out that the SCA effect of a single cross will be high and positive if at least one parent records a high GCA. Nevertheless, these results indicate that the crosses of parents with high GCA values will not necessarily obtain high SCA results. This information matches the findings of Picón-Rico *et al.* (2018), who concluded that the SCA effect cannot be totally predicted using the GCA of the parents. In addition, these crosses recorded an average increase of PPP (8.91 g), FHPP (43.46 fruits), AFW (0.14 g), FED (0.26 mm), and FPD (0.48 mm). Consequently, the SCA effects involved a non-additive gene action of the expression of one of the characteristics of the progeny resulting from a specific cross.

Meanwhile, there were significant negative values in the crosses G2×G6 ($P \leq 0.01$), G4×G7 ($P \leq 0.05$), G6×G9 ($P \leq 0.05$), G7×G8 ($P \leq 0.05$) and G1×G6 ($P \leq 0.05$). Who had a reduction in yield from 132 to 168.8 kg ha^{-1}. In this regard, 80% of the crosses had one GCA-negative and one GCA-positive parent. In average, these crosses recorded a reduction of PPP (6.85 g), FHPP (36.13 fruits), AFW (0.02 g), FED (0.09 mm), and FPD (0.22 mm).

CONCLUSIONS

The effects of the general combining ability in piquin pepper indicated the average potential of the hybrid combinations of the parents, while the effects of the specific combining ability provided data about the specific crosses with favorable or unfavorable expressions regarding the parents. This information is useful to select the genotypes of piquin pepper and to include them in genetic improvement programs with the aim of developing varieties or hybrids. The G6 and G7 parents are recommended in the development of piquin pepper varieties, because they recorded the highest significantly positive GCA values. Meanwhile, the best crosses were G6×G7, G8×G9, and G5×G9, whose remarkable yield components can be used for the creation of hybrids.

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