Genetic Variability and Correlation Studies in Chilli (Capsicum annuum L.) UnderAgro-climatic Condition of Prayagraj.

India

Abstract

The present research, entitled "Genetic variability and correlation studies in chilli (*Capsicum annuum* L.) underthe agro-climatic condition of Prayagraj" was conducted at Vegetable Research Farm, Department of Horticulture, Naini Agriculture Institute, SHUATS, Prayagraj (Uttar Pradesh) from December 2022 to June 2023. Twelve genotypes were used to study the genetic variability and correlation for growth and yield contributing characters in chilli at sixteen different characters, viz., days taken to germinate, no. of branches plant^{-1}, leaf area, days to 1st flower initiation, days of 50% flowering, days of 1st harvesting, and number of pickings under growth parameters. Length of fruits(cm), diameter of fruits(mm), number of fruit plant^{-1}, average fruit weight(g), fruit yield plant^{-1}(g), and fruit yield hectare^{-1}(t) are under fruit yield parameters, and ascorbic acid(mg/100g), TSS(Brix^{0}) were studied under quality parameters.The highest fruit yield plant^{-1}(382.91g) and per hectare (12.76t) were recorded in the genotype F1-6106. The highest TSS content was recorded in genotype VNR-305 (9.73Brix^{0}) and the highest value for the ascorbic acid content was recorded in genotype F1-6106(196.49mg/100g). A high genotypic ~~coefficient of variation (GCV) and phenotypic coefficient of variation (PCV)were recorded for the fruitweight and fruit~~ variation (GCV) and phenotypic coefficient of variation (PCV) were recorded for the fruit weight and yield plant^{-1}. All the characters showed high heritability estimates.However, the number of fruits plant^{-1}, fruit yield plant^{-1},and fruit weight exhibited a high genetic advance as a percentage of the mean. Fruit yield plant^{-1} was positively and significantly correlated with plant height, number of fruits plant^{-1} and fruit length. It revealed that the characters, viz., plant height, fruit length, number of fruits plant^{-1}, fruit weight and fruit yield are the most important traits for the genetic improvement of chilli.

Key Words: Chilli, correlation, genetic variability, GCV, PCV, yield, TSS, ascorbic acid.

Introduction

Chilli (*Capsicum annuum* L.) shrubs are perennial and short-lived; they can develop up to1.5 m in height; their stems are woody at the base, fleshy, and either ~~erects~~ erector semi-prostrate, and the shrub comprises ~~of~~ a primary tap root with various lateral roots. The leaves can grow up to 12 cm long and 7.5 cm wide and ~~are changing in~~change shape with a pointed tip. Chilli flowers are independently or in small groups of two or three flowers. They're small and bisexual, with five to six petals each; the flowers of *Capsicum annuum* are white-green. Red ~~chillies~~ chiliesget their color from a coloring compound called capsanthin and have a hot, pungent taste due to a chemical called capsaicin~~, and the~~. The numerous small ~~chilli~~ chiliseeds moreover contain capsaicin. Chilli is ~~basically~~ cultivated for fruits which are utilized as vegetables in pharmaceutical as a stimulant and source of oleoresin (Samadia 2007).

Fruit yield ~~as well as quality improvement efforts~~, as well as quality improvement efforts, proceed to be the major aims of the chilli improvement program. Fruit yield is a complex inherited character influenced by a few properties of the plant. (Datta & Jana 2004) detailed that the efficiency of ~~chilli~~ chilican be increased by cultivating new genotypes. So, area-based screening for upgrading the productivity of this crop is an important step to expanding production. A wide range of variability is available in ~~chilli~~ chiligenotypes, which ~~provide~~ providesgreat scope for improving fruit yield through systematized breeding. An estimation of the genetic variability show in the germplasm of a crop is a pre-requisite for designing a successful breeding program (Parkash 2012).

In Uttar Pradesh, chillies are ~~basically~~ developed in the eastern districts, viz., Ballia, Azamgarh, Mirzapur, Basti, Faizabad, and Ghazipur. The larger part of cultivators ~~are~~is still developing local cultivars. Other than soil and climatic components, the cultivar itself is really important in regard of its performance with respect to earliness, disease resistance, and yield. Numerous cultivars have been developed and suggested by different research institutes and State Agricultural Universities, but the ~~adoptability~~ adaptabilityand yielding capacity of the cultivars aren't the same in all regions. So, there's a pressing demand for ~~a~~ anappropriate variety in Prayagraj agro-climatic conditions. Therefore, an attempt was made in the present research at the Department of Horticulture, SHUATS, Prayagraj, to assess the extent of genetic variability and correlation in 12 different genotypes of chillies for various compositional and yield properties for identifying predominant genotypes for involvement in coming breeding programs.

Materials and Method

A field trial was conducted from December 2022 to June 2023 at the Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) for the genetic variability and correlation studies in chilli under the agro climate conditions of Prayagraj. This research was carried out in a randomized block design (RBD) with 12 genotypes (released varieties and local collection) which were collected from diverse sources (Table 1).

Table1- List of chilli genotypes and their sources used in study

Notation	Genotypes	Sources
$\mathbf{V_1}$	KSP-1350	Kalash Seeds Pvt. Ltd
$\mathbf{V_2}$	KSP-1342	Kalash Seeds Pvt. Ltd
$\mathbf{V_3}$	Hybrid Eagle	AcsenHyVegPvt. Ltd
$\mathbf{V_4}$	VNR-305	VNR Seed Pvt. Ltd.
$\mathbf{V_5}$	Shravani 301	Pancha Ganga Seeds Pvt. Ltd.
$\mathbf{V_6}$	TMPH-484	TriMurti Plant Science Pvt. Ltd.
$\mathbf{V_7}$	TMPH-404	TriMurti Plant Science Pvt. Ltd.
$\mathbf{V_8}$	TMPH-407	TriMurti Plant Science Pvt. Ltd.
$\mathbf{V_9}$	TMPH-409	TriMurti Plant Science Pvt. Ltd.
$\mathbf{V_{10}}$	F1-Hybrid	Eco Green Hybrid Seeds Co.
$\mathbf{V_{11}}$	Pusa Jwala	IARI, NEW DELHI
$\mathbf{V_{12}}$	F1-6106	Eco Care Seeds

Result and Discussion

Significant differences were obtained among the genotypes for all the characters, showing satisfactory variability among all the genotypes. F1-6106 took ~~a~~ theleast number of days (37.4) to first flowering taken after by KSP-1350 (42.2), and the most extreme days by TMPH-409 (49.93); however, F1-6106 also took a least day to 50% flowering, taken after by Pusa Jwala (48.2), and greatest days by VNR-305 (53.35). F1-6106 took the least number of days (63.34) to the first harvest, taken after by KSP-1350 (65.47) and the greatest days (73.17) taken by VNR-305. The highest plant height was recorded (89.74cm) in F1-6106, taken after by Pusa Jwala (88.67 cm), and the lowest plant height was recorded (75.8 cm) in VNR-305. The most extreme number of branches was recorded (19.33) in F1-6106, ~~taken after~~followed by Pusa Jwala (18.07), and the least number of branches recorded was (9.53) in TMPH-484. F1-6106 appears the highest leaf area (29.74 cm^2), taken after by Pusa Jwala (29.37 cm^2), and the lowest leaf area ~~appeared~~ appearsby

VNR-305 (23.32 cm^2). The maximum number of fruit plant^{-1} was recorded (63.99) in F1-6106, taken after by Pusa Jwala (63.21) and the minimum number of fruit plant^{-1} (52.33) in VNR-305. The maximum fruit weight was recorded in F1-6106 (6.41 g), taken after by F1-hybrid (5.31 g), and the minimum fruit weight was recorded in VNR-305 (2.36g). The maximum fruit length was recorded in F1-6106 (10.31 cm), taken after by Pusa Jwala (9.98 cm) and the minimum fruit length ~~were~~ wasrecorded in VNR-305 (6.44 cm). The greatest fruit diameter was recorded in F1-6106 (11.00 mm), taken after by Pusa Jwala (10.33 mm) and the least fruit diameter was recorded in VNR-305 (5.83 mm). The highest fruit yield plant^{-1} (g) was recorded in F1-6106 (382.91 g), taken after by Pusa Jwala (332.14 g), and the least fruit yield plant^{-1} was recorded (145.32 g) in VNR-305. The highest fruit yield ha^{-1} (t) was recorded in F1-6106 (12.76 t), taken after by Pusa Jwala (11.07 t), and the least fruit yield plant^{-1} was recorded (4.84 t) in TMPH-404. The highest TSS content was recorded in VNR-305 (9.73^0), Taken after by hybrid eagle (9.63^0), and the ~~least~~ lowestTSS content was recorded (6.07^0) in F1-6106. The highest ascorbic acid (mg/100g) content was recorded in F1-6106 (196.46mg/100g), taken after by VNR-305 (187.63mg/100g), and the lowest ascorbic acid content was recorded (105.56mg/100g) in hybrid eagle (Table 2 and Table 3). Prior Deb *et al.* (2008) and Warshamana*et al*. (2008) moreover detailed comparable results whereas working on chilli genotypes.

Table2- Mean performance of chilli genotypes for growth and earliness parameters

Genotypes	Plant height (cm)	Number of branches	Leaf area (cm^2)	Days taken to first flowering	Days taken to 50% of flowering	Days to first harvest
V1	79	16.53	24.43	42.2	49.56	65.47
V2	83.54	14.27	25.67	43.73	48.53	69.87
V3	76.2	12.26	24.67	44.2	48.94	70.33
V4	75.8	11.0	23.32	48.8	53.35	73.17
V5	82.64	13.8	25.54	46.87	50.67	70.67
V6	76.9	9.53	27.6	42.73	51.1	70.04
V7	83.6	12.0	26.57	48.44	52.6	70.4
V8	82.94	17.0	27.64	47.37	51.27	70.63
V9	80.8	13.6	27.77	49.93	50.37	72.4
V10	85.14	13.07	25.04	42.8	49.8	70.93
V11	88.67	18.07	29.37	43.13	48.2	69.4
V12	89.74	19.33	29.74	37.4	42.47	63.34
S.Ed(±)	**5.78**	**2.09**	**2.09**	**0.41**	**0.73**	**1.87**
CV	**8.63**	**17.98**	**9.72**	**1.12**	**1.80**	**3.29**
$CD_{0.05}$	**1.97**	**4.33**	**4.35**	**0.85**	**1.52**	**3.89**

Table3- Mean performance of chilli genotypes for quality and yield parameters

Genotypes	Number of fruit plant^{-1}	Average fruit weight (g)	Average fruit length (cm)	Average fruit diameter (mm)	Fruit yield plant^{-1} (g)	Fruit yield ha^{-1} (t)	TSS (Brix^0)	Ascorbic acid (mg/100g)
V1	59.18	4.47	7.69	9.27	235.19	7.83	6.47	132.1
V2	59.29	4.69	7.38	9.93	250.25	8.34	7.16	135.3
V3	55.4	4.23	7.12	7.01	250.41	8.65	9.63	105.56
V4	52.33	2.36	6.44	5.83	145.62	4.85	9.73	187.63
V5	59.4	3.35	7.94	7.31	209.91	6.99	7.66	126.8
V6	59.19	2.64	6.75	7.24	183.50	6.16	9.63	149.4
V7	52.82	2.43	7.35	7.65	146.05	4.84	6.47	166.6
V8	59.51	2.38	6.99	6.46	149.85	4.91	9.4	186.53
V9	53.56	2.62	7.03	6.12	154.74	5.84	7.7	193
V10	59.58	5.31	8.29	9.44	327.31	10.90	9.6	186.23
V11	63.21	5.11	9.98	10.33	332.14	11.07	7.5	185.3

V12	63.99	6.41	10.31	11.00	382.91	12.76	6.07	196.46
S.Ed(±)	**2.73**	**0.55**	**0.12**	**0.45**	**30.37**	**3.22**	**0.23**	**0.72**
CV	**5.75**	**17.47**	**1.94**	**6.77**	**16.11**	**17.56**	**3.34**	**0.57**
$CD_{0.05}$	**5.66**	**1.13**	**0.26**	**0.93**	**62.98**	**6.69**	**0.46**	**1.49**

The extent of variability ~~show~~ shownin 12 genotypes of chilli was measured in terms of range, mean, PCV, GCV, heritability, and genetic advance (Table 4). All the genotypes differed significantly ~~with regard to~~about the distinctive characters examined. A wide range of variation was observed in all the characters. Munshi &Behra (2000), Warshamana*et al.* (2008), and Gupta *et al.* (2009) moreover detailed a wide range of variation for most extreme of the characters. The genotypic coefficient of variance (GCV) and phenotypic coefficient of variance (PCV) were high for fruit weight (36.40 g and 36.44 g) taken after by fruit yield plant^{-1} (31.95 g and 41.67 g), and fruit diameter (21.82 mm and 21.80 mm), appearing great differences for these traits. GCV in common, was lower than the PCV (Table 4), which shown a close affiliation between phenotype and genotype. These results are in agreement with those detailed by Munshi &Behra (2000), Singh *et al.* (2005), and Gupta *et al.* (2009). Low genotypic coefficient of variance (GCV) and phenotypic coefficient of variance were recorded for days taken to 50% flowering (5.05 and 5.06), taken after by the number of fruits plant-1(6.54 and 6.55). These results are in similarity with the findings of Kumar *et al.* (1999), Singh *et al*. (2005) and Samadia (2007).

Heritability is a parameter of huge importance to breeders, as its magnitude indicates the dependability with which a genotype can be recognized through its phenotypic expression (Table 4). Johnson *et al.* (1955) stressed that for estimating the real effect of selection, heritability estimates, along with genetic advance are more significant. Heritability in a wide sense was observed to be high for all the traits examined. High heritability estimates were also detailed before by Verma *et al.* (2004) and Samadia (2007). Heritability estimates along with genetic ~~advance~~ advancesare more useful than heritability values alone in reading the selection of the best individuals. In the present studies, fruit yield plant^{-1}, fruit weight, ascorbic acid, and the number of branches plant^{-1} shown high genetic advance as percentage of the mean along with high heritability. These results shown the impact of additive gene action. High genetic ~~advance~~ advancesfor the number of fruits plant^{-1} and fruit yield plant^{-1} were also recorded ~~before~~ by Sreelathakumary&Rajamony (2002), Warshamana*et al.* (2008), and Gupta *et al.*(2009).

Table4- Genetic variability components for major characters in chilli

Characters	Range	Mean	Coefficient of variance (%)		Heritability (%)	Genetic advance	GAM (%)
			GCV	PCV			
Days taken to first flowering	49.93	44.77	7.79	7.80	7.80	7.17	16.03
Days taken to 50% flowering	53.27	49.78	5.05	5.06	5.06	5.16	10.37
Plant height	58.66	81.92	6.65	5.66	5.66	9.53	11.64
Number of branches	12.62	14.19	21.01	21.04	21.04	6.13	43.21
Number of fruits plant^{-1}	63.99	58.13	6.54	6.55	6.55	7.83	13.47
Fruit length	7.77	7.73	15.82	15.86	15.86	2.51	32.49
Fruit diameter	11.0	8.15	21.80	21.82	21.82	3.65	44.86
Fruit weight	6.41	3.83	36.40	36.44	36.44	2.86	74.91
Fruit yield plant^{-1} (g)	382.91	225.21	31.95	41.67	41.67	115.20	51.19
Leaf area	29.73	26.44	7.39	7.44	7.44	4.01	15.07
TSS	9.73	8.07	17.63	17.74	17.74	2.91	36.09
Ascorbic acid	196.47	162.61	19.21	19.12	19.12	64.38	39.57

Genotypic correlation of 12 yield and yield attributing characters displayed in (Table 5) shown that fruit yield plant^{-1} appears a positive and highly significant correlation with plant height (0.555), number of branches (0.635), number of fruit plant^{-1}(0.693), fruit length (0.769), fruit diameter (0.906) and fruit weight

(0.981); similarly, fruit weight shows a positive correlation with plant height (0.645), number of branches (0.623), number of fruits plant^{-1} (0.721),fruit length (0.836), and fruit diameter (0.913). Fruit diameter appears a positive correlation with plant height (0.754), number of branches (0.634), number of fruit plant^{-1}(0.784) and fruit length (0.834) though fruit length appears a positive correlation with plant height (0.856), number of branches (0.745) and number of fruit plant^{-1} (0.748). The number of fruit plant^{-1} appears a positive correlation with only plant height (0.685) and the number of branches (0.705). Prior, Hosamani& Shivkumar (2008), Gupta *et al.* (2009), and Singh & Singh (2011) moreover detailed that fruit yield plant^{-1} had a positive and highly significant correlation with the number of fruits plant^{-1} and fruit length.The positive association of fruit weight with fruit breadth and fruit length shown that selection of only one of the traits might lead to an increase in the size of fruit (Gupta *et al.* 2009).

Table5- Correlation coefficient (genotypic) of different characters in chilli

Characters	1	2	3	4	5	6	7	8	9	10
1	1.0000	0.819**	-0.440**	-0.473**	-0.796**	-0.679**	-0.821**	-0.841**	-0.737**	-0.295**
2		1.0000	-0.635**	-0.690**	-0.716**	-0.819**	-0.792**	-0.887**	-0.720**	-0.520**
3			1.0000	0.731**	0.685**	0.856**	0.754**	0.645**	0.555**	0.681**
4				1.0000	0.705**	0.745**	0.634**	0.623**	0.635**	0.566**
5					1.0000	0.748**	0.784**	0.721**	0.693**	0.547**
6						1.0000	0.834**	0.836**	0.769**	0.615**
7							1.0000	0.913**	0.906**	0.366*
8								1.0000	0.981**	0.256
9									1.0000	0.064
10										1.0000
11										
12										

1-Days taken to 1st flowering, 2- Days taken to 50% flowering, 3-Plant height, 4-Number of branches, 5-Number of fruits plant-1, 6-Fruit length, 7-Fruit diameter, 8- Fruit weight, 9-Fruit yield(g plant-1), 10-Leaf area, 11-TSS, 12-Ascorbic Acid
*Significant at P<0.01; **Significant at P<0.05

11	-0.528**	-0.479**	0.549**	0.384**	0.729*	0.523**	0.380*	0.393*	0.252	0.707	1.0000	
12	0.070	-0.037	0.455	0.316	0.091	0.307	0.054	0.022	0-.112	0.472**	0.384*	1.0000

The candidate manuscript does not have a robust scientific discussion, I suggest the authors incorporate the suggested paragraphs, in this way, it would improve the scientific quality of the manuscript:

The study delves into the intricate relationship between genetic diversity, climatic variables, and agronomic management practices in chili cultivation. The investigation, conducted over a period spanning December 2022 to June 2023 in the Prayagraj region of India, employed twelve distinct genotypes to analyze the genetic variability and correlation among various growth, yield-contributing, and quality parameters of chili plants.

Precipitation (Hernandez et al. 2018b; Hernandez and Olivares, 2020), temperature (Guevara et al. 2013), relative humidity (Hernandez and Olivares, 2019), and soil quality are fundamental climatic and environmental factors that profoundly influence the growth, development, and yield of chili plants. In the context of this study, these variables likely played pivotal roles in shaping the observed genetic variability and correlations among different traits. Precipitation patterns during the cultivation period (Olivares et al. 2013), for instance, can directly impact water availability and soil moisture content (Olivares et al. 2012; Hernandez et al. 2017), thereby influencing germination rates, plant growth, and ultimately, fruit yield (Olivares, 2018; Olivares and Zingaretti, 2018; Hernandez et al. 2020). Similarly, temperature fluctuations and relative humidity levels can affect the physiological processes within the chili plants, such as flowering, fruit development, and nutrient uptake, consequently modulating yield and quality attributes.

Climate change adds another layer of complexity to the interplay between genetic variability and environmental factors in chili cultivation (Cortez et al. 2018). With ongoing shifts in temperature regimes (Guevara et al. 2013; Casana and Olivares, 2020), altered precipitation patterns, and changing humidity levels, chili plants may face new challenges and opportunities. Adaptation strategies, such as breeding for heat or drought tolerance (Cortez et al. 2016), may become increasingly important to ensure crop resilience and productivity in the face of changing climatic conditions.

Moreover, soil quality (Raya et al. 2020; Campos, 2023) and agronomic management practices, including fertilization (Calero et al. 2022), irrigation (Campos et al. 2018), and pest control (Hernandez et al. 2018a), interact intricately with climatic variables to influence chili plant performance. Soil nutrient availability, pH levels, and organic matter content can significantly impact plant growth, nutrient uptake, and overall health. Effective agronomic management tailored to local environmental conditions is essential for optimizing chili yield and quality while minimizing environmental impacts (Rodriguez et al. 2013).

Comparisons with studies of agro-environmental factors in Latin America, a region known for its diverse climatic and ecological conditions, may provide valuable insights into the universality versus specificity of findings (Rodriguez et al. 2015; Viloria et al. 2023). While certain principles of crop-climate interactions may hold across different regions, the unique climatic regimes (Zingaretti and Olivares, 2019), soil types (Olivares et al. 2021a; Montenegro et al. 2021b), and agricultural practices prevalent in Latin America (Lobo et al. 2023) necessitate a nuanced understanding of how these factors collectively influence chili cultivation (Montenero et al. 2021a; Olivares et al. 2021b). By synthesizing findings from diverse geographical contexts, researchers can gain a more comprehensive understanding of the complex interplay between genetics, climate, and agronomy in chili production, ultimately contributing to the development of more resilient and sustainable agricultural systems worldwide.

Conclusion

Based on the overall performance of the various genotypes under study, genotypes F1-6106 and Pusa Jwala were found to be best under the agroclimatic conditions of Prayagraj. These can either be directly used as cultivars or may be involved in breeding programs to evolve superior cultivars and hybrids. ~~On the basis of~~Based on mean performance and other genetic parameters of different growth and yield characters, it was revealed that the characters, viz., plant height, fruit length, number of fruits plant^{-1}, fruit weight, and fruit yield are the most important traits for improving the genotypes, while the number of branches plant^{-1} can be considered the second most important character for selection in ~~chilli~~ chiligenotypes. Based on estimates of the correlation coefficient, the numbers of fruits plant^{-1} and fruit weight were adjudged as ~~yield attributing~~yield-attributing characters that needed to be focused during selection.

Acknowledgment

This paper forms a part of M.Sc. (Horticulture) Vegetable Science. The thesis of Preksha Yadav was submitted to SHUATS, 2024. The authors are sincerely thankful to Dr. Devi Singh, Associate Prof. Department of Horticulture, SHUATS, Prayagraj.

References

1) Anita Kerketta&J. P. Collis, Evaluation of Chilli (*Capsicum annuum* L.) Genotypes for Growth, Yield and Quality Characters under Allahabad Agro Climatic Conditions. Int. J. Pure App. Biosci. 6 (4): 451-455 (2018)

2) Araya-Alman, M., Olivares, B., Acevedo-Opazo, C. et al. (2020). Relationship Between Soil Properties and Banana Productivity in the Two Main Cultivation Areas in Venezuela. J Soil Sci Plant Nutr. 20 (3): 2512-2524. https://doi.org/10.1007/s42729-020-00317-8

3) Campos, B. O. (2023). Banana Production in Venezuela: Novel Solutions to Productivity and Plant Health. Springer Nature. https://doi.org/10.1007/978-3-031-34475-6

4) Campos-Olivares, B., Hernández, R; Coelho, R., Molina, JC., Pereira, Y. (2018). Análisis espacial del índice hídrico: un avance en la adopción de decisiones sostenibles en los territorios agrícolas de Carabobo, Venezuela. Revista Geográfica de América Central. 60 (1): 277-299. DOI: https://doi.org/10.15359/rgac.60-1.10

5) Calero, J., Olivares, B.O., Rey, J.C., Lobo, D., Landa, B.B., Gómez, J. A. (2022). Correlation of banana productivity levels and soil morphological properties using regularized optimal scaling regression. Catena,; 208: 105718. https://doi.org/10.1016/j.catena.2021.105718

6) Casana, S., Olivares, B. (2020). Evolution and trend of surface temperature and windspeed (1994 - 2014) at the Parque Nacional Doñana, Spain. Rev. Fac. Agron. (LUZ). 37(1):1-25. https://n9.cl/c815e

7) Cortez, A., Olivares, B., Muñetones, A. y Casana, S. (2016). Strategic Elements of Organizational Knowledge Management for Innovation. Case: Agrometeorology Network. Revista Digital de Investigación en Docencia Universitaria. 10 (1): 68-81. http://dx.doi.org/10.19083/ridu.10.446

8) Cortez, A., Olivares, B., Parra, R., Lobo, D., Rodríguez, M.F. y Rey, J.C. (2018). Description of meteorological drought events in localities of the central mountain range, Venezuela.Ciencia, Ingenierías y Aplicaciones. I (1):22-44. DOI: http://dx.doi.org/10.22206/cyap.2018.vlil.pp23-45.

~~1)~~

~~2)~~9) Datta S & Jana J C, Evaluation of chilli (*Capsicum annuum* L.) germplasm suitable for spices. Paper presented in 1st Indian Horticulture Congress 2004 on "Improving Productivity Quality Postharvest Management and Trade in Horticultural Crop.", 6–9 November, New Delhi (2004).

~~3)~~10) Deb P, Datta S & Paul P K, Studies on the performance of chilli genotypes under Terai zone of West Bengal. Indian J. Hort.65: 353–353(2008).
11) Gupta A M, Singh D & Kumar A, Genetic variability, genetic advance and correlation studies in chilli (*Capsicum annuum* L.). Indian J. Agri. Sci. 79: 221–223(2009).
12) Guevara, E., Olivares, B., Oliveros, Y., López, L. (2013).Estimation of thermal comfort index as an indicator of heat stress in livestock production in the Guanipa plateau, Anzoátegui, Venezuela. RevistaZootecniaTropical.. 31 (3): 209-223. https://n9.cl/ovcu9
13) Hernández, R., Olivares, B., (2020). Application of multivariate techniques in the agricultural land's aptitude in Carabobo, Venezuela. Tropical and Subtropical Agroecosystems, 23(2):1-12. https://n9.cl/zeedh
14) Hernández, R; Olivares, B. Arias, A; Molina, JC., Pereira, Y. (2018a). Agroclimatic zoning of corn crop for sustainable agricultural production in Carabobo, Venezuela. RevistaUniversitaria de Geografía.,. 27 (2): 139-159. https://n9.cl/l2m83
15) Hernandez, R., Olivares, B., Arias, A, Molina, JC., Pereira, Y. (2020). Eco-territorial adaptability of tomato crops for sustainable agricultural production in Carabobo, Venezuela. Idesia. 38(2):95-102. http://dx.doi.org/10.4067/S0718342920200002000095
16) Hernández, R; Olivares, B., Arias, A; Molina, JC., Pereira, Y. (2018b). Identification of potential agroclimatic zones for the production of onion (Allium cepa L.) in Carabobo, Venezuela. Journal of the Selva Andina Biosphere., 6 (2): 70-82. http://www.scielo.org.bo/pdf/jsab/v6n2/v6n2_a03.pdf
17) Hernández, R. Olivares, B. (2019). Ecoterritorial sectorization for the sustainable agricultural production of potato (Solanum tuberosum L.) in Carabobo, Venezuela. Agricultural Science and Technology. 20(2): 339-354. https://doi.org/10.21930/rcta.vol20_num2_art:1462
~~4)~~18) Hernández, R; Pereira, Y; Molina, JC; Coelho, R; Olivares, B, Rodríguez, K. (2017). Calendario de siembra para las zonas agrícolas del estado Carabobo en la República Bolivariana de Venezuela. Sevilla, Spain, Editorial Universidad Internacional de Andalucía. 247 p. https://n9.cl/sjbv
~~5)~~19) Hosamani R M & Shivkumar, Correlation and path coefficient analysis in chilli. Indian J. Hort. 65: 349–352(2008).
~~6)~~20) K Amit, I Ahad, V Kumar, S Thakur 2014. Genetic variability and correlation studies for growth and yield characters in chilli (Capsicum annuum L.). Journal of Spices & Aromatic Crops 23 (2).
21) Kumar K, Baswana K S & Partap P S, Genetic variability and heritability studies in chilli. (*Capsicum annuum* L.) Haryana J. Hort. Sci. 28: 125–126(1999).
22) Lobo, D; Olivares, B; Rey, J.C; Vega, A; Rueda-Calderón, A. (2023). Relationships between the Visual Evaluation of Soil Structure (VESS) and soil properties in agriculture: A meta-analysis. Scientia agropecuaria; 14 - 1, 67 - 78. https://doi.org/10.17268/sci.agropecu.2023.007
23) Montenegro, E; Pitti, J; Olivares, B. 2021. Adaptation to climate change in indigenous food systems of the Teribe in Panama: a training based on CRISTAL 2.0. Luna Azul. 51 - 2, 182 – 197. https://n9.cl/qwvw
~~7)~~24) Montenegro, E; Pitti, J; Olivares, B. 2021. Identification of the main subsistence crops of Teribe: a case study based on multivariate techniques. Idesia. 39 - 3, 83 - 94. http://dx.doi.org/10.4067/S0718-34292021000300083.
25) Munshi A D & Behera T K, Genetic variability, heritability and genetic advance for some traits in chilli. (*Capsicum annuum* L.) Veg. Sci. 27: 39–41. (2000).
26) Olivares, B., Torrealba, J. y Caraballo, L. (2013). Variability of the precipitation regime in the period 1990-2009 in the location of El Tigre, Anzoátegui state, Venezuela. Rev. Fac. Agron. (LUZ). 30 (1): 19-32. https://n9.cl/mic0l
27) Olivares, B., Parra, R., Cortez, A. y Rodríguez, M.F. (2012). Patterns of rainfall homogeneity in climatic stations of the Anzoátegui state, Venezuela. RevistaMulticiencias. 12 (Extraordinario): 11-17. https://n9.cl/xbslq

Formatted: Spanish (Spain, International Sort)
Formatted: Spanish (Spain, International Sort)
Formatted: Font: (Default) Times New Roman, 12 pt
Field Code Changed
Formatted: Hyperlink, Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt, Portuguese (Brazil)
Formatted: Font: (Default) Times New Roman, 12 pt
Field Code Changed
Formatted: Hyperlink, Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt, Portuguese (Brazil)
Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt, Spanish (Spain, International Sort)
Formatted: Font: (Default) Times New Roman, 12 pt
Field Code Changed
Formatted: Hyperlink, Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt, Spanish (Spain, International Sort)
Formatted: Font: (Default) Times New Roman, 12 pt
Field Code Changed
Formatted: Hyperlink, Font: (Default) Times New Roman, 12 pt

28) Olivares, B. and Zingaretti, ML. (2018). Analysis of the meteorological drought in four agricultural locations of Venezuela by the combination of multivariate methods. UNED Research Journal. 10 (1):181-192. http://dx.doi.org/10.22458/urj.v10i1.2026
29) Olivares, B. (2018). Tropical conditions of seasonal rain in the dry-land agriculture of Carabobo, Venezuela. La Granja: Journal of Life Sciences. 27(1):86-102. http://doi.org/10.17163/lgr.n27.2018.07
30) Olivares B, Rey JC, Lobo D, Navas-Cortés JA, Gómez JA, Landa BB. (2021a). Fusarium Wilt of Bananas: A Review of Agro-Environmental Factors in the Venezuelan Production System Affecting Its Development. Agronomy, 11(5):986. https://doi.org/10.3390/agronomy11050986
31) Olivares, B., Paredes, F., Rey, J., Lobo, D., Galvis-Causil, S. (2021b). The relationship between the normalized difference vegetation index, rainfall, and potential evapotranspiration in a banana plantation of Venezuela. SAINS TANAH - Journal of Soil Science and Agroclimatology, 18(1), 58-64. http://dx.doi.org/10.20961/stjssa.v18i1.50379
32) Parkash C, Estimation of genetic variability and implications of direct effects of different traits on leaf yield in bathua (*Chenopodium album*). Indian J. Agri. Sci.82: 71–74(2012).
33) Rohit Kumar, RS Meena, AK Verma, Hemant Ameta and Alka Panwar,Analysis of Genetic Variability and Correlation in Fennel (*Foeniculum Vulgare* Mill.) Germplasm.Agri Res & Tech: Open Access J 3(4): ARTOAJ.MS.ID.555616 (2017)
34) Rodríguez, M.F., Cortez, A., Olivares, B., Rey, J.C, Parra, R. y Lobo, D Análisis espacio temporal de la precipitación del estado Anzoátegui y sus alrededores. Agronomía Tropical 2013. 63 (1-2): 57-65. https://n9.cl/14iow
35) Rodríguez, M.F, Olivares, B., Cortez, A., Rey, J.C., Lobo, D. Caracterización físico natural de la comunidad indígena de Kashaama con fines de manejo sostenible de la tierra. Acta Nova. 2015. 7 (2):143-164. https://n9.cl/hakdx
36) Samadia D K, Genetic variability studies in chilli germplasm under hot arid ecosystem. Indian J. Hort. 64: 477–479(2007).
37) Singh D K & Singh A, Assessment of variability parameters and character association for quantitative traits in chilli (*Capsicum annuum* L.). Prog. Agri. 11: 113-116(2011).
38) Singh M D, Laisharam J M & Bhagirath T, Genetic variability in local chillies (*Capsicum annuum* L.) of Manipur. Indian J.Hort. 62: 203–205(2005).
39) Sreelathakumary&Rajamony L, Variability, heritability and correlation studies in chilli (*Capsicum* spp.) under shade. Indian J. Hort. 59: 77–83(2002).
40) Verma S K, Singh R K and Anja R R, Genetic variability and correlation studies in chilli. Prog. Hort. 36: 113–117(2004)
41) Viloria, J; Olivares, B. et al. 2023. Mapping Projected Variations of Temperature and Precipitation Due to Climate Change in Venezuela. Hydrology, 10, 96. https://doi.org/10.3390/hydrology10040096
42) Warshamana I K, Vikram A & Kohli U K, Genetic evaluation for physicochemical and yield traits in chilli (*Capsicum annuum* L.) under hilly conditions of Himachal Pradesh. The Hort. J. 21: 62–66(2008).
43) Zingaretti, M.L Olivares, B. 2019. Application of multivariate methods for the characterization of periods of meteorological drought in Venezuela. Revista Luna Azul. 48, 172:192. http://dx.doi.org/10.17151/luaz.2019.48.10
44)

Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Hyperlink, Font: (Default) Times New Roman, 12 pt
Field Code Changed
Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt, Spanish (Spain, International Sort)
Formatted: Font: (Default) Times New Roman, 12 pt
Field Code Changed
Formatted: Hyperlink, Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt, Spanish (Spain, International Sort)
Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Font: (Default) Times New Roman, 12 pt
Formatted: Font: 12 pt, Not Bold
Formatted: Font: (Default) Times New Roman, 12 pt, Portuguese (Brazil)
Formatted: Indent: Left: -0.25"
Formatted: Font: (Default) Times New Roman, 12 pt