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EVALUATION OFCHILLI GENOTYPES OF TRIPURA BASED ON MORPHO-CHEMICAL TRAITS

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Abstract

This study evaluated 15 local chilli genotypes (TCG1-15) for morphological traits, yield attributes, and biochemical properties during the rabi seasons of 2019 and 2020 at the Instructional Farm, KVK-Khowai, Tripura. TCG2 showed the highest average fruit weight (1.90 g), while TCG13 recorded the highest productivity (6.09 t/ha). TCG12 emerged as the second-best genotype for higher yield. In terms of pungency, TCG10 had the highest capsaicin content, while TCG10 and TCG3 recorded maximum ascorbic acid content. For rabi season cultivation in Tripura, TCG13 and TCG12 are recommended for higher yield, while TCG10 is the best suited for pungency. These findings can aid in commercializing local chilli genotypes for better utilization and market potential.

Introduction

Chilli (*Capsicum annuum* L.) is a globally significant spice and vegetable crop, ranking second among solanaceous vegetables. Presently India, leads in chilli production with 29.13 lakh tonnes from an area of 8.9 lakh ha of land (Spices Board of India 2024). The *Capsicum* genus has over 25 species, with only five domesticated and cultivating. India exhibits substantial variability in chilli fruit morphology, pungency, and crop characteristics. The North East region, though not a major commercial chilli growing area, boasts rich genetic resources in chilli landraces, notably the well-known Naga Jolokia and Bhut Jolokia. Tripura, is a biodiversity hotspot for chilli land races, cultivated by traditional farmers in diverse agro-climatic conditions. These landraces, adapted to local conditions, serve as genetic reservoirs. Despite the significance of Tripura's chilli landraces, there is a lack of systematic evaluation for growth, yield, and commercialization potential. This study aims to assess the productivity, quality, and biochemical properties of local chilli genotypes in Tripura, with implications for commercialization and potential contributions to future breeding programs.

Materials and Methods

The experiment was conducted over two consecutive summer seasons in 2019 and 2020 at the Instructional Farm of Krishi Vigyan Kendra, Chebri, Khowai, Tripura, situated at 24.024° N latitude and 91.63° E longitude, with an altitude of 12 m above sea level. Fifteen chilli (*C. annuum*) genotypes (TCG1-15), from various locations in Tripura, were included in a randomized block design (RBD) layout with three replications. A standard package of practice was followed for growing chilli.

Data were recorded on various parameters including plant height, number of branches per plant, fruit diameter, fruit length, pedicel length, flesh thickness, yield attributing characters, and biochemical parameters. Capsaicin content in fruits was determined using a colorimetric method, described by Balasubramanian *et al*. (1982), while ascorbic acid content in mature green fruits was estimated using a volumetric method outlined by Sadasivam and Balasubramanian (1987). Total soluble solids (TSS) content was determined using a refractometer, while titratable acidity was assessed by neutralizing the acid present in a known

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quantity of the sample with a standard base. Chlorophyll extraction and estimation was done following the methods described by Arnon (1949) and Kirk and Allen (1965). Statistical analysis of the data was conducted using the "Analysis of variance" method, as recommended by Panse and Sukhatme (1984).

The climatic conditions during the experiment featured warm and humid weather followed by a cool winter and warm spring. Notably, the region experienced substantial rainfall, with an average of approximately 2330.5 and 1448.25 mm during the years 2019 and 2020, respectively, primarily occurring from mid-March to September. The average maximum and minimum temperatures ranged from 34.7 to 0.8°C and 33.9 to 10.1°C during 2019 and 2020, respectively. The mean relative humidity reached up to 89 and 93% during the same periods, respectively.

Results and Discussion

Chilli genotypes were characterized based on 20 qualitative characters and frequency distribution of genotypes according to these traits is summarized in Table 1 and these characteristics are important morphological characters of chilli for identification (Padma *et al.* 2017).

Significant differences in plant height were observed among the genotypes with three exceeding 100 cm at harvest. TCG10 was the tallest plants (170.52 cm), followed by TCG11 and TCG13 (Table 2). The shortest plants were recorded in TCG14 (59.13 cm). Genetic variations, crop management, and agro-climatic conditions influenced vegetative growth. On average, there were 34.50 number of branches per plant, ranging from 19.17 (TCG14) to 42.33 (TCG13). Genotype TCG9 had the largest fruit diameter (1.95 cm), followed by TCG13, while TCG11 had the smallest (0.57 cm) (Table 2). Significant genetic variations in these parameters were noted by various researchers (Vijaya *et al*. 2014, Chowdhury *et al*. 2015, Dhaliwal *et al*. 2015). Data presented in Table 2 showed that fruit length among chilli genotypes ranged from 2.94 to 7.80 cm, with an average of 6.45 cm. TCG2 and TCG3, displayed the longest fruit, and TCG14 had the smallest, with TCG14 also exhibiting the maximum flesh thickness at 2.83 mm. Pericarp thickness positively correlated with fruit size, supporting genetic influences on variability. Variation in pedicel length was also observed, TCG2 having the maximum length and TCG14 the lowest.

No clear relationship was found between growth, phenological characters and yield attributes, reflecting genetic diversity. It was observed that chilli fruit weights ranged from 0.43 to 1.90 g, TCG1 exhibiting the heaviest fruits and TCG10 the lightest (Table 2). TCG2 had the maximum seeds per fruit (67.17), and test weight data showed significant variation. TCG13 demonstrated the highest fruit yield per plant (220.02 g/plant), while TCG14 recorded the least (71.45 g/plant). Positive correlations were observed between fruit yield and diameter, as well as fruit weight. In terms of yield per hectare, significant variations were observed among the 15 chilli genotypes, ranging from 2.02 to 6.09 t/ha, with an average yield of 4.33 t/ha. TCG13 exhibited the highest yield per hectare, while TCG14 displayed the lowest. The increase in total fruit yield could be due to variation in plant height, as well as the formation of more primary, secondary, and tertiary branches. Comparable results were reported by various researchers (Chaithali 2014, Vijaya *et al*. 2014, Kalyan 2016, Sial *et al*. 2016, Geetha and Selvarani 2017).

Table 3 summarizes the biochemical parameters of chilli fruits. Genotype TCG10 showed the highest capsaicin content (1.127%), significantly differing from other genotypes, while TCG4 exhibits the lowest capsaicin value of 0.290%. Ascorbic acid content ranges from 88.52 to 137.10 mg/100 g, TCG9 having the highest and TCG14 recorded significantly lower levels. TCG9 also displayed the highest total soluble solid (TSS) (6.48 ^{0}Brix), while TCG1 had the

Table 1. Frequency distribution for different qualitative characters of chilli genotypes.

Characters	Specification	No. of genotypes	% of genotypes
Stem colour	Green	9	60.00
	Purple	4	26.67
	Green With Purple Stripe	2	13.33
Plant Growth Habit	Prostrate	4	26.67
	Erect	4	26.67
	Intermediate	7	46.67
Branching Habit	Dense	5	33.33
	Intermediate	10	66.67
Leaf Size	Small	2	13.33
	Medium	8	53.33
	Large	5	33.33
Leaf Shape	Ovate	4	26.67
	Lanceolate	11	73.33
Leaf Margin	Entire	15	100.00
Leaf Colour	Purple	3	20.00
	Green	8	53.33
	Light Green	1	6.67
	Light Purple	1	6.67
	Dark Green	2	13.33
Leaf Pubescence	Sparse	1	6.67
	Absent	6	40.00
	Intermidiate	8	53.33
No. of Flower /Axil	One	15	100.00
Corolla Colour	White	11	73.33
	Purple	2	13.33
	Purple Whit White Base	2	13.33
Calyx Margin	Entire	0	0
	Dentate	7	46.67
	Intermidiate	8	53.33
Mature Fruit Colour	Purple	4	26.67
	Green	8	53.33
	White	1	6.67
	Dark Purple	1	6.67
	Lemon Yellow	1	6.67
Fruit Shape	Triangular	1	6.67
	Elongated	12	80.00
	Almost Round	2	13.33
Fruit Position	Intermidiate	1	6.67
	Erect	8	53.33
	Pendant	6	40.00
Fruit Shape At Pedicel Attachment	Obtuse	13	86.67
	Truncate	2	13.33
Blossom End Fruit Shape	Blunt	1	6.67
	Pointed	12	80.00
	Sunken	2	13.33
Fruit Surface	Wrinkled	4	26.67
	Semi Wrinkled	5	33.33
	Smooth	6	40.00
Seed Colour	Straw	15	100.00
Fruit Cross-Sectional Corrugation	Slightly Corrugated	14	93.33
	Corrugated	1	6.67
Number of Locules	2	11	73.33
	3	4	26.67

lowest (4.42 ^{0}Brix). TCG3 records the highest titratable acidity (0.261%), and TCG5 exhibited the highest chlorophyll content (1.867 mg/100g). These findings align with variations reports by other researchers (Sanatombi and Sharma 2008, Tasso *et al*. 2014, Swamy *et al*. 2014, Karak *et al*. 2015).

Table 2. Mean performance of chilli genotypes for different characters.

Genotypes	Plant height (cm)	Branches /plant (No.)	Fruit diameter (cm)	Fruit length (cm)	Flesh Thickness (mm)	Pedicel length (cm)	Average fruit weight (g)	Seeds/ fruit (No.)	Test Weight (g)	Yield/plant (g)	Yield (t/ha)	Average fruit weight (g)
TCG1	64.17	31.17	0.72	6.00	1.28	2.75	1.23	36.33	3.99	114.48	3.29	1.23
TCG2	60.53	26.33	0.87	7.80	1.18	4.50	1.90	67.17	4.56	176.69	5.14	1.90
TCG3	80.67	37.83	0.90	7.80	1.27	4.13	1.48	46.67	5.06	188.50	5.27	1.48
TCG4	78.97	27.67	0.73	6.85	0.58	2.90	1.25	30.17	4.09	139.99	3.60	1.25
TCG5	69.00	40.00	0.73	7.07	0.87	2.75	1.35	43.33	5.33	186.77	5.28	1.35
TCG6	71.33	32.17	0.82	7.00	1.23	3.02	1.58	60.33	5.46	159.72	4.63	1.58
TCG7	72.10	39.67	0.85	7.55	1.18	2.95	1.81	65.00	5.21	195.61	5.42	1.81
TCG8	65.47	34.67	0.92	7.42	1.17	3.22	1.22	54.00	5.95	171.08	4.85	1.22
TCG9	61.60	29.00	1.95	3.50	2.35	1.82	1.09	65.50	4.98	80.03	2.67	1.09
TCG10	170.52	40.50	0.73	5.50	0.75	2.38	0.43	24.83	4.19	101.71	2.85	0.43
TCG11	160.40	41.00	0.57	5.25	0.82	2.15	0.49	20.67	4.16	157.97	2.95	0.49
TCG12	93.20	39.67	0.98	7.28	1.25	2.93	1.76	59.00	5.39	211.89	5.87	1.76
TCG13	102.20	42.33	1.03	7.52	1.23	3.30	1.83	51.83	5.60	220.02	6.09	1.83
TCG14	59.13	19.17	2.30	2.97	2.83	1.27	1.89	36.83	6.02	71.45	2.02	1.89
TCG15	73.27	36.33	1.08	7.23	1.18	3.00	1.79	64.33	5.47	184.26	5.10	1.79
Mean	85.50	34.50	1.01	6.45	1.28	2.87	1.41	48.40	5.03	157.34	4.33	1.41
SE (m)	3.935	1.608	0.069	0.342	0.107	0.170	0.052	1.671	0.102	2.710	0.111	0.052
C.D.	11.458	4.682	0.202	0.996	0.311	0.495	0.151	4.867	0.298	7.890	0.323	0.151

Table 3. Comparison of metabolites during fruit maturation of chilli genotypes.

Genotypes	Capsaicin content (%)	Ascorbic acid (mg/100 g)	Total soluble solid (^{0}Brix)	Titrable acidity (%)	Chlorophyll content (mg/100 g)
TCG1	0.290	100.32	4.38	0.213	0.039
TCG2	0.482	94.23	4.99	0.220	1.712
TCG3	0.675	125.40	5.27	0.253	1.772
TCG4	0.262	113.17	4.74	0.244	0.034
TCG5	0.702	90.70	5.19	0.216	1.813
TCG6	0.627	111.78	5.91	0.226	1.708
TCG7	0.838	119.00	5.25	0.230	1.785
TCG8	0.812	102.28	5.26	0.221	1.682
TCG9	0.495	126.26	5.95	0.228	0.021
TCG10	1.163	133.24	4.66	0.233	1.147
TCG11	1.055	118.20	5.56	0.223	1.668
TCG12	0.782	113.07	4.70	0.253	0.028
TCG13	0.705	100.87	4.45	0.217	1.774
TCG14	1.065	83.10	4.37	0.222	1.221
TCG15	0.803	114.63	4.97	0.234	0.024
Mean	0.717	109.75	5.04	0.229	1.095
SE(m)	0.019	1.225	0.149	0.008	0.032
C.D.	0.055	3.568	0.433	0.023	0.092

For most characters, Phenotypic Coefficient of Variation (PCV) closely aligned with Genotypic Coefficient of Variation (GCV), consistent with previous findings of Ukkund *et al.* (2007). This implies that these traits are minimally influenced by the environment, making selection based on phenotypic performance highly rewarding. However, in a few traits (fruit diameter, flesh thickness, fruit pedicel length, and seed per fruit), PCV exceeded GCV, indicating environmental influence on trait variation (Table 4). Therefore, caution is advised against recommending selection solely based on phenotypic performance for these traits.

The strong agreement between PCV and GCV estimates is reflected in the broad sense heritability, exceeding 99% for all characters except flesh thickness of the fruit. As per Burton (1952), considering genetic variability and heritability is crucial for effective selection. Genetic advance represents the expected genetic progress achievable through selection over the original population.

The analysis of phenotypic (P) and genotypic (G) correlation coefficients for 16 traits is summarized in Table 5. Generally, it was observed that genotypic correlations were consistently higher than phenotypic correlations, suggesting a strong inherent genotypic relationship among the studied traits. However, the phenotypic expression of these traits appeared to be influenced by environmental factors. Both genotypic and phenotypic correlation coefficients revealed that fruit yield per plant exhibited significant positive correlations with individual fruit weight, fruit length, number of branches per plant, and plant height. Additionally, capsaicin showed significant positive correlations with various traits, including plant height, branches per plant, fruit diameter, fruit length, flesh thickness, pedicel length, seed/fruit, test weight, individual fruit weight, yield per plant, and yield (t/ha).These findings align with previous studies by Kumar *et al*. (2012) and Yatung *et al*. (2014), which reported similar positive correlations for traits such as fruit weight, fruit yield per plant, number of fruits per plant, fruit length, and number of branches per plant.

Table 4. Estimation of genetic variability in chilli.

Characters	Mean	Error	Genotypic Coefficient Variations (G.C.V.)	Phenotypic Coefficient Variations (P.C.V.)	Heritability % (H)	Genetic Advance (G.A.)	Genetic Advance as % of mean
Plant height (cm)	85.50	3.935	51.452	51.914	98.23	89.102	105.05
Branch/per plant	34.50	1.608	47.268	47.724	98.101	32.33	96.444
Fruit Diameter	1.01	0.069	69.615	70.218	98.289	1.396	142.174
Fruit Length	6.45	0.342	54.158	55.126	96.517	6.858	109.605
Flesh Thickness	1.20	0.107	68.191	71.378	91.269	1.622	134.201
Pedicel Length	2.87	0.170	54.547	55.08	98.074	2.945	111.28
Seed/Fruit	48.40	1.671	57.847	58.27	98.552	51.854	118.298
Test weight (g)	5.03	0.102	44.123	44.46	98.49	4.006	90.204
Individual Fruit Weight (g)	1.41	0.052	60.747	61.094	98.866	1.815	124.426
Yield /plant (g)	157.34	2.710	65.431	65.759	99.004	223.12	134.115
Yield (t/ha)	4.33	0.111	62.241	62.647	98.706	5.52	127.383
Capsaicin (%)	0.717	0.019	56.398	56.632	99.173	0.739	115.698
Ascorbic Acid	109.75	1.225	42.632	42.712	99.624	87.453	87.657
TSS	5.04	0.149	42.259	42.538	98.694	3.865	86.482
Titrable Acidity	0.229	0.008	41.128	41.352	98.92	0.17	84.264
Chlorophyll	1.095	0.032	85.238	85.316	99.817	1.724	175.429

Table 5. Phenotypic (P), genotypic (G) correlation coefficients among characters in chilli during winter season.

Parameter		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
A	P	1															
	G	1															
B	P	0.833**	1														
	G	0.849**	1														
C	P	0.156NS	0.364*	1													
	G	0.159NS	0.372*	1													
D	P	0.732**	0.810**	0.158NS	1												
	G	0.746**	0.835**	0.163NS	1												
E	P	0.168NS	0.355*	0.950**	0.168NS	1											
	G	0.175NS	0.376*	1.001**	0.180NS	1											
F	P	0.738**	0.779**	0.187NS	0.960**	0.198NS	1										
	G	0.752**	0.797**	0.196NS	0.985**	0.196NS	1										
G	P	0.409**	0.750**	0.608**	0.724**	0.582**	0.709**	1									
	G	0.414**	0.769**	0.623**	0.740**	0.603**	0.716**	1									
H	P	0.639**	0.841**	0.717**	0.702**	0.708**	0.683**	0.825**	1								
	G	0.646**	0.855**	0.729**	0.719**	0.738**	0.691**	0.838**	1								
I	P	0.403**	0.694**	0.612**	0.749**	0.592**	0.725**	0.873**	0.821**	1							
	G	0.402**	0.709**	0.619**	0.766**	0.625**	0.738**	0.881**	0.828**	1							
J	P	0.577**	0.860**	0.243NS	0.849**	0.233NS	0.796**	0.802**	0.731**	0.834**	1						
	G	0.584**	0.869**	0.243NS	0.869**	0.242NS	0.807**	0.813**	0.742**	0.846**	1						
K	P	0.610**	0.872**	0.254NS	0.874**	0.250NS	0.834**	0.821**	0.740**	0.849**	0.985**	1					
	G	0.618**	0.886**	0.261NS	0.900**	0.263NS	0.850**	0.832**	0.752**	0.858**	0.998**	1					
L	P	0.700**	0.659**	0.513**	0.383**	0.487**	0.355*	0.364*	0.726**	0.420**	0.392**	0.393**	1				
	G	0.712**	0.670**	0.522**	0.390**	0.504**	0.359*	0.365*	0.732**	0.424**	0.396**	0.398**	1				
M	P	0.797**	0.888**	0.553**	0.758**	0.536**	0.750**	0.786**	0.889**	0.668**	0.672**	0.706**	0.648**	1			
	G	0.803**	0.899**	0.556**	0.770**	0.563**	0.760**	0.792**	0.898**	0.670**	0.677**	0.713**	0.652**	1			
N	P	0.739**	0.844**	0.589**	0.677**	0.570**	0.703**	0.737**	0.888**	0.615**	0.593**	0.629**	0.664**	0.943**	1		
	G	0.752**	0.856**	0.599**	0.699**	0.601**	0.710**	0.744**	0.897**	0.620**	0.602**	0.639**	0.671**	0.950**	1		
O	P	0.814**	0.854**	0.529**	0.772**	0.500**	0.778**	0.677**	0.889**	0.661**	0.641**	0.669**	0.707**	0.944**	0.924**	1	
	G	0.831**	0.867**	0.536**	0.789**	0.540**	0.790**	0.689**	0.901**	0.670**	0.651**	0.679**	0.712**	0.952**	0.932**	1	
P	P	0.561**	0.587**	0.151NS	0.560**	0.151NS	0.561**	0.364*	0.536**	0.479**	0.568**	0.589**	0.625**	0.404**	0.499**	0.475**	1
	G	0.565**	0.592**	0.153NS	0.570**	0.161NS	0.568**	0.366*	0.541**	0.482**	0.571**	0.594**	0.628**	0.404**	0.502**	0.479**	1

A: Plant height, B: Branch per plant, C= Fruit Diameter; D= Fruit Length; E= Flesh Thickness; F= Pedicel Length; G= Seed/Fruit; H= Test weight (g); I= Individual Fruit Weight (g); J= Yield per plant (g); K= Yield (t/ha); L= Capsaicin (%); M= Ascorbic Acid; N= TSS; O= Titrable; P= Chlorophyll.

Genotype TCG7 performed best in summer season with respect to average fruit weight (2.47 g) and productivity (7.96 t/ha). For higher production genotype TCG3 may be considered as second best genotype during summer season. On the basis of capsaicin content TCG10 was identified as most pungent chilli genotype. Maximum ascorbic acid content was recorded in TCG9 and TCG10. Therefore, genotype TCG7 can be suggested for growing in summer season for better yield and other horticultural traits in Tripura.

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