

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(7): 42-47
www.biochemjournal.com
Received: 16-04-2026
Accepted: 18-05-2026

Aditya Singh

M.Sc. Student, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology (ANDUA&T), Uttar Pradesh, India

Aastik Jha

Associate Professor, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology (ANDUA&T), Uttar Pradesh, India

CN Ram

Professor, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology (ANDUA&T), Uttar Pradesh, India

Ashish Kumar Singh

Assistant Professor, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology (ANDUA&T), Uttar Pradesh, India

Lokesh Yadav

Subject Matter Specialist (Horticulture), Krishi Vigyan Kendra (KVK), Ambedkar Nagar, Uttar Pradesh, India

Santosh Kumar

Research Scholar, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology (ANDUA&T), Uttar Pradesh, India

Corresponding Author:**Aastik Jha**

Associate Professor, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology (ANDUA&T), Uttar Pradesh, India

Estimation of Genetic variability, Heritability and Genetic advance in Summer Squash (*Cucurbita pepo*)

Aditya Singh, Aastik Jha, CN Ram, Ashish Kumar Singh, Lokesh Yadav and Santosh Kumar

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i7Sa.8924>

Abstract

The present study was conducted to assess genetic variability, heritability and genetic advance as a percentage of mean for twenty yield contributing and quality traits in summer squash (*Cucurbita pepo* L.) genotypes. Analysis of variance revealed highly significant differences among the genotypes for all the traits studied, indicating the existence of substantial genetic variability within the experimental material. The phenotypic coefficient of variation (PCV) was consistently higher than the genotypic coefficient of variation (GCV) for all characters, suggesting the influence of environmental factors on trait expression. High estimates of GCV and PCV were recorded for total carotenoids (21.95% and 22.07%, respectively) and dry matter content (19.20% and 19.77%, respectively), reflecting a wide range of genetic variation for these biochemical traits. Moderate levels of variability were observed for flesh thickness, lamina length of fully grown leaf and leaf width. High broad-sense heritability was exhibited by total carotenoids (98.88%), dry matter content (94.26%), moisture content (94.12%), ascorbic acid content (89.48%) and flesh thickness (87.80%). Furthermore, high heritability coupled with high genetic advance as a percentage of mean was observed for total carotenoids (98.88% and 44.96%), dry matter content (94.26% and 38.39%), flesh thickness (87.80% and 19.67%) and ascorbic acid content (89.48% and 17.12%), indicating the predominance of additive gene action and suggesting that direct phenotypic selection for these traits would be highly effective for developing superior summer squash genotypes.

Keywords: Genetic variability, heritability, genetic advance, coefficient of variation and germplasm evaluation

Introduction

Summer squash (*Cucurbita pepo* L., $2n = 2x = 40$) is an important warm-season vegetable crop belonging to the family Cucurbitaceae, which originated from the New World. It is widely adapted to temperate and subtropical regions and is characterized by rapid growth and early maturity, maturing within 40–50 days after sowing. In India, it is cultivated across diverse agro-climatic zones under the local names such as *Vilayati Kaddu*, *Chappan Kaddu* and *Safed Kaddu*, performing best at an optimal temperature range of 16–27°C (Robinson and Decker-Walters, 1997; Paris, 2008) ^[24, 20].

The crop is cultivated primarily for its tender, immature fruits harvested when the rind remains soft and seeds are underdeveloped. It is an excellent source of Vitamin C, folate, potassium, magnesium and Vitamin A, with high water content (~95%) and very low calories (~25 per fruit), making it ideal for weight management and hydration (USDA, 2020; Slavin and Lloyd, 2012) ^[28]. Despite its nutritional significance, productivity improvement remains a major challenge due to limited knowledge of genetic potential among available genotypes.

Genetic variability forms the foundation of any successful crop improvement programme. A thorough understanding of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2) and genetic advance (GA) enables breeders to identify superior genotypes and predict the response to selection (Burton and De Vane, 1953; Allard, 1960; Hanson *et al.*, 1956) ^[4, 2, 11]. High heritability coupled with high genetic advance indicates the predominance of additive gene action, making selection more effective and reliable.

Materials and Methods

The present investigation was conducted during the *Rabi* season 2024–25 at the Main Experiment Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh. The experimental material for the present investigation comprised 30 genotypes of Summer Squash (*Cucurbita pepo* L.), maintained in the Department of Vegetable Science, ANDUAT, Kumarganj, Ayodhya (U.P.). The high-yielding variety Kashi Shubhangi was included as the check variety. The details of the genotypes are presented in Table 1. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Each genotype was planted in a plot of 3.0 m × 1.2 m, maintaining a spacing of 60 cm × 60 cm between rows and plants, respectively.

Observations were recorded on fifteen quantitative traits, namely node number at first staminate flower, days to first pistillate flower, node number at first female flower, days to 50% flowering of pistillate flowers, leaf length (cm), leaf width (cm), petiole length of fully grown leaf (cm), days to first fruit harvest, fruit length (cm), fruit circumference (cm), number of fruits per plant, average fruit weight (kg), flesh thickness (mm), fruit yield per plant (kg) and fruit yield (q/ha). Five biochemical traits were also recorded, namely ascorbic acid content (mg/100 g), moisture content (%), dry matter content (g/100 g), total carotenoid content (mg/100 g) and total soluble solids (°Brix). Additionally, morphological traits were recorded based on NBPGR descriptors. Data for each trait were recorded from five randomly selected plants per genotype in each replication and the mean value was calculated by averaging observations from the five sampled plants.

Statistical analysis was performed using analysis of variance (ANOVA) following the procedure described by Panse and Sukhatme (2000) to determine the significance of differences among genotypes. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were estimated according to the method of Burton and DeVane (1953)^[4]. Broad-sense heritability (h^2_{bs}) was computed following Allard (1960)^[2], while genetic advance (GA) and genetic advance as per cent of mean were calculated using the methodology proposed by Hanson *et al.* (1956). Correlation coefficient was estimated following Pearson (1909), path coefficient analysis was carried out following Dewey and Lu (1959), genetic divergence was estimated using Mahalanobis D^2 statistics (1936) and principal component analysis (PCA) was performed following Pearson (1901). These genetic parameters were used to assess the magnitude of variability and the effectiveness of selection for yield and quality traits in summer squash.

Results and Discussion

The analysis of variance (Table 1.) revealed highly significant differences among the genotypes for all twenty traits studied, indicating the existence of substantial genetic variability in the experimental material. The presence of significant variation among genotypes suggests ample scope for selection and genetic improvement of fruit yield and its associated traits in summer squash.

Mean sum of squares (Table 2.) due to treatments were highly significant for all the traits, indicating significant differences among the genotypes with respect to traits under

study. Days to first pistillate flowering ranged from 37.11 (NDSS-23-18) to 43.36 (NDSS-23-23) with a mean value of 39.55. Days to 50% flowering pistillate ranged from 46.27 (NDSS-23-23) to 50.00 (NDSS-23-28) with a mean value of 48.60. Days to first fruit harvest ranged from 56.55 (NDSS-23-27) to 60.24 (NDSS-23-1) with a mean value of 58.38. Node number at first staminate flower ranged from 2.67 (NDSS-23-20) to 3.40 (NDSS-23-29) with a mean value of 3.02. Node number at first pistillate flower ranged from 4.60 (NDSS-23-6) to 5.33 (NDSS-23-20) with a mean value of 4.95. Lamina length of fully grown leaf ranged from 19.10 cm (NDSS-23-17) to 26.33 cm (NDSS-23-14) with a mean value of 22.15 cm. Leaf width ranged from 20.83 cm (NDSS-23-23) to 29.93 cm (NDSS-23-2) with a mean value of 24.09 cm. Petiole length of full-grown leaf ranged from 26.33 cm (NDSS-23-27) to 29.20 cm (Kashi Shubhang) with a mean value of 27.74 cm. Fruit length ranged from 26.17 cm (NDSS-23-23) to 32.50 cm (NDSS-23-20) with a mean value of 30.29 cm. Fruit circumference ranged from 25.30 cm (NDSS-23-10) to 32.87 cm (NDSS-23-24) with a mean value of 29.95 cm. Number of fruits per plant ranged from 3.11 (NDSS-23-6) to 3.78 (NDSS-23-2 and NDSS-23-10) with a mean value of 3.50. Average fruit weight ranged from 0.445 kg (NDSS-23-14) to 0.522 kg (NDSS-23-28) with a mean value of 0.481 kg. Flesh thickness ranged from 17.61 mm (NDSS-23-7) to 25.66 mm (NDSS-23-29) with a mean value of 22.24 mm. Ascorbic acid content ranged from 10.18 mg/100g (NDSS-23-1) to 13.56 mg/100g (NDSS-23-26) with a mean value of 11.92 mg/100g. Moisture content ranged from 91.63% (NDSS-23-19) to 95.63% (NDSS-23-28) with a mean value of 94.25%. Dry matter ranged from 4.37 g/100g (NDSS-23-3) to 8.37 g/100g (NDSS-23-28) with a mean value of 5.75 g/100g. Total carotenoids ranged from 1.25 mg/100g (NDSS-23-1) to 3.25 mg/100g (NDSS-23-22) with a mean value of 2.45 mg/100g. Total soluble solids ranged from 4.33 °Brix (NDSS-23-4) to 5.73 °Brix (NDSS-23-7) with a mean value of 5.16 °Brix. Fruit yield per plant ranged from 1.46 kg (NDSS-23-16) to 1.84 kg (NDSS-23-28) with a mean value of 1.69 kg. Fruit yield ranged from 387.06 q/ha (NDSS-23-16) to 453.64 q/ha (NDSS-23-28) with a mean value of 421.07 q/ha.

The estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for the twenty characters are presented in Table 3. In general, PCV values were slightly higher than the corresponding GCV values for all traits, indicating the influence of environmental factors on trait expression. High estimates (>20%) of both GCV and PCV were observed for dry matter content (19.20% and 19.77%, respectively) and total carotenoids (21.95% and 22.07%, respectively), suggesting the presence of substantial genetic variability for these biochemical traits. Moderate estimates (10–20%) of GCV and PCV were recorded for flesh thickness (10.19% and 10.88%), lamina length of fully grown leaf (8.91% and 10.35%) and leaf width (8.97% and 10.45%), indicating the existence of moderate variability and the possibility of improvement through selection. The remaining traits, namely days to first pistillate flowering, days to 50% pistillate flowering, days to first fruit harvest, node number at first staminate flower, node number at first pistillate flower, petiole length, fruit length, fruit circumference, number of fruits per plant, average fruit weight, ascorbic acid content, moisture content, total soluble solids, fruit yield per plant and fruit

yield, exhibited low estimates (<10%) of GCV and PCV, indicating relatively narrow genetic variability for these traits. The estimates of broad-sense heritability and genetic advance are also presented in Table 3. Broad-sense heritability ranged from 19.11% for fruit yield per plant to 98.88% for total carotenoids. High heritability estimates (>80%) were observed for total carotenoids (98.88%), dry matter content (94.26%), moisture content (94.12%), ascorbic acid content (89.48%), flesh thickness (87.80%), lamina length of fully grown leaf (74.15%) and leaf width (73.72%). High heritability indicates that a large proportion of the observed variation in these traits is genetically controlled and less influenced by environmental factors. Similar findings for biochemical and vegetative traits in summer squash were reported by Soniya and Arivazhagan (2023) ^[29] and Abdelkader and Abdein (2023) ^[1]. Moderate heritability estimates (40–70%) were recorded for days to first pistillate flowering (45.16%), days to 50% pistillate flowering (53.49%), node number at first staminate flower (50.00%), fruit circumference (52.79%), number of fruits per plant (46.80%), total soluble solids (67.36%) and fruit yield (53.72%), while comparatively lower estimates were observed for node number at first pistillate flower (19.38%), petiole length (27.47%), average fruit weight (22.00%) and fruit yield per plant (19.11%). Genetic advance as per cent of mean ranged from 1.52% for days to first fruit harvest to

44.96% for total carotenoids. High genetic advance (>20%) was observed for total carotenoids (44.96%), dry matter content (38.39%), flesh thickness (19.67%), ascorbic acid content (17.12%) and leaf width (15.87%), indicating the effectiveness of selection for these traits. Moderate genetic advance (10–20%) was recorded for lamina length of fully grown leaf (15.81%), node number at first staminate flower (7.82%), fruit circumference (6.93%) and total soluble solids (11.61%), whereas days to first pistillate flowering, days to 50% pistillate flowering, days to first fruit harvest, node number at first pistillate flower, petiole length, fruit length, number of fruits per plant, average fruit weight, moisture content, fruit yield per plant and fruit yield exhibited low genetic advance values. High heritability coupled with high genetic advance as per cent of mean was observed for total carotenoids, dry matter content, flesh thickness and ascorbic acid content. This combination indicates the predominance of additive gene action governing these traits and suggests that direct phenotypic selection would be highly effective for their improvement. Similar results were reported by Soniya and Arivazhagan (2023) ^[29], El-Gazzar *et al.* (2020) ^[7] and Abdelkader and Abdein (2023) ^[1]. Therefore, these traits may be considered reliable selection criteria for the development of high-yielding and quality summer squash genotypes.

Table 1: Analysis of variance (mean squares) for twenty quantitative and qualitative characters in Summer Squash

S. No.	Characters	Source of Variation			
		Replication	Genotype	Error	Total
	d. f.	2	30	60	89
1	Days to 1 st Pistillate flowering	0.99	3.54**	1.02	1.84
2	Days to 50% flowering Pistillate	1.26	2.28**	0.51	1.11
3	Days to 1 st fruit harvest	0.83	2.21**	0.77	1.24
4	Node no. of 1 st staminate flower	0.005	0.105**	0.026	0.051
5	Node no. of 1 st pistillate flower	0.001	0.124*	0.072	0.088
6	Lamina length of Fully Grown Leaf (cm)	0.37	13.06**	1.36	5.15
7	Leaf width (cm)	0.49	15.67**	1.66	6.20
8	Petiole length of full-grown leaf (cm)	0.76	2.17**	1.02	1.39
9	Fruit length (cm)	0.48	4.59**	2.01	2.82
10	Fruit circumference (cm)	0.11	7.50**	1.72	3.57
11	Number of fruits per plant	0.001	0.0853**	0.0234	0.0431
12	Average fruit weight (kg)	0.005	0.027**	0.016	0.047
13	Flesh thickness (mm)	0.15	16.13**	0.71	5.72
14	Ascorbic acid (mg/100 g)	0.081	3.418**	0.129	1.200
15	Moisture content (%)	0.074	3.717**	0.076	1.259
16	Dry matter (%)	0.029	3.730**	0.074	1.265
17	Total carotenoids (mg/100 g)	0.007	0.870**	0.003	0.286
18	Total soluble solids (°Brix)	0.026	0.580**	0.17	0.776
19	Fruit yield per plant (kg)	0.004	0.019**	0.011	0.014
20	Fruit Yield(q/ha)	47.94	906.26**	202.20	437.82

Table 2: The mean performance of twenty quantitative and qualitative characters of Summer Squash genotypes

SN	Genotypes	DPF	D50FP	DFH	NSF	NPF	LLFGL	LW	PLFGL	FL	FC	NFP	AFW	FT	AA	MO	DM	TC	TSS	FYP	FYH
1	NDSS-23-1	40.80	49.50	60.24	2.87	4.80	25.53	27.60	27.60	30.27	30.37	3.39	0.486	22.83	10.18	93.97	6.13	1.25	5.60	1.70	419.23
2	NDSS-23-2	39.50	49.05	58.33	2.80	4.87	25.73	29.93	27.75	30.93	30.00	3.78	0.502	19.44	10.79	95.50	4.50	1.65	5.67	1.79	448.97
3	NDSS-23-3	40.19	49.56	58.58	2.93	4.73	22.13	25.13	27.23	32.17	32.07	3.22	0.493	23.87	10.90	95.63	4.37	2.60	5.40	1.70	418.68
4	NDSS-23-4	40.25	48.67	58.50	3.00	5.27	21.47	26.57	27.17	30.67	30.60	3.61	0.469	19.12	10.79	94.95	5.05	1.55	4.33	1.58	415.33
5	NDSS-23-5	39.00	48.91	58.56	3.27	5.20	19.27	22.07	28.80	28.50	27.67	3.39	0.486	24.17	12.59	94.09	5.91	2.35	4.93	1.69	387.06
6	NDSS-23-6	39.19	48.36	58.28	2.93	4.60	21.00	21.83	27.00	30.30	28.67	3.11	0.497	25.03	10.88	91.90	8.10	2.45	5.00	1.65	393.51
7	NDSS-23-7	39.53	48.94	57.14	3.27	5.27	22.67	26.63	27.68	30.13	30.17	3.72	0.516	17.61	13.06	94.52	5.48	2.30	5.73	1.80	449.69
8	NDSS-23-8	40.25	49.05	58.05	3.20	5.07	22.07	24.73	28.90	30.87	31.47	3.67	0.469	19.90	12.65	93.92	6.08	1.95	5.67	1.55	423.42
9	NDSS-23-9	39.30	49.05	58.67	2.87	4.67	20.97	23.33	29.10	31.83	29.93	3.50	0.457	24.63	11.68	93.86	6.14	1.50	4.60	1.72	424.49
10	NDSS-23-10	39.00	49.19	58.72	2.80	4.93	25.07	26.57	27.70	29.10	25.30	3.78	0.476	18.59	13.48	94.75	5.25	2.85	5.60	1.61	421.26
11	NDSS-23-11	39.39	48.91	58.00	3.07	4.80	21.43	26.27	26.60	28.83	30.40	3.50	0.483	22.59	12.45	95.33	4.67	3.21	4.40	1.72	401.14
12	NDSS-23-12	39.58	49.45	58.56	2.73	5.07	20.67	24.93	27.43	30.23	31.17	3.28	0.494	20.20	11.78	94.43	5.57	3.05	5.47	1.76	419.82
13	NDSS-23-13	39.61	48.89	58.33	2.73	5.07	22.53	26.23	27.97	29.13	29.30	3.33	0.495	24.40	11.49	95.35	4.65	2.82	5.53	1.71	410.45
14	NDSS-23-14	39.61	47.83	58.05	3.00	5.13	26.33	25.43	29.00	30.73	28.87	3.28	0.445	20.20	10.76	93.97	6.03	2.51	4.93	1.65	411.37
15	NDSS-23-15	39.56	48.78	59.41	3.13	5.20	20.80	20.93	26.97	30.07	31.63	3.67	0.474	24.33	13.12	94.77	5.23	2.71	5.20	1.74	441.65
16	NDSS-23-16	39.22	48.05	57.61	3.20	4.93	19.93	21.47	27.13	29.83	28.60	3.50	0.488	18.80	12.55	95.53	4.47	3.08	5.33	1.46	421.60
17	NDSS-23-17	38.08	47.58	57.33	2.87	4.87	19.10	22.60	28.67	29.97	29.07	3.44	0.463	22.83	11.32	94.77	5.23	2.44	4.80	1.71	411.50
18	NDSS-23-18	37.11	46.67	56.67	3.00	5.07	20.60	22.57	28.97	29.67	31.00	3.39	0.478	21.49	13.55	94.57	5.43	1.85	5.47	1.67	408.45
19	NDSS-23-19	39.92	49.28	60.10	3.13	4.67	24.83	23.47	28.77	30.70	31.00	3.39	0.498	19.44	12.65	91.63	8.37	1.95	5.33	1.66	433.90
20	NDSS-23-20	39.33	48.66	57.72	2.67	5.33	20.30	21.50	27.77	32.50	30.40	3.33	0.484	24.10	10.83	94.02	5.98	2.82	4.87	1.69	417.91
21	NDSS-23-21	38.89	48.78	59.33	3.13	4.60	21.57	25.60	26.77	31.71	31.67	3.50	0.496	21.83	10.67	92.99	7.01	3.01	5.60	1.61	407.42
22	NDSS-23-22	41.12	48.06	58.03	3.20	4.87	21.87	24.13	27.83	30.50	28.83	3.56	0.472	23.05	11.26	94.36	5.64	3.25	4.53	1.74	414.48
23	NDSS-23-23	43.36	46.27	59.50	2.87	5.00	21.43	20.83	28.17	26.17	29.33	3.61	0.480	19.83	10.65	94.00	6.00	2.42	4.93	1.68	409.16
24	NDSS-23-24	39.50	48.80	57.94	3.13	4.87	20.23	21.80	26.77	30.77	32.87	3.44	0.453	23.23	12.32	94.61	5.39	1.85	5.00	1.73	433.42
25	NDSS-23-25	39.86	48.28	58.33	3.13	5.00	20.20	21.57	27.63	30.60	30.50	3.56	0.473	24.17	11.62	93.00	7.00	2.65	5.47	1.56	416.00
26	NDSS-23-26	39.30	49.28	58.69	3.20	5.07	21.47	23.33	27.37	29.00	29.43	3.72	0.459	24.33	13.56	95.45	4.55	2.82	5.27	1.76	443.16
27	NDSS-23-27	37.58	46.73	56.55	2.87	4.93	24.40	23.50	26.33	30.27	28.83	3.61	0.468	22.83	13.53	93.60	6.40	2.44	4.80	1.71	423.26
28	NDSS-23-28	39.97	50.00	58.22	3.00	4.67	20.93	22.23	26.47	30.50	28.10	3.50	0.522	24.23	10.83	91.63	8.37	2.47	5.40	1.84	453.64
29	NDSS-23-29	38.89	48.33	58.78	3.40	4.93	25.37	23.40	27.33	31.00	28.90	3.67	0.484	25.66	12.47	95.51	4.49	2.61	4.80	1.73	431.56
30	Kashi Shubhangi (C)	39.61	49.05	59.11	3.20	5.07	24.70	26.40	29.20	31.67	32.40	3.56	0.475	24.40	13.16	94.97	5.03	3.05	5.27	1.61	420.65
	Mean	39.55	48.60	58.38	3.02	4.95	22.15	24.09	27.74	30.29	29.95	3.50	0.481	22.24	11.92	94.25	5.75	2.45	5.16	1.69	421.07
	Min	37.11	46.27	56.55	2.67	4.60	19.10	20.83	26.33	26.17	25.30	3.11	0.445	17.61	10.18	91.63	4.37	1.25	4.33	1.46	387.06
	Max	43.36	50.00	60.24	3.40	5.33	26.33	29.93	29.20	32.50	32.87	3.78	0.522	25.66	13.56	95.63	8.37	3.25	5.73	1.84	453.64
	SE(d)	0.83	0.59	0.71	0.13	0.22	0.95	1.05	0.82	1.16	1.07	0.13	0.013	0.69	0.29	0.23	0.22	0.05	0.044	0.09	11.61
	C.D.	1.66	1.17	1.43	0.27	0.44	1.91	2.11	1.65	2.32	2.15	0.25	0.027	1.38	0.59	0.45	0.45	0.09	0.089	0.17	23.30
	C.V.	2.56	1.47	1.50	5.37	5.43	5.26	5.36	3.64	4.68	4.38	4.37	3.398	3.80	3.01	0.29	4.74	2.34	2.18	6.18	5.38

DPF- Days to first pistillate flower, **D50FP**- Days to 50% flowering of pistillate flowers, **DFH**- Days to first fruit harvest, **NSF**-- Node number of first staminate flower, **NPF**- Node number of first female flower appears, **LLFGL**- Leaf length of fully grown leaf, **LW**-Leaf width (cm), **PLFGL**- Petiole length of fully grown leaf (cm), **FL**- Fruit length (cm), **FC**- Fruit circumference (cm), **NFP**- Number of fruits per plant, **AFW**- Average fruit weight (kg), **FT**- Flesh thickness (mm), **AA**- Ascorbic acid (mg/100 g), **MO**- Moisture content (%), **DM**- Dry matter(g/100 g), **TC**- Total carotenoids content(mg/100 g), **TSS**- Total soluble solids (°Brix / %), **FYP**- Fruit yield per plant (kg), **FYH**- Fruit yield per hectare (q)

Table 3: Mean, Range, coefficient of variation, heritability, GA, GCV, PCV and contribution (%) for twenty characters in Summer squash

Characters	Mean	Min	Max	Heritability (%)	GA	GA% mean	GCV (%)	PCV (%)
Days to 1 st Pistillate flowering	39.55	37.11	43.36	45.16	1.27	3.21	2.32	3.45
Days to 50% flowering Pistillate	48.60	46.27	50.00	53.49	1.16	2.38	1.58	2.16
Days to 1 st Fruit Harvest	58.38	56.55	60.24	38.61	0.89	1.52	1.19	1.91
Node no. of 1 st staminate flower	3.02	2.67	3.40	50.00	0.24	7.82	5.37	7.59
Node no. of 1 st pistillate flower	4.95	4.60	5.33	19.38	0.12	2.41	2.66	6.05
Lamina Length of Fully Grown Leaf	22.15	19.10	26.33	74.15	3.50	15.81	8.91	10.35
Leaf Width	24.09	20.83	29.93	73.72	3.82	15.87	8.97	10.45
Petiole Length of Full-Grown leaf	27.74	26.33	29.20	27.47	0.67	2.42	2.24	4.27
Fruit Length (cm)	30.29	26.17	32.50	30.04	1.05	3.46	3.07	5.59
Fruit Circumference(cm)	29.95	25.30	32.87	52.79	2.08	6.93	4.63	6.38
No. of Fruit/Plant	3.50	3.11	3.78	46.80	0.20	5.78	4.10	6.00
Average Fruit Weight (kg)	0.481	0.445	0.522	22.00	0.01	1.60	1.65	3.52
Flesh Thickness (mm)	22.24	17.61	25.66	87.80	4.38	19.67	10.19	10.88
Ascorbic acid (mg/100gm)	11.92	10.18	13.56	89.48	2.04	17.12	8.79	9.29
Moisture content	94.25	91.63	95.63	94.12	2.20	2.34	1.17	1.20
Dry Matter (gm)	5.75	4.37	8.37	94.26	2.21	38.39	19.20	19.77
Total Carotenoids (mg/100gm)	2.45	1.25	3.25	98.88	1.10	44.96	21.95	22.07
Total Soluble Solids (°B)	5.16	4.33	5.73	67.36	0.60	11.61	6.87	8.37
Fruit Yield/Plant (Kg)	1.69	1.46	1.84	19.11	0.05	2.70	3.00	6.87
Fruit Yield (q/ha)	421.07	387.06	453.64	53.72	23.13	5.49	3.64	4.96

Conclusion

Among all the traits studied, the phenotypic coefficient of variation (PCV) was consistently higher than the corresponding genotypic coefficient of variation (GCV), indicating the influence of environmental factors on trait expression. However, the relatively narrow differences between PCV and GCV values for most traits suggested that the observed variability was predominantly genetic in nature. High estimates of both PCV and GCV were recorded for total carotenoids and dry matter content, reflecting the presence of substantial genetic variability and a greater scope for improvement through selection. Furthermore, total carotenoids, dry matter content, flesh thickness and ascorbic acid content exhibited high heritability coupled with high genetic advance as per cent of mean. This combination indicates the predominance of additive gene action in the inheritance of these traits and suggests that their expression is largely governed by heritable genetic factors. Therefore, direct phenotypic selection for total carotenoids, dry matter content, flesh thickness and ascorbic acid content would be highly effective for enhancing fruit quality and yield potential in summer squash. Among the genotypes evaluated, NDSS-23-28 recorded the highest fruit yield (453.64 q/ha) along with superior performance for flesh thickness, ascorbic acid content and number of fruits per plant, making it a promising genotype for direct selection or utilization as a parent in future hybridization programmes aimed at developing high-yielding and quality summer squash varieties.

References

1. MFM, Abdein MA. Interrelationship of squash characteristics under different environmental conditions. Horticultural Science Journal, Suez Canal University. 2023;12(1):10–18.
2. Allard RW. Principles of Plant Breeding. New York: John Wiley and Sons; 1960. 430 p.
3. Burgos AR, Carrillo-Lopez A, Osuna-Enciso T, Manuel BS, Sanudo-Barajas A, Contreras-Martinez R, Dolores MR. Growth dynamics and water potential components of three summer squash. Notulae Botanicae Horti Agrobotanici Cluj-Napoca. 2015;43(2):420–429.
4. Burton GM, DeVane EM. Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. Agronomy Journal. 1953;45(10):478–481.
5. Decoteau DR. Vegetable Crops. Upper Saddle River (NJ): Prentice Hall; 2003. 464 p.
6. Dewey DR, Lu KH. A correlation and path-coefficient analysis of components of crested wheatgrass seed production. Agronomy Journal. 1959;51(9):515–518.
7. El-Gazzar TM, Nada MM, Hussein AH, Dawood AR. Evaluation of new summer squash hybrids (*Cucurbita pepo* L.) compared with some commercial cultivars. Journal of Plant Production. 2020;11(9):841–845.
8. El-Khatib EHM. Genetic behavior of some economical traits in squash (*Cucurbita pepo* L.) [MSc thesis]. Mansoura (Egypt): Faculty of Agriculture, Mansoura University; 2013.
9. Gebhardt SE, Thomas RG. Nutritive Value of Foods. Agriculture Handbook No. 72. Washington (DC): US Government Printing Office; 2002.
10. Gholami R, Lorestani AN, Jalilantabar F. Determination of physical and mechanical properties of zucchini (summer squash). Agricultural Engineering International: CIGR Journal. 2012;14(1):136–140.
11. Hanson CH, Robinson HF, Comstock RE. Biometrical studies of yield in segregating populations of Korean *Lespedeza*. Agronomy Journal. 1956;48(6):268–272.
12. Jekemboi E, Koitilio B, Pkani K, Chepkoech E, Churu H. Morphological characterization of selected pumpkin (*Cucurbita pepo* L.) accessions in Baringo County, Kenya. Journal of Crops, Livestock and Pests Management. 2023;1(1):54–64.
13. Kuslu Y, Sahin U, Kiziloglu FM, Memis S. Fruit yield and quality and irrigation water use efficiency of summer squash drip-irrigated with different irrigation quantities in a semi-arid agricultural area. Journal of Integrative Agriculture. 2014;13(11):2518–2526.
14. MacGillivray JH, Hanna GC, Minges PA. Vitamin, protein, calcium, iron and calorie yield of vegetables per acre and per man-hour. Proceedings of the American Society for Horticultural Science. 1942;41:293–297.

15. Mahadeen A. Effect of polyethylene black plastic mulch on growth and yield of two summer vegetable crops under rain-fed conditions in semi-arid regions. *American Journal of Agricultural and Biological Sciences*. 2014;9(2):202–207.
16. Mahalanobis PC. On the generalized distance in statistics. *Proceedings of the National Institute of Sciences of India*. 1936;2(1):49–55.
17. Marie AJI, Mohammed GH. Correlation, path coefficients and regression analysis in summer squash. *Mesopotamia Journal of Agriculture*. 2010;38(1):52–54.
18. Martínez-Valdivieso D, Gomez P, Font R, Alonso-Moraga A, Del Río-Celestino M. Physical and chemical characterization in fruit from 22 summer squash (*Cucurbita pepo* L.) cultivars. *Lebensmittel-Wissenschaft und Technologie – Food Science and Technology*. 2015;64:1225–1233.
19. Panse VG, Sukhatme PV. *Statistical Methods for Agricultural Workers*. New Delhi: Indian Council of Agricultural Research; 2000. p. 187–197.
20. Paris HS. Summer squash. In: *Vegetables I*. New York: Springer; 2008. p. 351–379.
21. Pearson K. On lines and planes of closest fit to systems of points in space. *The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*. 1901;2(11):559–572.
22. Pearson K. Determination of the coefficient of correlation. *Science*. 1909;30(757):23–25.
23. Regmi R, Bhusal N, Neupane S. Efficacy of mulching materials on growth performance and yield characters of summer squash (*Cucurbita pepo* cv. Shlesha 1214) in Mahottari, Nepal. *International Journal of Research in Applied Science and Biotechnology*. 2021;8(1):57–63.
24. Robinson RW, Decker-Walters DS. *Cucurbits*. Wallingford (UK): CAB International; 1997. 226 p.
25. Seymen M, Yavuz D, Dursun A, Kurtar ES, Türkmen Ö. Identification of drought-tolerant pumpkin (*Cucurbita pepo* L.) genotypes associated with certain fruit characteristics, seed yield and quality. *Agricultural Water Management*. 2019;221:150–159.
26. Singh VP, Singh PK, Rai R, Bhatt L. Enhancing earliness and productivity in summer squash through black polymulch in Uttarakhand hills. *Progressive Horticulture*. 2011;43(1):163–165.
27. Singh S, Dubey A, Rajput SS. Genetic variability studies in summer squash (*Cucurbita pepo* L.). *International Journal of Current Microbiology and Applied Sciences*. 2019;8(3):1245–1252.
28. Slavin JL, Lloyd B. Health benefits of fruits and vegetables. *Advances in Nutrition*. 2012;3(4):506–516.
29. Soniya T, Arivazhagan E. Evaluation of summer squash genotypes (*Cucurbita pepo* L.) under tropical conditions. *Ecology, Environment and Conservation*. 2024;30(Suppl July):S123.
30. Swingle HD, Brown JF, Coffee DL, Mullins CA. Evaluation of vegetable varieties. *Bulletins*. 1975;543:1–32.
31. Thamburaj S, Singh N. *Textbook of Vegetables, Tuber Crops and Spices*. New Delhi: Indian Council of Agricultural Research; 2001. 469 p.
32. Trumbull JH. Vegetables cultivated by the American Indians. *Bulletin of the Torrey Botanical Club*. 1876;6(13):69–71.
33. United States Department of Agriculture. FoodData Central [Internet]. Washington (DC): USDA; 2020 [cited Year Month Day]. Available from: <https://fdc.nal.usda.gov>
34. Yoldaş F. Effect of plant variety and growing methods on yield and quality in summer squash. In: *Fifth International Scientific Agricultural Symposium (AGROSYM)*; Izmir, Turkey. 2014. p. 358–363.