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Variability studies for vitamin C, beta carotene and total phenol content in kale (*Brassica oleracea* L. var. *acephala*) genotypes

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Abstract
The present investigation was undertaken to estimate the vitamin C, beta carotene and total phenol content in kale genotypes collected from different regions of Jammu and Kashmir including Ladakh. The experiment was undertaken in Randomized Block Design (RBD) with three replications at the Experimental Farm of the Department of Vegetable Science and Floriculture, SKUAST, Jammu. Thirty genotypes of kale were evaluated during Rabi season of 2015-16 and 2016-17 and their corresponding pooled data were worked out and further analysed. Analysis of variance revealed significant variability for most of the traits. The PCV and GCV were found to be low for all the three traits during both the year and pooled analysis which could be due to differences in genetic material and growing conditions. High heritability with low genetic advance as percentage of mean was marked for all the three biochemical traits indicating that these traits are more likely under the control of non-additive gene action and selection for these traits would be less effective.

Keywords: *Brassica oleracea*, beta carotene, total ascorbic acid content, total phenol content, PCV, GCV and heritability

Introduction
Kale (*Brassica oleracea* L. var. *acephala* DC.) is one of the oldest forms belonging to Cruciferaceae family (Khan *et al*., 2011) [14] and is probably the first brassicas to be cultivated which are quite similar to wild cabbage. Kale has originated from eastern Mediterranean region and is being used as a food crop since 2000 BC (Acikgoz, 2011) [1].
Cruciferous vegetables particularly cauliflower, broccoli and kale are a good source of natural antioxidants like carotenoids, tocopherols and ascorbic acid (Murtaza *et al*., 2005) [26]. Kale is one of the most nutritious vegetables known so far. It is because of the antioxidant properties associated with it due to vitamin C, pro-vitamin (β-carotene & lutein), minerals and anti oxidants (Cao *et al*., 1996) [5]. It is one of the richest source of carotenoids especially xanthophylls (Ligor and Buszewski, 2012) [19]. Consumption of kale juice is determined to raise the HDL levels and lower the LDL levels, and also improve their atherogenic profiles which measured their likelihood of developing coronary artery disease (Kim *et al*., 2008). Among all 100 of the worlds healthiest foods, kale grabs the first position in terms of lutein content and is the primary lutein-containing food in the USDA's National Nutrient Database that analyzes 5,350 foods that contain this carotenoid nutrient. Epidemiological findings have now established that among phtochemicals, phenols contribute more quantitatively towards total antioxidant activity of the foods than nutrient antioxidants like vitamin C and E. Consumption of kale reduces the risk of several forms of cancer such as breast (Fowke *et al*., 2003) [9]; stomach and colorectal (Zickute *et al*., 2005) [42], kidney (Moore *et al*., 2007) [24], bladder (Munday *et al*., 2008) [25] and prostate (Traka *et al*., 2008) [39].
In view of growing interest in health promoting properties of antioxidant in diet, there is an urgent need to identify promising genotypes with higher levels of these antioxidant compounds. Kale is a highly cross pollinated vegetable crop and is reported to be rich in diversity due to complex natural intra and inters specific crosses and geographical barriers. Also, genetic diversity of North West Himalayan region has not been properly documented and characterized for further use in any plant breeding programme. Keeping this in view, thirty kale genotypes collected from different regions of Jammu and Kashmir including Ladakh were evaluated for total ascorbic acid content, beta carotene content and total phenol content and further estimates of variability were worked out so as select genotypes with higher antioxidant properties which can be used for further vegetable breeding programme.

Material and method
Location and Climate: The experiment was conducted in Division of Vegetable Science and Floriculture, SKUAST, Jammu with an elevation of 332 m above mean sea level which is

situated at 32° 40´N latitude and 74° 58´ E longitude. Agro climatically the location represents Zone V of Jammu and Kashmir and is characterized by subtropical climate with hot dry summer, hot and humid rainy season and cold winter months. The place experiences the maximum temperature of 45°C during summers (May to June) and minimum temperature upto 1°C during winters. The mean annual rainfall is about 1000-1200 mm. The weather conditions during the crop season with respect to average rainfall, maximum to minimum temperature and relative humidity was recorded on weekly basis from the Division of Agrometerology, Chatha. The meteorological data pertaining to the period of crop season in 2015-16 and 2016-17 is given in Table 1 and 2 below.

Experimental material and observations: The experimental material comprised of thirty diverse genotypes of kale locally collected from all the three region of J&K including Jammu, Kashmir and Ladakh. The details of the genotypes along with their source are given in Table 3.The replicated field trial was carried out at the research farm of SKUAST, Jammu, India during the year 2015-16, 2016-17 with standard agricultural practices. A disease-free, healthy crop was cultivated and, at the edible maturity stage, three uniform-size plants, free of insect and/or physical damage were selected from each species to constitute replicates. Three independent samples were analyzed from each genotypes and values mentioned are the mean of three different determinations. The means were then worked out for statistical analysis as per method given by Panse and Sukhatme (1967) [27].

Biochemical traits: The biochemical work was done in the laboratory of Division of Vegetable Science and Floriculture using the following methods:

Ascorbic acid content (mg/100 g): The ascorbic acid content in kale leaves was extracted as per the method suggested by Sadasivam and Theymoli (1987) [29]. 0.5 gm of leaf sample was taken and grinded with a pestle and mortar using 10 ml of 4% oxalic acid. Extract was filtered and the volume was made upto 100 ml. To this 5 ml of aliquot, 10 ml of 4% oxalic acid was added and titrated against 2,6-dichloro phenol indophenols dye till the appearance of pink colour (V2). The dye factor (V1) was calculated by titrating standard ascorbic acid content against the 2,6-dichloro phenol indophenols dye. The ascorbic acid content of the sample was expressed as:

$$\text{Ascorbic acid (mg/100 g)} = \frac{0.5\,mg}{V1\,ml} \times \frac{V2}{15\,ml} \times \frac{100\,ml}{weight\ of\ sample} \times 100$$

Beta carotene (mg/100 g): Estimation of Beta carotene was carried out as per the method suggested by Sadasivam and Manickam (1992) [28]. 2 g of leaf sample was crushed using a pestle and mortar by adding 40 ml of acetone (80%) slowly so that till it becomes colourless and a pinch of 0.1% magnesium carbonate was added to it. The extract was filtered and transferred to the separating funnel and to it 60 ml of hexane and 20 ml of petroleum ether was added. Again 5% sodium sulphate was added and mixes thoroughly. Lower phase was discarded and upper phase was collected in a separate volumetric flask and volume was made upto 100 ml using petroleum ether. The absorbance was read at 452 nm using petroleum ether as a blank.

$$\text{Beta carotene (mg/100 g)} = \frac{O.D \times 13.9 \times 10^4 \times 100}{Weight\ of\ sample \times 560 \times 1000}$$

Total phenols content (mg/100 g): The contents of total phenol was estimated spectrophotometrically using Folin-Ciocalteu reagents i.e FCR (Thimmaiah, 1999) [38]. 1g of leaf sample was crushed in 10 ml of 80% ethanol and centrifuged. The supernatant was decanted and the residue was re-extracted with 5 ml of 80% ethanol. Supernatant were then pooled and evaporated to dryness. The residue obtained was dissolved in 2 ml of distilled water, 0.1 ml of aliquot was extracted and volume was made up to 3 ml to which 0.5 ml of FCR, 2 ml of 20% sodium carbonate was added after 3 min and was then placed in boiling water for a minute and then cooled. Finally the absorbance was made at 650 nm against a blank reagent. The standard curve was prepared using different concentration of standard catechol solution (0.1, 0.2, 0.3, 0.4 & 0.5).

Statistical analysis: The analysis of variance was performed on data obtained from differences between the genotypes using the ANOVA (SPSS Ver. 10). Mean separations were determined by least significant difference (LSD) at P less than equal to 0.05%. The data obtained from biochemical traits was analyzed as per Gomez and Gomez (1983). The genotypic, phenotypic and environmental coefficients of variation were estimated by method of Burton and De Vane (1953) [4]. Heritability in broad sense expected genetic advance (GA) resulting from the selection of 5% superior individuals was calculated as per Burton and De Vane (1953) [4] and Johnson *et al*. (1955) [12].

Result and discussion: The analysis of variance for three biochemical traits 'F' values revealed significant differences among genotypes for all the three traits thirty different genotypes of kale were then assayed for variability between the genotypes for these biochemical traits.

Parameters of variability: The estimates of mean (Table 4), range and parameters of variability viz., phenotypic and genotypic coefficients of variability (PCV and GCV) along with heritability in broad sense and expected genetic advance as per cent of mean during the year 2015-16, 2016-17 and pooled for the biochemical traits are given in Table 5, 6 and 7 respectively.

Ascorbic acid content varied from 127.53 mg/100g to 158.57 mg/100g during the year 2015-16. The maximum ascorbic acid was found in SJK-11 (158.57 mg/100g) followed by SJK-20 (156.34 mg/100g) while the minimum ascorbic acid content was found in SJK-15 (127.53 mg/100g). During the year 2016-17, the ascorbic acid content ranged from 140.62 mg/100g to 158.53 mg/100g. The maximum ascorbic acid content was recorded in SJK-11 (158.53 mg/100g) followed by SJK-20 (156.29 mg/100g) and minimum ascorbic acid content was found in SJK-27 (140.62 mg/100g). Further the pooled analysis of ascorbic acid content revealed that the value ranged from 127.67 mg/100g in SJK-16 to 158.50 mg/100g in SJK-11 followed by SJK-20 (156.31 mg/100g). The beta carotene content in kale genotypes during the year 2015-16 varied from 6.26 mg/100g to 7.78 mg/100g. The maximum beta carotene content was found in SJK-24 (7.78 mg/100g) followed by SJK-12 (7.71 mg/100g) and SJK-20 (7.68 mg/100g). The minimum value for beta carotene content was noted in SJK-16 (6.26 mg/100g). During the year 2016-17, the value for beta carotene content varied from 6.41 mg/100g to 7.93 mg/100g. The maximum value was found in SJK-11 (7.93 mg/100g) followed by SJK-12 (7.86 mg/100g); SJK-20 (7.83 mg/100g) and SJK-05 (7.70 mg/100g). Pooled

analysis, depicted that highest beta carotene content was found in SJK-24 (7.86 mg/100g) and lowest in SJK-16 (6.34 mg/100g). Total phenol content was also estimated in kale genotypes during the two consecutive years 2015-16 and 2016-17. The value obtained from both the year and pooled data revealed that minimum total phenol content in SJK-09 (139.95 mg/100g ; 139.97 mg/100g & 139.96 mg/100g) and maximum in SJK-04 (198.42 mg/100g; 198.53 mg/100g & 198.48 mg/100g) followed by SJK-27 (198.23 mg/100g; 198.19 mg/100g & 198.21 mg/100) and SJK-01(197.51 mg/100g; 197.48 mg/100g & 197.49 mg/100g). Similar findings for various traits were obtained by other workers namely Saleem *et al.* (2017) [30], Khan *et al.* (2010) [13] and Malode and Shelke (2010) [21] for number of leaves per plant; Saleem *et al.* (2017) [30], Synrem (2017) [37] and Tripathi *et al.* (2015) [40] for plant height; number of seeds per siliqua and number of siliqua per plant.

Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV): The Knowledge of phenotypic and genotypic coefficient of variation is essential in predicting the extent of variation present in the given genetic stock which in turn helps in formulating an efficient breeding programme. The estimates of PCV were slightly higher with lesser magnitude than corresponding GCV for all the three traits studied during 2015-16, 2016-17 and pooled analysis which indicated lesser influence of environmental factors. These results are in close agreement with those reported by Manaware *et al.* (2017) [22], Shiwani *et al.* (2016) [32], Chittora and Singh (2015) [7].

The phenotypic coefficient of variability and genotypic coefficient of variability were found to be low for all the three traits during both the year and pooled analysis. This could be due to differences in genetic material and growing conditions. Similar findings for plant height was reported by Sikarwar *et al.* (2017) [34]; number of leaves per plant by Chittora and Singh (2015) [6]; ascorbic acid (Kumar *et al*., 2011) [16]; marketable yield and gross weight (Chittora and Singh, 2015) [6].

Heritability and genetic advance: Burton, 1952 [3] reported that coefficient of variation cannot be used alone to partition the heritable components of variation (Burton, 1952) [3]. This suggested that genetic coefficient of variation together with heritability estimates would give the real scenario of the amount of advance to be expected from selection. Heritability is a measure of the genetic relationship between parents and progeny and had widely used in determining the degree to which a character may be transmitted from parents to offspring. The information on heritability estimates is helpful in studying the inheritance of traits as well as for planning breeding programmes with desired degree of expected general progress. Heritability in broad sense is of tremendous significance to the breeders as its magnitude indicates the reliability with which a genotype can be recognized by its phenotypic expression (Lush 1940). These high estimates revealed the lesser influence of environment and greater role of genetic component of variation. All the three biochemical traits viz. ascorbic acid content, beta carotene and total phenol content gave high heritability. The results are in line with the findings of earlier workers who also recorded high heritability for above traits namely Singh *et al*., 2013 [36] for ascorbic acid content, Hasan *et al.* (2014) [11] for days to first flowering, Sikarawar *et al.* (2017) [34]; for plant height, Chittora and Singh (2015) [7] for total yield, Mehra and Singh (2013) [23] for leaf area index. This indicated that large proportion in the expression of the phenotypic variance was attributable to the genotypic component of variance and the difference for these traits were real (2015-16, 2016-17 and pooled analysis).

Selection for a particular trait is generally made on the basis of its phenotypic expression which is the outcome of genotype and environment. Therefore, the phenotypic superiority of plants over the original population is not solely due to favourable environmental factors. In such a situation, genetic advance gives good idea for actual gain to be made in the population under evaluation. Johnson *et al*., (1955) [12] stressed that for estimating the real effects of selection, heritability alone is not sufficient and genetic advance along with heritability is more useful. Genetic advance may or may not be in proportion to genetic variability and heritability estimates because both high heritability and genetic variability are important to obtain higher genetic gain (Kumari, 2010) [18]. The estimates of genetic advance as percentage of mean along with the heritability values are more useful because it provides better response during selection than either of the parameters alone, whereas, Burton (1952) [3], was of the opinion that the genetic coefficient of variation along with heritability give the best picture of the genetic advance to be expected from selection. The high heritability does not necessarily mean high genetic gain and alone it is not sufficient to make improvement through selection. Thus, the genetic advance has an edge over heritability as a guiding factor to breeders in selection programme (Sharma *et al*., 2018) [31].

High heritability with low genetic advance as percentage of mean was marked for all the three biochemical traits t indicating that these trait are more likely under the control of non-additive gene action and selection for this trait would be less effective. High heritability along with low genetic gain clearly shows the major role of non-additive gene action in the transmission of these characters from parents to offspring as reported earlier by Buhroy *et al.* (2017) [2] and therefore cannot be improved by selection. Similar findings have also been reported for days to marketable curd maturity from date of transplanting and plant height (Kumar and Thakur, 2004; Dhatt and Garg, 2008 and Singh *et al*., 2010) [17, 8, 35].

Table 1: Meteorological observations: a weekly average during the experimental period (Oct. 2015 to May 2016)

Met. Week	Date & month	Max Temp (^{0}C)	Min Temp (^{0}C)	Max RH (%)	Min RH (%)	Rainfall (mm)
1.	1-7 Oct	33.0	18.4	84	48	0.0
2.	8-14 Oct	31.9	20.6	85	51	0.0
3.	15-21Oct	30.2	16.7	85	44	19.0
4.	22-28 Oct	27.6	14.2	83	68	14.4
5.	29-4 Nov	27.0	13.8	90	81	3.0
6.	5-11 Nov	25.2	11.6	93	91	0.8
7.	12-18Nov	26.7	10.6	92	47	0.0
8.	19-25 Nov	25.4	9.0	90	46	0.0
9.	26-2 Dec	25.3	9.3	91	47	0.0

10.	3-9 Dec	23.4	8.8	94	47	0.0
11.	10-16 Dec	19.2	6.7	94	68	28.4
12.	17- 23 Dec	18.8	3.7	93	52	0.0
13.	24-31Dec	20.4	2.5	93	49	0.0
14.	1-7 Jan	20.4	4.6	91.3	57.6	1.8
15.	8-14 Jan	20.6	5.3	92.3	52.3	0.0
16.	15-21Jan	13.0	6.5	93.0	83.1	0.0
17.	22-28 Jan	14.2	4.0	96.3	71.6	0.0
18.	29-4 Feb	20.5	6.3	94.1	61.3	10.0
19.	5-11 Feb	21.6	6.3	88.1	51.1	2.8
20.	12-18 Feb	22.9	5.5	88.9	39.0	0.0
21.	19-25 Feb	25.6	9.1	85.1	51.6	12.8
22.	26-4 Mar	27.3	11.2	86.0	53.0	0.0
23.	5-11 Mar	27.0	13.0	80.9	51.4	7.0
24.	12-18 Mar	22.8	12.4	87.7	69.0	51.6
25.	19-25Mar	27.6	12.5	81.3	47.6	5.4
26.	26-1 Apr	30.0	14.2	83.4	55.1	0.0
27.	2-8 Apr	31.5	16.1	77.1	46.0	1.2
28.	9-15Apr	32.4	13.9	77.4	39.1	1.8
29.	16-22 Apr	34.5	17.3	66.4	31.0	0.2
30.	23-29 Apr	36.1	15.0	66.6	22.7	0.0
31.	30-6 May	36.7	17.9	54.0	54.0	2.6
32.	7-13 May	38.1	21.9	54.9	34.6	4.0
33.	14-20 May	40.9	21.2	48.0	24.7	0.0
34.	21-27 May	38.6	22.0	61.0	30.9	3.6

Table 2: Meteorological observations: a weekly average during the experimental period (Oct. 2016 to May 2017)

Met. Week	Date & month	Max Temp (^{0}C)	Min Temp (^{0}C)	Max RH (%)	Min RH (%)	Rainfall (mm)
1	1-7 Oct	34.2	23.5	79	63	001.2
2	8-14 Oct	32.7	18.0	75	57	000.0
3	15-21Oct	32.0	16.1	78	43	000.0
4	22-28 Oct	31.4	13.8	76	39	000.0
5	29-4 Nov	28.6	12.6	80	53	000.0
6	5-11 Nov	28.1	10.0	87	39	000.0
7	12-18Nov	24.7	8.4	79	43	000.0
8	19-25 Nov	24.8	9.2	90	45	000.0
9	26-2 Dec	26.1	8.2	92	41	000.0
10	3-9 Dec	23.8	6.9	94	51	000.0
11	10-16 Dec	21.9	7.4	92	62	000.0
12	17- 23 Dec	22.7	3.6	92	51	000.0
13	24-31Dec	22.0	5.7	90	54	000.0
14	1-7 Jan	19.7	8.6	92.0	59.0	32.4
15	8-14 Jan	16.9	2.4	90.0	53	10.0
16	15-21Jan	16.7	5.2	87	61	21.2
17	22-28 Jan	18.1	9.4	93	79	69.2
18	29-4 Feb	18.6	9.7	97	76	10.2
19	5-11 Feb	20.1	7.4	86	58	24.0
20	12-18 Feb	24.2	9.0	86	58	0
21	19-25 Feb	24.2	9.6	76	52	7.4
22	26-4 Mar	25.4	8.7	82	38	0.0
23	5-11 Mar	21.7	8.2	84	53	38.4
24	12-18 Mar	22.9	7.3	78	44	2.0
25	19-25Mar	28.9	12.5	82	43	0.0
26	26-1 Apr	33.1	15.6	84	43	0.0
27	2-8 Apr	30.4	15.1	79	41	19.8
28	9-15Apr	33.4	11.9	70	33	0.0
29	16-22 Apr	38.8	20.1	62	29	1.8
30	23-29 Apr	35.1	16.9	61	28	1.8
31	30-6 May	36.1	16.4	56	24	0
32	7-13 May	39.9	20.6	56	30	0.0
33	14-20 May	37.8	20.9	55	27	1.0
34	21-27 May	37.8	21.7	59.6	33	2.8

Table 3: List of thirty genotypes along with their source of collection

S. No.	Code no.	Genotype	Source
1.	SJK-01	Khanyari Sel.-1	SKUAST-K
2.	SJK-02	Khanyari Sel.-2	Kupwara
3.	SJK-03	Khanyari Sel.-3	CITH

4.	SJK-04	Khanyari Sel. -4	Bandipura
5.	SJK-05	Khanyari Sel.-05	FFPRS, Karlah
6.	SJK-06	G. M. Dari Sel.-1	SKUAST-K
7.	SJK-07	G. M. Dari Sel.-2	Kupwara
8.	SJK-08	G. M. Dari Sel. -3	CITH
9.	SJK-09	G. M. Dari Sel.-4	Bandipura
10.	SJK-10	G. M. Dari Sel.- 5	FFPRS, Karlah
11.	SJK-11	Leh local Sel.-1	Leh
12.	SJK-12	Leh local Sel.-2	Leh
13.	SJK-13	Jammu local -1	Kanachak
14.	SJK-14	Jammu local -2	Sarora
15.	SJK-15	Jammu local -3	Marh
16.	SJK-16	Jammu local -4	Karloop
17.	SJK-17	Jammu local -5	Chenani
18.	SJK-18	Jammu local -6	Assar
19.	SJK-19	Anchari green	SKUAST-K
20.	SJK-20	Kawdari	SKUAST-K
21.	SJK-21	Wantipuri	SKUAST-K
22.	SJK-22	Sag Purple Selection	SKUAST-K
23.	SJK-23	Japanese green	CITH
24.	SJK-24	Siberian Kale	CITH
25.	SJK-25	Drass kale	Drass
26.	SJK-26	Sag-81	SKUAST-K
27.	SJK-27	Sag-88	SKUAST-K
28.	SJK-28	Sag-100	SKUAST-K
29.	SJK-29	Hanz Hak	CITH
30.	SJK-30	Kashmir local	Pulwama

Table 4: Mean values of three traits during theyear 2015-16, 2016-17 and pooled analysis

Genotype	Asc. acid content (mg/100g)			Beta carotene (mg/100g)			Total phenol content (mg/100g)		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
SJK-01	150.56	150.53	150.54	7.15	7.30	7.23	197.51	197.48	197.49
SJK-02	153.88	154.10	153.99	7.31	7.46	7.39	196.19	196.26	196.23
SJK-03	152.90	153.12	153.01	7.15	7.30	7.23	196.97	196.99	196.98
SJK-04	149.66	149.63	149.65	7.27	7.42	7.35	198.42	198.53	198.48
SJK-05	152.37	152.37	152.37	7.55	7.70	7.63	192.26	192.19	192.23
SJK-06	148.64	148.64	148.64	7.19	7.34	7.27	148.73	148.74	148.73
SJK-07	149.74	149.79	149.77	7.00	7.15	7.08	166.04	166.11	166.08
SJK-08	149.48	149.56	149.52	6.91	7.06	6.99	146.10	146.26	146.18
SJK-09	149.42	149.50	149.46	7.19	7.34	7.27	139.95	139.97	139.96
SJK-10	148.75	148.88	148.81	7.09	7.24	7.17	155.99	156.07	156.03
SJK-11	158.57	158.43	158.50	7.78	7.93	7.86	162.77	162.80	162.78
SJK-12	144.88	144.91	144.90	7.71	7.86	7.79	167.67	167.78	167.73
SJK-13	138.81	138.80	138.81	6.71	6.86	6.79	186.60	186.66	186.63
SJK-14	138.51	138.39	138.45	6.57	6.72	6.65	185.38	185.42	185.40
SJK-15	127.53	127.88	127.71	6.53	6.68	6.61	190.03	189.97	190.00
SJK-16	127.68	127.66	127.67	6.26	6.41	6.34	181.71	181.81	181.76
SJK-17	137.62	137.91	137.76	6.38	6.53	6.46	180.51	180.43	180.47
SJK-18	139.94	139.95	139.95	6.58	6.73	6.66	186.49	186.53	186.51
SJK-19	145.44	145.24	145.34	6.94	7.09	7.02	196.74	196.78	196.76
SJK-20	156.34	156.29	156.31	7.68	7.83	7.76	185.04	185.11	185.08
SJK-21	141.45	141.57	141.51	7.24	7.39	7.32	183.31	183.29	183.31
SJK-22	142.68	142.79	142.73	7.15	7.30	7.23	187.55	187.50	187.52
SJK-23	148.97	148.85	148.90	7.27	7.42	7.35	153.68	153.73	153.71
SJK-24	140.37	140.29	140.33	7.78	7.93	7.86	174.54	174.55	174.55
SJK-25	137.24	136.97	137.11	7.52	7.67	7.60	192.32	192.29	192.30
SJK-26	145.64	145.85	145.75	7.45	7.27	7.36	157.38	157.53	157.46
SJK-27	140.46	140.62	140.54	7.53	7.68	7.61	198.23	198.19	198.21
SJK-28	128.06	128.30	128.18	7.32	7.47	7.40	193.08	193.00	193.04
SJK-29	143.04	135.26	139.15	7.34	7.49	7.42	189.88	197.46	193.67
SJK-30	143.18	151.16	147.17	7.12	7.27	7.20	189.99	182.60	186.29
General Mean	144.39	144.44	144.42	7.16	7.29	7.23	179.37	179.40	179.39
SE m±	0.93	1.05	0.96	0.14	0.16	0.15	2.05	2.15	2.09
CV (%)	1.12	1.25	1.15	3.48	3.83	3.59	1.98	2.08	2.02
CD (0.05)	2.65	2.97	2.72	0.41	0.46	0.43	5.82	6.10	5.94

Table 5: Estimates of variability during the year 2015-16

Estimates of variability		Ascorbic acid content (mg/100g)	Beta carotene (mg/100g)	Total phenols content (mg/100g)
Mean ± SE		144.39 ± 0.93	7.15 ± 0.14	179.37 ± 2.05
Range		127.53-158.57	6.26-7.78	139.95-198.42
Coefficient of variation (%)	PCV	5.59	6.37	9.93
	GCV	5.47	5.33	9.73
Heritability (%) (Broad sense)		95.97	70.13	96.03
Genetic Advance		15.94	0.66	35.25
Genetic Advance as % age of mean		11.04	9.20	19.65

Table 6: Estimates of variability during the year 2016-17

Estimates of variability		Ascorbic acid content (mg/100g)	Beta carotene (mg/100g)	Total phenols content (mg/100g)
Mean ± SE		144.44 ± 1.05	7.29 ± 0.16	179.40 ± 2.15
Range		127.66-158.43	6.41-7.93	139.97-198.53
Coefficient of variation (%)	PCV	5.76	6.36	9.99
	GCV	5.63	5.08	9.77
Heritability (%) (Broad sense)		95.28	63.72	95.68
Genetic Advance		16.34	0.61	35.33
Genetic Advance as % age of mean		11.31	8.35	19.69

Table 7: Estimates of variability during pooled analysis

Estimates of variability		Ascorbic acid content (mg/100g)	Beta carotene (mg/100g)	Total phenols content (mg/100g)
Mean ± SE		144.42 ± 0.96	7.23 ±0.15	179.39 ±2.09
Range		127.67-158.50	6.34-7.86	139.46-198.48
Coefficient of variation (%)	PCV	5.63	6.32	9.94
	GCV	5.51	5.20	9.74
Heritability (%) (Broad sense)		95.81	67.69	95.88
Genetic Advance		16.03	0.64	35.24
Genetic Advance as % age of mean		11.10	8.81	19.64

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