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Influence of variety on morphological and some phytochemical and biochemical characteristics of okra seed

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Abstract
The field experiment was conducted with a view to work out the phytochemical, morphological and biochemical characters in twenty seven genotypes of okra. The results revealed, that all the phytochemicals, only flavanoids, glycosides and terpenoids are present and remaining two were absent in all the genotypes of okra. The genotypes AOL 14-32, Kashi kranti and AOL 09-02 was registered as a higher content of glycosides, flavanoids and terpenoids. While in biochemical, the genotype JDNO 11-11 contains the maximum moisture (7.02 %), acid value (9.74%) and free fatty acids (4.90 %).The crude protein content was higher in Pusa sawani (21.33%), whereas, the total lipid was found higher in Kashi kranti (16.01%). That higher plant height observed was in Red okra (127.06 cm). Parbhani kranti recorded as a higher fruit length (12.76 cm), while fruit weight (17.30 gm), fruit girth (7.83 cm) and fruit density (1.69 g/ cm^3) was higher in GP OK-292. The fruit volume was recorded higher in AOL 14-08 (10.46 cm^3).

Keywords: Influence of variety, morphological, phytochemical, characteristics, okra seed

Introduction
Okra (*Abelmoschus esculentus* L. Moench), known in many English-speaking countries as ladies' fingers and it is a flowering plant belongs to *Malvaceae* family. It is an economically important vegetable crop grown in tropical and sub-tropical region of the world. This crop is mainly grown in arid as well as semi-arid region of India. Various scientists have reported that okra is an economically important vegetable crop grown in tropical and sub-tropical parts of the world (Naveed *et al*., 2009, Oyelade *et al.,* 2003; Andras *et al.,* 2005; Saifullah & Rabbani, 2009) [18, 20, 3, 23].

The seeds are dicotyledonous and they vary in shape; roundness, kidney or spherical with epigeal germination (Hamon *et al.,* 1991; Ariyo, 1993) [8, 4]. Camciuc and his colleague (1998) have suggested that the okra seed are most often used due to its superior nutraceutical value. Rubatzky and Yamaguchi (1997) [22] reported that the seed is a rich source of protein and oil. They have also reported that okra seed oil contains cyclopropenoid fatty acids which cause some toxicity concerns and is used as a substitute for coffee in some countries. Karakottsides and Constantinides (1975) [15] found that the protein efficiency ratio of okra seed flour heated at 130ºC for 3hr was not different from the non heated flour, indicating the absence of anti-nutritional factors. They have also suggested that the amino acid composition of gumbo seed protein is similar to that of soybean and the protein efficiency ratio is higher than that of soybean. Okra (*A. esculentus*) seed oil has a similar composition to that of cotton seed oil and it may be used as a substitute for cotton seed oil in pharmaceutical formulations (Sengupta *et al*., 1974) [25]. The high percentage of linoleic acid (42%) makes okra seed oil desirable and the amino acid pattern of the protein renders it an adequate supplement to legume or cereal based diets (Savello *et al*., 1982) [22]. Mature okra seed has a harsh flavour; it can be improved by processing.

Okra provides an important source of nutraceutical such as vitamins, calcium, potassium and other mineral matters, which are often lacking in the diet of developing countries (IBPGR, 1990) [20]. The composition of 100g edible portion of okra seeds contain moisture 89.6 g, protein 1.9 g, carbohydrates 6.4 g, fat 0.2 g, calcium 66 mg, fibre 1.2 g, iron 0.35 mg, calories 35, potassium 103 mg, phosphorus 56 mg, thiamine 0.07 mg, sodium 6.9 mg, nicotinic acid 0.6 mg, sulphur 30 mg, vitamin C 13 mg, riboflavin 0.1 mg, magnesium 53 mg, oxalic acid

8 mg and copper 0.19 mg (Gopalan *et al.*, 2007) [7].

As the demand, for vegetables is rapidly increasing due to the growing human population, okra, which is currently grown mainly as a vegetable crop, has potential for cultivation as nutritional crop due to its mature pods contain high quantity of seeds containing considerable amount of various nutrients which could be characterized and utilized for commercial purposes. Generally, fruits and vegetables have shown the basic useful properties especially in providing an excellent health and nutritional qualities in the area of prevention and delay in the onset of chronic diseases and the provision of vitamins and enzymes necessary for proper body function.

Materials & Methods

The present experiment was carried out at Department of Biochemistry, B.A. College of Agriculture, and Main Vegtatble Research Station, Anand Agricultural University, Anand. The seeds from fully mature and ripened okra pods consisted of twenty seven genotypes AOL 12-52, AOL 14-32, AOL 13-94, AOL 09-02, AOL 14-29, JOL 11-12,AOL 13-141, JDNO 11-11, Kashi kranti, JDNO 11-12, AOL 13-133, JOL 09-05, AOL 14-11, JOL 13-05, GP-OK-296, GP-OK-213 GP-OK-292, Red okra, Pusa sawani, Parbhani kranti, AOL 13-73, AOL 12-55, AOL 13-112, AOL 14-08, AOL 12-59, JOL 13-07, AOL 13-144 were obtained from the Main Vegetable Research Station, Anand Agricultural University, Anand. The recommended methods of the various parameters were adopted to determine.

The present investigation is planned to study the morphological and biochemical characterization among twenty seven genotypes of okra seeds with its objective to examine okra seed for variation in moisture, crude protein, total lipid, Acid value, and free fatty acids, as well as morphological characters such as plant height, fruit length, fruit volume, fruit density and fruit girth.

Plant height was observed by 5 randomly selected plants were measured from the base of the stem to the apex of the central leaf at the time of harvest and average was worked out and expressed in centimeters. Fruit length was observed taken by randomly 5 fruits were selected from each selected plant and length was measured by using vernire calipers and expressed in centimeters. Randomly 5 fruits were selected from each selected plant and fruit girth was measured and expressed in centimeters. For fruit weight measurement five randomly plants are selected volumes of fruits were measured by the water displacement method. Fruit density was calculated by ratio of fruit weight to the fruit volume for all the genotypes.

The methods of A.O.A.C (2000) were used to determine the moisture content. The total lipid content (determining using Petroleum ether in Soxhlet reflux extractor) and crude protein was determined by A.O.A.C., (1965). The Free fatty acid and Acid value content were determined by (Cox & pearson, 1962) [6].

Results & Discussion

Phytochemical screening

During the present investigation total of five parameters / attributes were determined for twenty seven genotypes of okra seeds. On the present study, it was observed that tannins and alkaloids were recorded trace in overall twenty seven (27) genotypes. The genotypes AOL 14-32, Kashi kranti and AOL 09-02 was registered as a higher content and AOL 12-52 and JDNO 11-11 registered with lower content of glycosides, Flavanoids and terpenoids (Table 1).

Table 1: Phytochemical characteristics of okra seed

	Cultivars	Tannins	Alkaloids	Flavanoids	Glycosides	Terpenoids
1	AOL 12-52	Trace	Trace	+	+	-
2	AOL 14-32	"	"	++	+++	+++
3	AOL 13-94	"	"	++	+	-
4	AOL 09-02	"	"	+	++	+++
5	AOL 14-29	"	"	+	-	-
6	JOL 11-12	"	"	-	+++	+++
7	AOL 13-141	"	"	++	+	-
8	JDNO 11-11	"	"	-	+	+
9	Kashi kranti	"	"	+++	++	++
10	JDNO 11-12	"	"	-	++	+++
11	AOL 13-133	"	"	+++	++	++
12	JOL 09-05	"	"	+	+	++
13	AOL 14-11	"	"	++	+++	++
14	JOL 13-05	"	"	+	+	+
15	GP OK 296	"	"	+	+	+
16	GP OK 213	"	"	+	-	-
17	GP OK 292	"	"	+	+	-
18	Red okra	"	"	+	+	+++
19	Pusa sawani	"	"	++	-	++
20	Parbhani kranti	"	"	+	+	-
21	AOL 13-73	"	"	+	+	+
22	AOL 12-55	"	"	++	+	+
23	AOL 13-112	"	"	++	+	+++
24	AOL 14-08	"	"	+++	-	++
25	AOL 12-59	"	"	++	+	++
26	JOL 13-07	"	"	+++	+	++
27	AOL 13-144	"	"	++	+	++

Biochemical Attributes

Moisture deficiency brings about low quality and quantity of the yield and finally results in plant death. Moisture content was measured in seed of different okra cultivars and presented in (Table 2).Moisture content ranged from 2.38 to 7.02 percent. Significantly higher moisture content was recorded in JDNO 11-11 (7.02%). Significantly lower moisture content was recorded for AOL 14-32 (2.38%), which is at par with AOL 12-52(2.85%).

Protein is an important biochemical factor for disease resistance in plant. It is the average percentage of nitrogen in the food proteins and that may contain an appreciable error if the nitrogen is derived from non protein material or from a protein of unusual composition. The maximum protein content was observed in Pusa Sawani (21.33 %), while the minimum protein content was observed in AOL 13-112 (15.87 %). Rubatzky and Yamaguchi (1997) [22] have reported from that investigation on okra seed, which is a rich source of protein.

Okra seed oil is a rich source of unsaturated fatty acids. Okra seed oil is also a rich source of linoleic acid, a polyunsaturated fatty acid essential for human nutrition. In the present experiment the maximum oil content recorded in Kashi kranti (16.01%) and the minimum oil content recorded in AOL 14-29 (10.33%) followed by AOL 14-08 (10.50%), AOL 12-59 (10.66%). Dhruve *et al*., (2015) found that the highest and the lowest oil content were recorded in AOL 10-22 (15.70%) and Red okra (10.94%) respectively.

Fatty acids are found in the triglyceride form, however during processing the fatty acids may get hydrolyzed into free fatty acid. The higher the acid value found, the higher the level of free fatty acids which translates into decreased oil quality. In this present investigation measured free fatty acid% and acid value (mg KOH/g) from seeds of different twenty seven okra genotypes/ cultivars. The maximum and minimum free fatty acid% recorded in JDNO 11-11 (4.90%), while minimum free fatty acid% recorded in AOL 14-08 (2.72%). The maximum acid value recorded in JDNO 11-11 (9.74 mgKOH/g), AOL 14-08 (5.41 mg KOH/g), respectively.

Table 2: Biochemical constituents in various genotypes of okra seed

	Genotypes	Moisture %	Crude protein%	Total lipids %	Acid value (mg KOH/g)%	Free fatty acid
1	AOL 12-52	2.85	19.34	13.83	7.48	3.76
2	AOL 14-32	2.38	18.18	11.28	6.83	3.43
3	AOL 13-94	3.22	17.48	11.16	7.18	3.61
4	AOL 09-02	3.08	21.03	12.16	7.98	4.01
5	AOL 14-29	3.35	18.93	10.33	8.13	4.09
6	JOL 11-12	3.79	18.25	14.16	8.72	4.39
7	AOL 13-141	6.59	16.28	14.68	9.72	4.89
8	JDNO 11-11	7.02	20.12	12.16	9.74	4.90
9	Kashi kranti	3.78	21.28	16.01	7.03	3.54
10	JDNO 11-12	5.31	20.24	15.50	8.43	4.24
11	AOL 13-133	4.11	18.87	14.66	6.13	3.08
12	JOL 09-05	5.35	19.82	12.00	7.16	3.60
13	AOL 14-11	5.70	18.17	14.33	6.16	3.10
14	JOL 13-05	5.52	18.55	11.00	8.56	4.31
15	GP OK 296	4.98	18.56	12.16	6.55	3.29
16	GP OK 213	3.83	18.87	11.66	6.63	3.33
17	GP OK 292	3.84	20.43	12.67	7.44	3.74
18	Red okra	3.25	20.85	11.03	8.23	4.14
19	Pusa sawani	5.08	21.33	12.66	7.53	3.79
20	Parbhani kranti	6.58	20.85	11.83	8.23	4.14
21	AOL 13-73	3.66	17.02	11.33	6.82	3.43
22	AOL 12-55	6.11	17.98	12.50	7.38	3.71
23	AOL 13-112	4.09	15.87	11.33	7.15	3.60
24	AOL 14-08	4.39	18.40	10.50	5.41	2.72
25	AOL 12-59	5.37	16.83	10.66	5.78	2.91
26	JOL 13-07	4.59	19.27	14.33	8.82	4.44
27	AOL 13-144	6.70	18.86	12.83	7.42	3.73
1	Sem±	0.22	0.24	0.54	0.11	0.09
2	C.D .at 5%	0.61	0.68	1.52	0.32	0.264
3	C.V.%	8.02	2.74	7.01	2.54	2.69

Morphological Attributes

Plant height is a central part of plant ecological strategy. It is strongly correlated with life span, seed mass and time to maturity and is a major determinant of a species ability to compete for light. The present investigation clearly indicated that okra plant height was ranging from 61.26 – 127.06 (cm) (Fig.1). Significantly maximum plant height was registered for Red okra (127.06 cm), which was at par with AOL 09-02 (123.00 cm).The non significant differences were observed for plant height among AOL 13-94(61.26 cm) and AOL 14-29(64.31 cm). Rahman and his colleagues (2012) have reported maximum and minimum okra plant height in cv. Puja (96.83 cm) and cv. Anmol (63.40 cm), respectively. The highest average plant height (131.2 cm) of okra variety BARI Dherosh-1 was recorded by, (Hasan *et. al.*, 2012).

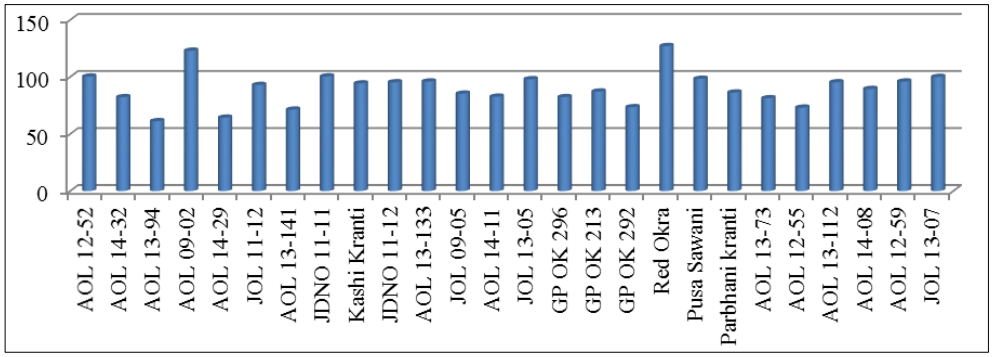

Fig 1: Plant height (cm)

Fruit length (cm)

The okra fruit length was measured and the data are presented in Fig 2. Significantly maximum fruit length was recorded for Parbhani Kranti (12.76 cm), which was at par with GP OK-292 (12.73 cm), The significantly minimum fruit length was observed for GP OK-213 (2.03 cm). Non significant differences were recorded among AOL 14-29, AOL 13-133, AOL 14-08 and JOL 09-05.

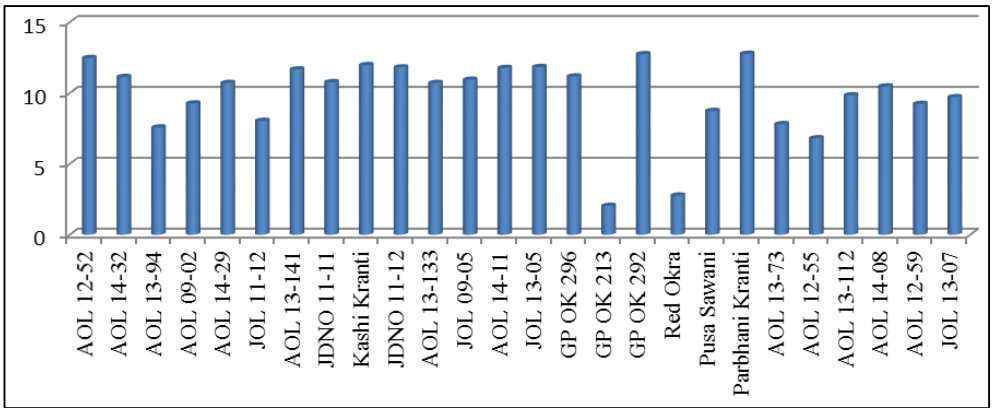

Fig 2: Fruit length (cm)

Fruit girth (cm)

The fruit girth of okra ranged between 2.38 – 7.83 cm (Fig. 3).The maximum and minimum fruit girth recorded for GP OK-292 (7.83) and GP OK-213 (2.38cm), respectively. Tapankumar *et al.*, (2009) studied the different okra cultivars and found that higher fruit girth was 1.69 cm in Makhmali, while lower fruit girth was 1.51 cm in INDO-321.

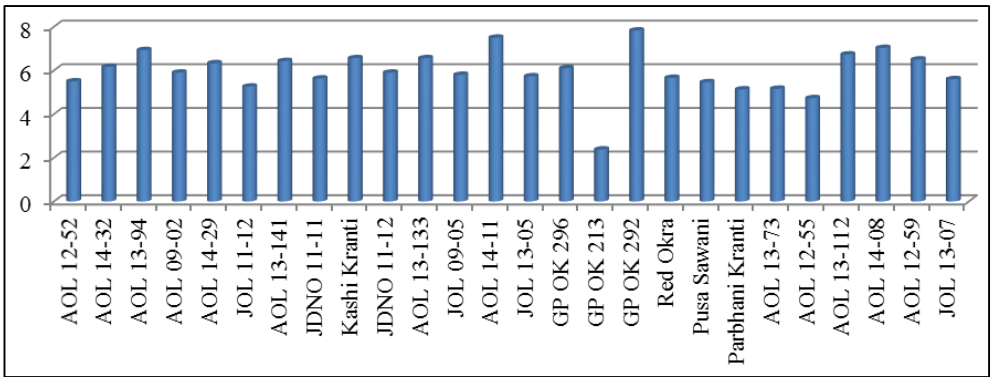

Fig 3: Fruit girth (cm)

Fruit weight (gm)

The higher fruit weight was recorded for GP OK 292 (17.30 gm) followed by AOL 14-08 (14.58 gm). Minimum fruit weight was (Fig. 4) recorded for GP OK 213 (2.13 gm), and it was statistically at par with Red okra (3.68 gm). Kabir and Pillu (2011) studied fruit weight of okra at different stages. In this study maximum fruit weight was found with Sinnova (12.77gm) followed by in Shagun (12.39 gm) and Arka Anamika (10.23gm).

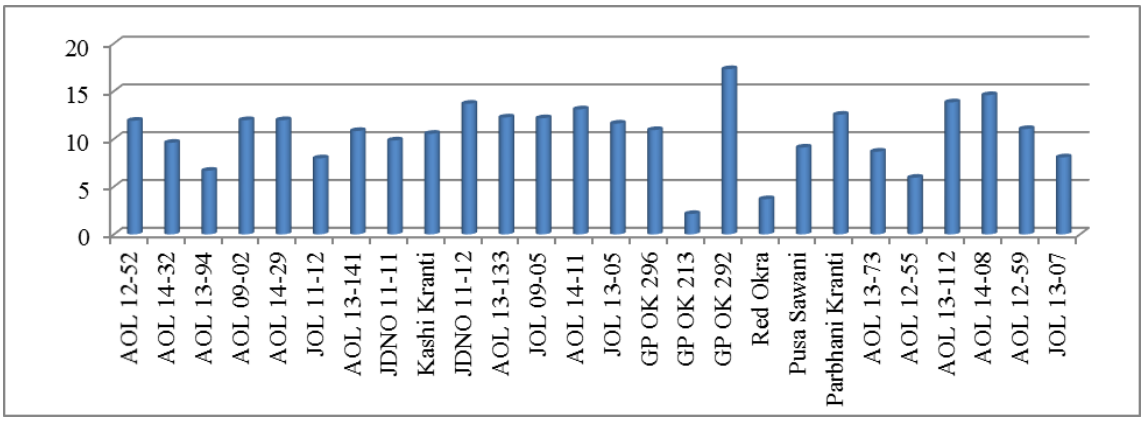

Fig 4: Fruit girth (gm)

Fruit volume (cm^3)

The fruit volume of okra determined by liquid displacement method and data are presented in Fig.5. Significantly higher fruit volume was registered for AOL 14-08 (10.46 cm^3), which was statistically at par with GP OK-292 (10.26 cm^3), AOL 13-112 (10.20 cm^3), JDNO 11-12 (9.93 cm^3), AOL14-29 (9.90 cm^3) and AOL-14-11 (9.83 cm^3).Whereas, significantly lower fruit volume was recorded for GP OK-213 (2.00 cm^3). Ikrang (2014) observed that average value of volumes of three fruits of okra was 13.28 cm^3.

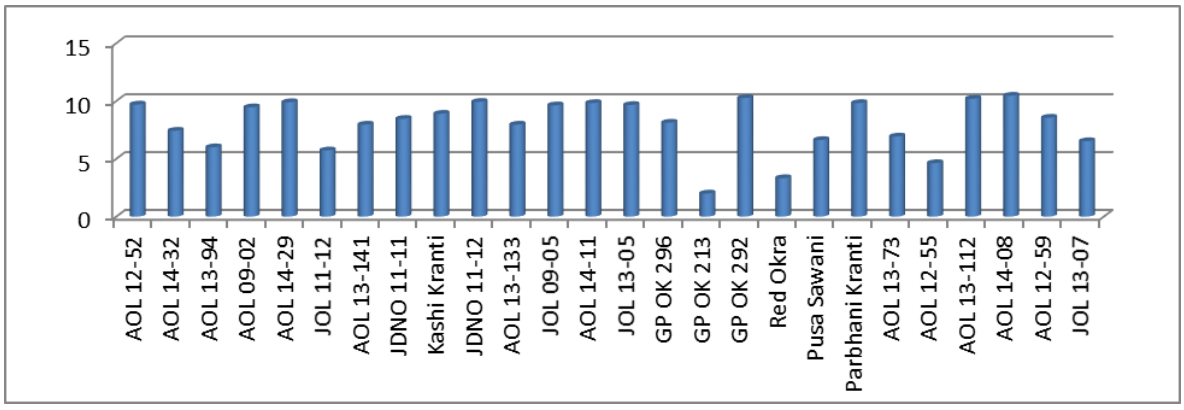

Fig 5: Fruit volume (cm^3)

Fruit density (g/cm^3)

Density is the ratio of weight to volume. Fruit density was calculated and presented in Fig.6. The maximum and minimum fruit density was recorded for GP OK-292 (1.69 g/cm^3), and GP OK-213 (1.06g/cm^3), respectively. Ikrang (2014) reported that average value of fruit density in the three fruits of okra was 1.04 g/cm^3.

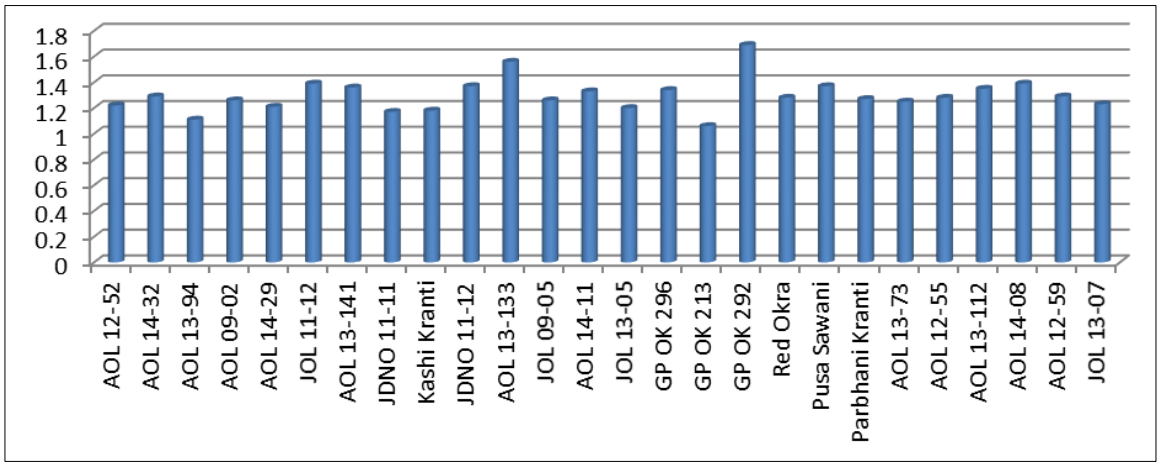

Fig 6: Fruit density (g/cm^3)

Correlation study of Morphological and Biochemical attributes

Morphological and biochemical correlation study revealed that Plant height is highly significant positive relation with crude protein and true protein. Fruit length is highly significant positive relation with fruit girth, fruit weight, fruit volume and significant positive relation with fruit density and total lipids. In case of fruit girth, it has highly significant positive relation with fruit weight, fruit volume, fruit density, also shows non-significant relation with biochemical

attributes. Fruit weight has highly significant positive relation with fruit volume and fruit density but non-significant relation with biochemical attributes. Fruit volume has significant relation with fruit density, but the non-significant relation with biochemical attributes. There is no positive significant relation with biochemical attributes. Free fatty acids has significant positive relation with moisture and highly significant positive relation with acid value. Crude protein has highly significant relation with true protein.

Table 3: Simple correlation matrix between morphological and biochemical attributes

	Plant height	Fruit length	Fruit girth	Fruit weight	Fruit volume	Fruit density	Moisture	Crude protein	True protein	Total lipids	Acid value	Free fatty acids
Plant height	1.00											
Fruit length	-0.1091	1.00										
Fruit girth	-0.0605	0.6168**	1.00									
Fruit weight	-0.0354	0.8142**	0.6652**	1.00								
Fruit volume	-0.0224	0.8492**	0.6141**	0.9484**	1.00							
Fruit density	0.0441	0.3539*	0.5147**	0.6317**	0.3725*	1.00						
Moisture	-0.0541	0.2559	-0.0191	0.2603	0.2781	0.1181	1.00					
Crude protein	0.4815**	0.1204	0.0060	-0.0088	-0.0274	0.04361	-0.1681	1.00				
True protein	0.4738**	0.0480	-0.0260	-0.0331	-0.0418	0.00369	-0.0196	0.9783**	1.00			
Total lipids	0.1353	0.3490*	0.1371	0.1128	0.0622	0.2053	0.1244	0.2626	0.0582	1.00		
Acid value	0.1896	0.1197	-0.1512	-0.0751	-0.0083	-0.1233	0.3292	0.1720	0.1341	0.2456	1.00	
Free fatty acids	0.1685	0.1042	-0.1742	-0.0384	0.0238	-0.0869	0.3687*	0.1095	0.0771	0.2131	0.9861**	1.00

* (significant) and ** (highly significant)

Conclusion

Various phytochemicals *viz.*, flavanoids, glycosides, terpenoids, tannins, alkaloids were qualitatively measured. The results shows that tannins and alkaloids are absent among all thirty genotypes, while flavanoids were present in all genotypes except JOL 11-12, JDNO11-11, JDNO11-12. Glycosides were present in all genotypes except AOL 14-29, GP OK-213, Pusa sawani, and the terpenoids were absent in AOL 12-52, AOL13-94, AOL 13-141, GP OK-213, GP OK-292 and parbhani kranti. Different biochemical attributes were measured from seeds of okra. The okra seeds have 2.38 – 7.02% moisture, 15.87 – 22.01% crude protein, 10.33 – 16.01% total lipids, 5.41 – 9.74% acid value, 2.91 – 4.90% free fatty acids. Morphological attributes like plant height, fruit length, fruit girth, and fruit weight fruit volume and fruit density was measured. Significantly the highest plant height was recorded for Red okra (127.06 cm) as compared to other okra genotypes. Fruit length was higher in Parbhani kranti (12.76 cm),Fruit girth (7.83 cm) and fruit weight (17.30 cm) was recorded higher in GP OK-292 as compared to other genotypes, while fruit volume and fruit density was higher in AOL 14-08 (10.46 cm3) and (1.69 g/cm3) respectively. This might be due to its genetic makeup and more adoptability towards environment.

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