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Image Analysis for Characterization of Groundnut (*Arachis hypogaea* L.) Varieties

A.R. Karthikeyan, S. Ezhilkumar, P. Karthikeyan and V. Manonmani

Department of Genetics and Plant Breeding,
Faculty of Agriculture, Annamalai University, Annamalai Nagar, T.N., India

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ABSTRACT

Varietal characterization of cultivars is essential for the quality of seed production and protection of plant varieties under PPV&FR Act, 2001. Digital image analysis is a fast and reliable method of variety discrimination. Seventy-five varieties of groundnut (*Arachis hypogea* L.) were studied to know various seed characters like area, perimeter, length, width, length in Y axis, width in X axis, variation, CMRV, circular, elongation, and shape factor. The cluster analysis revealed that the seventy-five varieties of groundnut could be grouped into five main clusters it was easy to characterize TMV-9 in cluster I and CO-1 in cluster 3.

Key words: *Groundnut, Varietal characterization, Discrimination, Image Analysis.*

Introduction

Groundnut (*Arachis hypogaea* L.) is the most important legume crop and a valuable source of oil and protein. It is 96 countries around the world, including many tropical and subtropical countries. Groundnut is a self- pollinated and allotetraploid crop (2n = 4x = 40). Varietal identification or discrimination of genotypes is essential for quality seed production. Only high-quality seeds of assured genetic purity can be expected to respond fully to all other inputs. Maintenance of varietal purity is an important goal of the seed production program. The image analysis technique is an important system that offers the guidelines that researchers will be able to study seed surface features more closely and hence increase the available characters set. Dana and Ivo (2008) stated that computer image analysis to group together flax cultivars (*Linum usitatissimum L.*) according to their similarity in commercially import and dry seed traits. This study to characterize groundnut varieties by image analysis system.

Materials and Methods

Genetically pure seeds of seventy-five genotypes of groundnut were obtained from National Oil Seed Research Station, Junagadh, Gujarat, India. The seeds were subjected to image analysis at Department of Seed Science and Technology, TNAU, Coimbatore. This technique was carried out using Delta-T (@ Delta-Instrument device Cambridge, U.K). Image analysis system by running custom-written software 'win DIAS' (Nick and Dick, 2000). Five seeds of each variety were placed on the lighting hood in such a way that the embryo axis of the seed faced the image analysis system and the longitudinal axis of the seed ran parallel to the surface of the camera lens. Seeds were viewed with the video camera (DSP surveillance color CCD camera CVS 200/3300) using transmitted light so that a binary image of the silhouette of the seed was recorded by

the 'win DIAS.' The idea of the support was removed by software after image grabbing in the computer, which thus leaves a picture of the objects consists five columns for geometric data measurements.

Data Measurements

Calibration of the image analysis was done by placing the transparent plastic ruler on the lighting hood illuminated from below. A ruler was aligned diagonally across the field of view and adjusting focus sharpened the image. Again, aperture adjustment was made until optimum color and contrast were achieved. Input measurement was given in centimeters. To measure descriptors like area, perimeter, length, and width from the menu, an object meter was selected. After the image was grabbed using an image grabber and color thresholding was done until the entire area was highlighted. By logging the data and clicking in the measurement the entire data were extracted every time clicked real object. Data were viewed from the review and mean data for each parameter were summed up for average value in the 'win DIAS' itself. The entire images and their data were saved in the document file and interpreted data results and images were reported.

Area (m^2)

The quantity or amount of the space occupied by the object or measurement of the number of unity squares that covers the object surface.

Perimeter (cm^2)

Multiplication of length, breadth and highest of the object and expressed in cm.

Length (cm)

The distance between two apex points in the object along the vertical axis and it was measured as length in y-axis. Then, the seed length was expressed in cm.

Width (cm)

The distance between two extreme points in the object along the horizontal and it was measured as length in X- axis. Then, the seed length was expressed in cm.

Shape factor

Shape factor is the ratio of the actual perimeter to that of a circle with the same area

$$S = P/PC$$

Table 1. List of genotypes used for image analyzing method

S.No	Genotypes	S.no	Genotypes	S.no	Genotypes
1	AK 12-24	26	ICGS 11	51	S 206
2	AK 159	27	ICGS 37	52	SB XI
3	ALR 2	28	ICGS 44	53	SG 84
4	BSR 1	29	ICGV 86590	54	SG 99
5	CO 1	30	J 11	55	SP. IMPROVED
6	CO 2	31	JAWAN	56	TAG 24
7	CO 3	32	JL 220 (PHULE VYAS)	57	TG 17
8	CSMG 2001-2	33	JL 286 (PHULE UNAP)	58	TG 22
9	DH 40	34	JYOTHI	59	TG 26
10	DH 4-3	35	K 134	60	TG 3
11	DH 8	36	KADIRI 4	61	TG 37A
12	DH 86	37	KADIRI 5	62	TG 38
13	DRG 12	38	KISAN	63	TG 51
14	GANGAPURI	39	KOPARGAON 3	64	TIRUPATI 2
15	GAUG 1	40	KRG 1	65	TIRUPATI 4
16	GG 2	41	LGN 1	66	TKG 19 A
17	GG 3	42	M III	67	TLG 45
18	GG 4	43	MH 1	68	TMV 11
19	GG 5	44	MH 4	69	TMV 12
20	GG 6	45	OG 52-1	70	TMV 2
21	GIRNAR 1	46	R 2001-2	71	TMV 9
22	GIRNAR 3	47	R 2001-3	72	TPG 41
23	GPBD 4	48	R 8808	73	VG 9521
24	ICG (FDRS)4	49	R 9251	74	VRI 2
25	ICGS 1	50	RG 141	75	VRI 4

Table 2. Physical parameters variation of Groundnut seed using Image analysis system

Genotype	Area	Perimeter	length	width	length in y	width in x	centroid x	centroid y	Ave. radial	Radial var	CMRV	circular	elongation	S. factor
G1	5.08	10.56	3.80	3.38	35.56	21.67	16.86	20.97	13.46	11.02	589.37	0.67	0.89	1.32
G2	4.50	8.70	3.26	3.05	31.11	22.92	15.80	16.15	12.27	5.68	333.55	0.73	0.94	1.16
G3	4.62	8.74	3.13	2.59	28.89	19.58	15.40	17.51	12.29	4.09	239.57	0.77	0.83	1.15
G4	4.62	8.74	3.13	2.59	28.89	19.58	15.40	17.51	12.29	4.09	239.57	0.77	0.83	1.15
G5	4.63	8.82	3.45	2.03	27.22	27.22	17.19	17.96	12.80	8.09	455.16	0.70	0.59	1.16
G6	5.04	8.92	3.34	2.92	30.56	23.61	14.62	20.83	12.92	5.34	297.44	0.76	0.87	1.12
G7	5.66	9.80	3.62	2.96	30.83	27.50	17.18	19.99	13.85	7.18	373.04	0.74	0.82	1.16
G8	4.49	8.25	2.80	2.24	24.58	24.31	16.30	17.64	12.06	1.31	78.25	0.85	0.80	1.10
G9	5.91	9.57	3.45	3.04	29.44	28.33	16.18	17.82	14.02	4.53	232.93	0.79	0.88	1.11
G10	7.08	10.65	3.64	3.38	35.97	27.08	14.12	19.23	15.06	4.57	218.60	0.82	0.93	1.13
G11	5.47	9.51	3.49	2.98	34.86	21.53	15.77	22.60	13.32	5.29	286.02	0.76	0.85	1.15
G12	5.32	9.88	3.42	2.84	34.31	21.39	15.17	24.43	13.16	5.02	274.69	0.76	0.83	1.21
G13	5.50	9.37	3.52	2.88	34.86	21.25	19.73	24.65	13.38	5.51	296.34	0.75	0.82	1.13
G14	6.25	11.22	3.57	2.35	35.00	23.47	20.01	19.52	14.23	3.94	199.22	0.79	0.66	1.27
G15	6.92	11.26	4.05	3.24	40.56	23.33	14.46	25.16	15.18	8.11	384.71	0.73	0.80	1.21
G16	5.70	10.56	3.39	2.93	33.33	22.22	18.53	21.55	13.75	4.26	223.25	0.80	0.86	1.25
G17	6.01	9.72	3.30	2.46	32.92	24.72	14.69	22.15	13.85	2.14	111.49	0.84	0.75	1.12
G18	5.62	9.97	3.35	2.16	33.61	21.67	18.94	19.66	13.54	3.92	208.20	0.80	0.64	1.19
G19	4.78	8.71	2.71	2.60	26.25	24.17	15.51	16.67	12.31	0.50	29.09	0.91	0.96	1.12
G20	4.77	9.16	2.71	2.59	26.11	24.31	15.48	16.73	12.30	0.49	28.66	0.91	0.96	1.18
G21	4.61	8.56	2.93	2.16	28.47	21.94	15.11	19.27	12.16	1.59	94.11	0.83	0.74	1.12
G22	6.13	10.92	3.97	2.07	39.03	22.92	12.84	20.94	14.49	11.14	553.29	0.70	0.52	1.24
G23	5.39	10.68	3.21	2.32	32.22	23.33	15.32	17.90	13.39	2.16	115.95	0.82	0.72	1.30
G24	5.81	11.99	3.78	3.26	37.78	20.42	15.05	23.30	13.45	11.07	592.51	0.72	0.86	1.40
G25	6.48	10.59	3.37	3.04	33.61	24.86	16.57	22.79	14.49	2.49	123.92	0.85	0.90	1.17
G26	5.00	9.15	3.09	2.13	30.42	22.36	13.67	21.12	12.70	2.70	153.33	0.82	0.69	1.15
G27	6.41	11.07	3.46	3.05	33.75	25.00	16.82	26.04	14.37	3.21	160.74	0.82	0.88	1.23
G28	5.60	9.91	3.30	2.97	32.92	22.36	15.17	18.08	13.41	3.95	212.34	0.81	0.90	1.18
G29	7.94	12.58	4.26	2.44	42.36	24.58	13.15	25.43	16.35	10.28	452.95	0.75	0.57	1.26
G30	4.50	9.25	3.23	2.94	30.42	20.42	12.19	23.21	12.15	4.33	256.37	0.74	0.91	1.23
G31	5.30	9.63	3.45	2.89	34.17	21.81	13.28	23.40	13.25	4.74	257.81	0.75	0.84	1.18
G32	5.64	9.67	3.62	2.97	35.97	20.97	16.69	23.89	13.54	6.77	360.00	0.74	0.82	1.15
G33	5.73	10.05	3.67	1.93	36.67	20.14	14.17	25.88	13.66	8.59	452.41	0.74	0.53	1.18
G34	4.42	8.40	2.88	1.99	28.33	19.86	13.91	22.94	11.91	2.05	124.23	0.82	0.69	1.13
G35	5.63	10.12	3.50	2.93	35.14	20.69	15.22	22.02	13.54	6.16	327.83	0.76	0.84	1.20
G36	5.51	10.08	3.14	2.83	30.00	25.42	16.27	23.77	13.35	1.42	76.84	0.84	0.90	1.21
G37	5.44	10.43	3.41	2.93	32.92	23.89	15.70	23.87	13.26	3.50	190.04	0.77	0.86	1.26

Table 2. *Continued ...*

Genotype	Area	Perimeter	length	width	length in y	width in x	centroid x	centroid y	Ave. radial	Radial var	CMRV	circular	elongation	S. factor
G38	4.75	9.25	3.36	2.82	32.22	21.25	16.36	22.73	12.55	5.17	296.74	0.73	0.84	1.20
G39	4.97	10.19	3.13	2.88	30.97	20.83	17.30	25.81	12.86	3.82	213.95	0.80	0.92	1.29
G40	3.90	7.71	2.47	2.32	22.92	20.97	16.86	19.44	11.12	0.41	26.62	0.90	0.94	1.10
G41	3.90	7.71	2.47	2.32	22.92	20.97	16.86	19.44	11.12	0.41	26.62	0.90	0.94	1.10
G42	5.27	10.82	3.53	2.03	35.42	20.56	11.62	22.29	13.32	6.58	355.35	0.73	0.57	1.33
G43	5.63	10.15	3.40	2.96	33.89	21.67	15.18	24.65	13.69	5.17	271.67	0.79	0.87	1.21
G44	4.44	9.54	3.53	2.95	34.86	18.47	14.69	24.05	12.49	9.17	528.33	0.67	0.84	1.28
G45	3.67	7.81	2.80	1.89	26.81	19.44	14.27	20.12	10.93	2.35	154.92	0.77	0.68	1.15
G46	3.46	7.79	2.51	1.86	24.72	18.61	17.62	18.61	10.53	1.27	87.00	0.83	0.74	1.18
G47	6.33	11.34	3.53	2.36	35.69	23.75	15.06	22.18	14.28	5.24	264.00	0.80	0.67	1.27
G48	4.98	10.59	3.38	2.95	33.47	20.00	14.83	23.38	12.98	6.73	373.46	0.75	0.87	1.34
G49	6.12	12.33	4.04	3.39	39.58	21.81	14.53	22.44	14.59	9.51	469.08	0.69	0.84	1.41
G50	5.83	12.53	3.99	3.31	39.86	21.25	15.38	22.75	13.83	10.55	549.24	0.68	0.83	1.46
G51	4.64	8.69	3.18	2.59	31.81	20.28	17.29	20.64	12.41	3.75	217.55	0.76	0.81	1.14
G52	5.67	10.01	3.55	3.02	35.14	22.22	16.31	24.79	13.61	5.86	310.08	0.76	0.85	1.19
G53	3.76	8.40	2.94	2.58	28.19	17.78	14.91	17.74	11.22	3.97	254.56	0.74	0.88	1.22
G54	6.20	11.60	3.68	3.36	36.39	23.06	16.70	20.55	14.32	7.16	359.90	0.76	0.91	1.31
G55	7.02	13.42	4.46	3.49	43.89	22.22	16.09	25.41	15.77	14.38	656.57	0.67	0.78	1.43
G56	6.21	10.65	3.67	3.17	33.33	26.81	17.75	25.17	14.37	4.56	228.50	0.77	0.86	1.21
G57	8.48	11.94	4.32	2.53	43.19	25.56	14.87	23.30	16.55	8.99	391.25	0.76	0.59	1.16
G58	8.51	11.96	4.40	3.57	44.03	25.97	13.64	22.49	16.60	9.52	412.84	0.75	0.81	1.16
G59	5.24	9.31	3.06	2.74	30.56	22.92	16.45	24.23	12.98	1.64	90.71	0.84	0.89	1.15
G60	5.29	9.25	3.31	2.85	31.67	22.50	15.04	19.66	13.15	4.47	244.83	0.78	0.86	1.13
G61	5.42	10.62	3.67	2.00	36.81	20.56	13.68	20.19	13.30	8.85	479.06	0.72	0.54	1.29
G62	6.05	10.17	3.13	2.87	31.39	25.28	14.73	18.94	13.94	1.22	63.07	0.89	0.92	1.17
G63	5.30	9.21	3.39	2.84	33.61	20.14	17.28	24.34	13.08	5.72	315.04	0.77	0.84	1.13
G64	4.45	10.26	3.06	1.95	30.56	19.58	16.03	19.57	12.16	3.56	210.75	0.78	0.64	1.37
G65	5.72	10.49	3.48	2.94	34.72	21.94	13.89	22.45	13.63	5.54	292.48	0.78	0.84	1.24
G66	6.70	12.94	3.99	3.56	39.58	24.31	17.36	23.02	15.07	8.80	420.60	0.73	0.89	1.41
G67	6.79	10.71	3.68	2.43	36.67	24.58	17.71	20.82	14.79	4.77	232.38	0.80	0.66	1.16
G68	4.24	8.09	2.74	2.47	26.94	20.97	14.25	23.20	11.77	1.48	90.36	0.85	0.90	1.11
G69	3.89	8.89	2.43	2.17	23.89	21.67	14.44	20.39	10.98	0.43	28.44	0.91	0.89	1.27
G70	4.78	9.24	3.08	2.72	30.42	22.22	12.57	20.65	12.45	2.29	132.28	0.80	0.88	1.19
G71	3.74	0.11	0.04	1.24	26.39	20.28	13.68	13.61	7.54	0.02	2.28	52.40	29.67	0.02
G72	6.32	10.88	3.60	3.19	35.28	23.19	14.73	22.25	14.40	5.06	252.96	0.79	0.89	1.22
G73	5.29	9.69	3.25	2.89	31.39	23.75	17.28	20.91	13.16	3.43	187.81	0.80	0.89	1.19
G74	4.66	10.25	3.34	2.81	33.33	18.75	16.03	26.67	12.57	6.24	357.25	0.73	0.84	1.34

Table 2. *Continued ...*

Genotype	Area	Perimeter	length	width	length in y	width in x	centroid x	centroid y	Ave. radial	Radial var	CMRV	circular	elongation	S. factor
G75	6.80	11.58	3.85	3.23	38.47	23.61	13.89	21.03	14.90	5.90	285.20	0.76	0.84	1.25
Mean	5.44	9.88	3.34	2.71	32.93	22.40	15.54	21.50	13.25	5.00	263.16	1.46	1.19	1.20
SE d	20.92	0.38	16.18	16.19	1.26	0.86	0.54	0.83	0.51	0.22	11.28	0.23	0.13	0.05
CD (0.05)	41.34	0.75	31.97	32.00	2.48	1.69	1.07	1.63	1.00	0.43	22.29	0.45	0.26	0.09
CD (0.01)	54.59	0.99	42.21	42.25	3.28	2.23	1.41	2.15	1.32	0.57	29.44	0.60	0.34	0.12
CV %	4.71	4.72	56.98	69.74	4.67	4.68	4.26	4.70	4.67	5.33	5.25	19.06	13.51	4.68

Where, P is the perimeter of the object and Pc is the perimeter of a circle with the same area as the object. Pc is calculated as follows

Pc = 2 (ð X A) 0.5

Where, A is the actual area of the object.

Result and Discussion

The individual seed area was maximum (8.51 m^2) in G58 and minimum (3.46 m^2) in G46. The highest perimeter of the seed was recorded for G55 (13.4 cm^2) and the lowest for G71 (1.09 cm^2). Centroid X was maximum (20.01) in G14 and minimum (11.62) in G42. Centroid Y was maximum (26.67) in G74 and minimum (13.61) in G71. The length of the seed was maximum of (4.46 cm) in G55 and it was a minimum (0.04 cm) in G71. The varieties G58 a maximum (3.57 cm) width, while it was a minimum (1.24 cm) in G71. Elongation of seed was maximum (29.67 cm) in G71 and minimum (0.52 cm) in G22. G58 recorded a maximum (16.60) average radial, while the minimum (7.54) was recorded in G71. The varieties expressed a maximum (1.46) shape factor, while it was a minimum (0.02) in G71. The radial variance of the seed was recorded maximum (14.38) in G55, and it was a minimum (0.02) in G71. The maximum (656.57) CMRV was observed in G55, and the minimum (2.28) in G71. The circularity of the seed was maximum (52.40) in G71, and it was minimum (0.67) in G1.

Traditionally varietal identification has involved the visual inspection of morphological characters with the help of a reference manual, listing systematic descriptions of a national set of varieties. The manual identification of seeds by specialized technicians is slow and has low reproducibility. A digital image analysis provides an alternative to the manual classification of biological seeds by integrating an image acquisition device and a computer (jayas *et al*., 2000). It is considered more accurate and consistent than subjective methods. It produces a truly objective measure of product features. Shahin and Symons (2003) differentiated the lentil seeds based on changes in color, uniformity and discoloration due to developmental variation, which could be traced through machine vision. The shape coefficient for mineral grains of sieve sizes below 0.3 mm can be calculated using an image analyzer (Peszko *et al*., 2007).

The cluster was formed from the recorded mean data and the genotypes were grouped based on similarity in the observed parameters. A dendrogram (Fig. 1) based on R (studio) statistical analysis indicated that the 75 varieties were grouped into five main clusters (main cluster I, II, III, IV and V). Cluster I consisted of one variety (TMV 9) and

cluster II was consisted of 13 variety. Cluster III consisted of one variety (CO 1), cluster IV consisted of 18 variety and cluster V was consisted of 42 variety. Similar results were obtained by (Shete, 2004) in castor, (Suma, 2005) in and sesame, (Nisha, 2007) in wheat.

The result were in confirmity with the findings of seventy-five varieties of groundnut seeds were qualitative seed descriptors routinely used for genotype characterization. The study will be useful more informative continuous quantitative descriptors using image analysis.

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