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Assessment of biochemical parameters and genetic variability in chickpea (*Cicerar arietinum* L.) genotypes

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Abstract
The present investigation was conducted to evaluate biochemical constituents and genetic variability of fifty six genotypes of chickpea at ZARS, Ganeshkhind, Pune (M.S) during *rabi,* 2018-19. Significant variations was observed in biochemical attributes *viz.*, Calcium, Carbohydrates, Crude fibre, Protein, Fat, Iron, Niacin, Phosphorus, Riboflavin, Starch, Thiamine, Vitamin B-6 and Vitamin A ranging from 83.99 to 185.2 mg, 46.89 to 73.33 per cent, 1.98 to 9.28 per cent, 21.26 to 32.96 per cent, 0.11 to 1.44 per cent, 3.55 to 14.14 mg 0.68 to 2.16 mg, 348.2 to 446.87 mg, 0.16 to 0.33 mg, 26.80 to 50.08 per cent, 0.33 to 0.62 mg, 0.39 to 0.8 mg, 10.77 to 30.82 mg respectively. High estimates of heritability were observed for almost all the characters. Highest heritability was observed for riboflavin (99 per cent), followed by crude fibre, thiamine, vitamin B-6 (93 per cent), starch (92 per cent) and phosphorous (88 per cent). The lowest heritability was recorded for iron (59 per cent). The character calcium (13.69) exhibited highest magnitude of genetic advance followed by phosphorous (13.31), starch (8.03) and vitamin A (4.16). The lowest genetic advance was exhibited by riboflavin (0.05). High heritability accompanied with high genetic advance was observed for phosphorous calcium, vitamin A and crude fibre indicated that these traits were governed by additive gene action. Based on mean performance of biochemical parameters and *per se* performance genotypes RVSSG-54, CSJ-740, C-1830, Phule-G-171105, C-1829 and Phule-G-1115-13-16 were found promising and suggested for future breeding programme.

Keywords: Additive gene action, heritability, variability, genetic advance, genotypic coefficient of variation, *Cicer arietinum* (L.)

Introduction

Chickpea (*Cicerar arietinum* L.) is one of the most important leguminous crop used for grain as well as green pod vegetables. Chickpea is also known as Gram or Bengal gram and dried pulses is called Chana seems to hold in Agriculture to meet out the challenges of under nutrition to much extent. Chickpea (*Cicer arientinum* L.) with 17-24% protein, 41-50.8% carbohydrates and high percentage of other mineral nutrients and unsaturated linloeic and oleic acid is one of the most important crops for human consumption. Chickpea with low production cost, wide climate adaptation, use in crop rotation and atmospheric nitrogen fixation ability is one of the most important legume plants in sustainable agriculture system

Chickpea is one of the most important *Rabi* pulse crops in Asia. India is largest producer (25%), importer (20%) and consumer (27%) of Pulses in the world. It is cultivated in diverse agro-climatic conditions in India. The major chickpea producing states of India are Madhya Pradesh, followed by Maharashtra, Rajasthan, Uttar Pradesh, Andhra Pradesh & Karnataka.

Chickpea is very good source of protein as well as carbohydrates which together constitute 80 per cent of the total dry seed weight. Besides protein and carbohydrates it also contains ash, calcium, phosphorus, iron, essential amino acids and vitamins. Chickpea flour has been found to contain vitamins, mainly B-complex. In addition, the flour is reported to be an important source of minerals compared to wheat flour, namely phosphorus (P), magnesium (Mg), and potassium (K) [9]. Adequate intake of these essential macro minerals is reported to be potentially protective against obesity and metabolic disorders. It is well recognized as a valuable source of complex carbohydrate, dietary fibre, protein, vitamins and minerals and is an important constituent of daily diets in many countries (Aguilera *et al.*, 2009) [3]. Health benefits associated with consumption of chickpea include reduction in the risks of diabetes, cardiovascular disease and cancer The present study was therefore, under-taken to evaluate quality attributes of chickpea collections in order to nutritionally found the superior genotypes of multiple use.

Material and methods

The experimental materials used for the present investigation comprised of 56 genotypes of Chickpea obtained from Pulses Improvement Project, MPKV, Rahuri. The experiment was conducted during *rabi,* 2018-19, in Randomized Block Design with three replications. Each entry was represented by a single row of 4 m length with a spacing of 30 cm between rows and 10 cm between the plants. All the crop management and plant protection operations were carried out as per recommended package of practices. The thirteen characters under study *viz.*, Calcium, Carbohydrates, Crude fibre, Protein, Fat, Iron, Niacin, Phosphorus, Riboflavin, Starch, Thiamine, Vitamin B-6 and Vitamin A content of each dried seeds of Chickpea genotypes were analyzed by instrument NIR spectrophotometer. The phenotypic and genotypic coefficients of variation was estimated as per standard procedure of Burton (1952) [5], heritability in broad sense and expected genetic advance by using the methodology suggested by Allard (1960) [4].

Results and discussion

The data pertaining to the biochemical constituents of seeds of various genotypes of Chickpea are presented in Table 1. Significant variation in calcium was ranged from 83.99 to 185.2 mg with its highest value in Phule-G-171105 followed by RVSSG-54, CSJ-740, C-1830 and C-1829 (Table1.). The mean value for biochemical constituents of calcium was 146.29 mg. The lowest value was exhibited by genotype C-1843. Similar, findings were reported by Agrawal and Singh (2003) [2] and Ghavidel and Prakash (2007) [7].

Table 1: Mean performance of 56 genotypes of Chickpea for 12 characters

S. No.	Genotype	Calcium [mg/100g]	Carbohydrate %	Crude fibre %	crude protein%	Fat %	Iron mg/100g	Niacin [mg/100g]	Phosphorous [mg/100g]	Riboflavin [mg/100g]	Starch %	Thiamine [mg/100g]	Vit B-6 [mg/100g]	Vit A [mg/100g]
1	Phule G-16111	149.74	55.37	4.23	23.61	1.07	5.05	1.64	381.06	0.23	42.15	0.53	0.62	25.27
2	RG-2015-07	145.99	53.17	4.48	25.22	1.02	4.83	1.75	382.03	0.24	41.85	0.5	0.66	24.49
3	RUSSG-64	139.33	46.89	4.35	25.59	0.92	5.03	1.65	387.66	0.24	38.93	0.48	0.64	23.03
4	BGD-139	145.19	55.89	4.24	25.3	1.01	5.27	1.48	374.38	0.23	39.45	0.49	0.67	24.29
5	CSJ-944	147.62	52.33	4.82	24.43	1.04	4.72	1.7	383.94	0.23	42.77	0.5	0.6	24.83
6	CSJ-740	170.47	73.33	9.28	25.32	1.14	14.14	1.74	376.3	0.33	47.09	0.4	0.71	30.3
7	DBGV-214	138.94	49.15	4.2	27.28	0.93	6.2	1.49	386.93	0.25	38.19	0.46	0.63	22.99
8	RVSSG-57	153.77	56.76	4.89	23.64	1.13	5.5	1.72	376.15	0.24	42.97	0.52	0.7	26.19
9	Phule G-1005-5-4	149.43	57.86	5.4	24.97	1.07	5.92	1.73	385.91	0.23	44.99	0.51	0.59	25.24
10	RVSSG-54	174.48	71.67	8.03	22.88	1.44	6.19	**2.15**	348.2	0.26	49.43	0.61	0.78	30.82
11	JG-2017-47	145.91	57.35	4.59	24.99	1.02	5.05	1.73	387.55	0.23	41.01	0.53	0.63	24.46
12	H-14-21	144.43	56.57	3.8	24.68	0.99	5.45	1.53	376.47	0.23	39.39	0.52	0.64	24.14
13	NBeG-699	148.69	58.28	4.84	24.38	1.06	5.58	1.7	372.74	0.24	42.09	0.5	0.63	25.11
14	GJG-1509	145.86	51.1	3.99	24.45	1.01	5.41	1.68	384.61	0.23	42.01	0.51	0.59	24.45
15	RCBD-2	145.78	53.17	5.17	25.31	1.02	4.93	1.75	386.47	0.23	42.24	0.52	0.61	24.42
16	Phule G-15109	141.91	47.21	4.47	27.15	0.96	5.22	1.75	386.98	0.25	40.85	0.47	0.64	23.62
17	GCP-101	140.09	50.5	5.35	26.91	0.95	6.91	1.59	388.83	0.26	39.31	0.43	0.61	23.28
18	RLBG-1	152.56	52.72	5.12	21.77	1.12	5.25	1.78	375.83	0.24	41.23	0.54	0.8	25.93
19	GBM-2	143.48	60.19	6.62	26.27	0.98	5.62	1.72	384.18	0.23	41.17	0.5	0.58	23.92
20	IPC-2013-70	141.26	52.04	3.44	26.05	0.95	4.46	1.67	381.55	0.24	39.47	0.5	0.63	23.46
21	Local-1	138.76	51.19	4.2	26.23	0.92	4.95	1.61	392.4	0.23	38.98	0.49	0.6	22.88
22	Local-2	142.7	52.48	4.4	26.88	0.98	5.24	1.82	392.13	0.24	42.24	0.5	0.61	23.77
23	Local-3	148.82	59.8	5.8	25.3	1.07	5.96	1.89	379.044	0.25	43.55	0.51	0.64	25.14
24	Local-4	147.25	57.5	5.09	26.75	1.04	5.86	1.74	378.47	0.23	42.8	0.5	0.64	24.77
25	Local-5	148.51	53.42	4.03	25.45	1.06	5.45	1.77	380.81	0.24	43.1	0.51	0.59	25.06
26	Local-6	150.79	58.07	4.61	25.5	1.09	6.16	1.89	384.72	0.25	44.8	0.51	0.63	25.58
27	Local-7	150.1	59.98	5.22	24.61	1.07	5.76	1.74	380.55	0.24	42.89	0.53	0.64	25.38
28	Local-8	145.99	55.54	3.57	24.94	1.02	4.71	1.71	382.55	0.23	41.31	0.54	0.64	24.46
29	Phule-G-171101	143.11	47.23	1.98	25.16	0.98	3.55	1.83	384.6	0.24	40.94	0.53	0.54	23.88
30	Phule-G-171103	146.9	54.04	5.78	24.84	1.05	7.34	1.71	379.88	0.27	40.91	0.44	0.71	24.82
31	Phule-G-171104	152.84	56.47	5.65	24	1.13	6.14	1.68	373.01	0.25	42.73	0.47	0.67	26.07
32	Phule-G-171105	185.2	57.09	5.84	21.26	1.21	7.97	1.81	379.19	0.26	44.97	0.49	0.72	27.28
33	Phule-G-171113	153.57	53.68	4.67	22.7	1.13	5.6	1.73	375.54	0.24	43.39	0.51	0.67	26.17
34	Phule-G-1107-27-5	148.2	54.61	5.84	26.05	1.06	6.82	1.58	381.68	0.25	41.66	0.46	0.66	25.04
35	Phule-G-1115-13-16	151.67	57.08	6.28	25.8	1.13	8.07	1.67	383.75	0.27	42.93	0.43	0.66	25.89
36	Phule-G-1131-31-4	136.37	51.99	5.19	24.05	0.91	7.84	1.57	389.19	0.28	37.84	0.4	0.67	22.55
37	Phule-G-1131-31-9	145.3	55.59	4.92	25.17	1.01	5.49	1.61	382.31	0.24	40.36	0.51	0.64	24.33
38	Phule-G-1131-31-18	138.7	53.12	4.47	26.1	0.92	5.91	1.56	383.76	0.25	38.44	0.46	0.63	22.94
39	C1821	150.49	56.82	5.7	25.55	1.09	5.41	1.96	371.25	0.24	44.56	0.51	0.69	25.5
40	C-1822	151.69	56.07	5.94	23.5	1.11	6.46	1.73	380.34	0.25	43.25	0.48	0.63	25.8
41	C-1823	149.04	51.16	4.73	26.41	1.08	6.16	1.51	378.95	0.26	40.78	0.46	0.59	25.25
42	C-1824	146.69	67.84	4.82	24.91	1.03	6.57	1.6	382.68	0.23	40.85	0.52	0.61	24.63
43	C-1825	147.75	50.9	4.15	26.51	1.05	6.08	1.75	384.63	0.24	43.47	0.48	0.59	24.91
44	C-1826	134.96	49.4	4.45	28.36	0.87	5.27	1.74	384.78	0.26	38.91	0.46	0.57	22.14
45	C-1827	136.17	47.97	5.2	25.5	0.88	4.74	1.71	388.18	0.24	38.99	0.48	0.64	22.33
46	C-1835	146.15	58.25	4.2	26.23	1.03	5.5	1.8	370.83	0.25	42.93	0.49	0.54	24.61
47	C-1829	161.6	63.09	5.2	25.55	1.26	6.67	1.84	371.68	0.27	46.28	0.53	0.53	28.07
48	C-1830	162.78	70.39	8.2	25.54	1.29	10.56	2.03	383.41	0.28	50.08	0.45	0.58	28.41
49	C-1831	133.59	49.24	4.27	26.88	0.84	5.42	1.52	396.88	0.24	35.19	0.49	0.67	21.76
50	C-1833	132.02	57.21	3.99	28.15	0.83	6.28	1.42	390.59	0.25	34.56	0.44	0.61	21.48

51	C-1837	131.84	49.39	3.83	27.26	0.82	4.67	1.62	393.61	0.24	37.99	0.45	0.55	21.41
52	C-1838	160.52	57.41	5.97	23.99	1.25	7.52	1.88	377.39	0.27	45.75	0.49	0.73	27.8
53	C-1843	83.99	55.65	4.59	32.96	0.12	4.37	0.68	446.87	0.16	26.79	0.33	0.39	10.77
54	Digvijay(ch)	148.04	53.7	4.97	23.9	1.06	5.85	1.79	380.38	0.25	43.28	0.49	0.62	24.92
55	PhuleVikram(ch)	124.34	51	4.04	28.59	0.71	5.09	1.39	394.64	0.24	33.39	0.42	0.55	19.76
56	Phule Vikrant(ch)	150.78	57.77	5.333	27.28	1.12	7.96	1.75	376.9	0.28	42.7	0.46	0.62	25.75
	GM	146.29	55.42	4.98	25.50	1.02	6.00	1.69	382.95	0.24	41.43	0.49	0.63	24.49
	S.E.+/-	3.8815	0.1194	0.1449	0.4771	0.0582	0.3728	0.0914	1.4775	0.0037	0.6765	0.0066	0.0115	0.5088
	C.D. at 5%	10.877	0.3345	0.4061	1.3372	0.1632	1.0447	0.2563	4.1395	0.0105	1.8959	0.0186	0.0323	1.4258
	C.V. %	4.59	0.37	5.04	3.24	9.88	10.76	9.37	0.67	2.71	2.83	2.36	3.17	3.59

Table 2: Genetic variability for thirteen biochemical parameters in 56 genotypes of Chickpea

S. No.	**Characters**	**Range**	**General mean**	**Phenotypic coefficient of variation (PCV)**	**Genotypic coefficient of Variation (GCV)**	**Heritability (h^2) (bS) %**	**GA**	**GA as per cent of mean**
1	Calcium (mg/100gm)	83.99-185.2	146.29	7.4	5.8	61	13.69	9.36
2	Carbohydrates (%)	46.89-73.33	55.42	0.91	0.83	84	0.87	1.56
3	Crude fibre (%)	1.98-9.28	4.98	18.5	17.8	93	1.75	35.28
4	Protein (%)	21.26-32.96	25.50	7.54	6.8	82	3.23	12.66
5	Fat (%)	0.11-1.44	1.02	22.4	20.1	80	0.37	37.15
6	Iron (mg/100 gm)	3.55-14.14	6	16.8	12.9	59	1.22	20.4
7	Niacin (mg/100 gm)	0.68-2.16	1.69	18.2	15.6	73	0.47	27.54
8	Phosphorus (mg/100 gm)	348.2-446.87	382.95	1.92	1.8	88	13.31	3.47
9	Riboflavin (mg/100 gm)	0.16-0.33	0.24	12.4	12.1	95	0.05	24.32
10	Starch (%)	26.80-50.08	41.43	10.2	9.8	92	8.03	19.39
11	Thiamine (mg/100 gm)	0.33-0.62	0.49	9.1	9.4	93	0.09	18.15
12	Vitamin B-6 (mg/100 gm)	0.39-0.8	0.63	12.8	12.4	93	0.15	24.74
13	Vitamin A (mg/100 gm)	10.77-30.82	24.49	9.6	8.9	86	4.16	16.99

Chickpea is a good source of carbohydrates and protein, and the protein quality is considered to be better than other pulses. Biochemical parameter carbohydrate exhibited wide variability ranging from 46.89 to 73.33 per cent. The mean values for carbohydrate was 55.42 per cent (Table 2.). Genotype CSJ-740 exhibited highest carbohydrate content followed by RVSSG-54, C-1830 and C-1824.The lowest value of carbohydrate content was exhibited by genotype RUSSG-64. Similar, finding were reported by Agrawal and Bhattacharya (1980) [1], Singh *et al*., (1996) [12] and Ghavidel and Prakash (2007) [7]. The mean value for Crude fibre content was 4.98per cen. Crude fibre varied significantly from 1.98 to 9.28 per cent. Genotype CSJ-740 exhibited highest value for crude fibre content followed by C-1830, RVSSG-54, GBM-2 and Phule-G-1115-13-16. The lowest value was exhibited by Phule-G-171101. Similar, findings were reported by Singh *et al*., (1996) [12]. Protein content showed significant variability ranging from 21.26 to 32.96 per cent. The mean value of protein was 25.5 per cent. Genotype C-1843 exhibited highest value for protein content followed by Phule Vikram, C-1833, DBGV-214 and C-1837. The results obtained in relation to protein content is confirmed with the findings of Fernandez and Bery (1988) [6], Kutos *et al*., (2003) [9] and Parashi and Lad (2013) [11]

The mean value of one of the important biochemical parameter, iron content was 6.00 mg and varied significantly from 3.55 to 14.14 mg. Genotype CSJ-740 showed highest value of iron content followed by C-1830, Phule-G-1115-13-16, Phule-G-171105 and Phule Vikrant. The lowest value was exhibited by genotype Phule-G-171101. Similar, findings were reported by Agrawal and Singh (2003) [2] and Ghavidel and Prakash (2007) [7]. The population mean for niacin content was 1.69 mg and ranged between 0.68 to 2.16 mg. The genotype RVSSG-54 exhibited highest niacin content followed by C-1830, C-1821, Local-6 and Local-3 genotypes. The lowest value for niacin content was exhibited by genotype C-1843.

The population mean value for phosphorous content was 382.95 mg and varied significantly from 348.2 to 446.87 mg. Genotype C-1843 exhibited highest phosphorous content followed by C-1831, Phule Vikram and C-1837.The lowest value was exhibited by genotype RVSSG-54. Similar, findings were reported by Lal *et al.*, 1963 [10]. The mean value of Riboflavin was 0.24 mg and varied significantly from 0.16 to 0.33 mg. Genotype CSJ-740 exhibited highest value for riboflavin content followed by Phule Vikrant, C-1830 and Phule-G-1131-31-4. The lowest value was exhibited by genotype C-1843.

Among fifty six genotype, C-1830 exhibited highest starch content followed by RVSSG-54, CSJ-740, C-1829 and C-1838. The population mean value for starch was 41.43 per cent and showed significant variation between 26.79 to 50.08 per cent. Similar, finding were reported by Gupta *et al.*, (2006) [8] and Ghavidel and Prakash (2007) [7]. The mean value of thiamine content was 0.49 mg and recorded significant variation ranged from 0.33 to 0.62 mg. Genotype RVSSG-54 exhibited highest value followed by RLBG-1, Local-8 and Phule-G-171101.The lowest value for thiamine content was exhibited by genotype C-1843.

Vitamin B6 in coenzyme forms performs a wide variety of functions in the body and is extremely versatile, with involvement in more than 100 enzyme reactions, mostly concerned with protein metabolism. Legumes such as chickpeas supply significant amounts of vitamin B-6. Present study revealed that population mean value for vitamin B-6 was 0.63 mg and varied significantly from 0.39 to 0.8 mg. The genotype RLBG-1 showed highest value followed by RVSSG-54, C-1838, Phule-G-171105 and Phule-G-171103.The lowest value was exhibited by C-1843.The population mean value for vitamin A was 24.49 mg and significantly varied from 10.77 to 30.82 mg. The genotype RVSSG-54 exhibited highest value followed by CSJ-740, C-1830,C-1829 and C-1838.The lowest value was exhibited by genotype C-1843.

The present study revealed that the estimates for genotypic coefficient of variation (GCV) were lower in magnitude than the phenotypic coefficient variation (PCV) for almost all the characters (Table 2.). The highest GCV and PCV was recorded for the biochemical parameter fat content (20.1 and 22.4), followed by crude fibre (17.8 and 18.5) and niacin

(15.6 and 18.2). The highest magnitudinal difference between GCV and PCV was recorded for iron content (3.9), followed by niacin (2.6). The heritability (bs) estimate varied between 59 (iron) and 95(riboflavin) per cent. High estimates of heritability were observed for almost all the characters. Highest heritability was observed for riboflavin (95%), followed by crude fibre, thiamine, vitamin B-6 (93 per cent), starch (92 per cent) and phosphorous (88 per cent). The lowest heritability was recorded for iron content (59 per cent).

Conclusion

The parameter calcium (13.69) exhibited highest magnitude of genetic advance followed by phosphorous (13.31), starch (8.03) and vitamin A (4.16). The lowest genetic advance was exhibited by riboflavin (0.05). However, the parameter phosphorous recorded high genetic advance coupled with high heritability estimates, suggested that these parameters are governed by additive gene action. High value of genetic advance as per cent of mean was observed for fat content (37.15), followed by crude fibre (35.28) and niacin (27.54), whereas, carbohydrates (1.56) recorded the lowest value for genetic advance as per cent of mean, suggested role of non-additive gene action. Besides identifying superior genotypes in individual quality traits to be useful for breeding and crop improvement purposes. The genotypes RVSSG-54, CSJ-740, C-1830, Phule-G-171105, C-1829 and Phule-G-1115-13-16 were identified in order of excellence as multipurpose collections for further crop improvement programme.

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