Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 (1) : 54-64 (January-2022) Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Characterization of Kabuli Chickpea (*Cicer arietinum* L.) Genotypes through Quality Seed Parameters and Chemical Tests

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Abstract

An experiment was carried out at the Seed Testing Laboratory, Department of Seed Science and Technology, Junagadh Agricultural University, Junagadh, to characterize forty two kabuli chickpea genotypes based on seed quality parameters and chemical tests. Among 42 genotypes, seed germination percent was observed in HK-16-30 (100%) with a mean of 90.46% while, seedling vigour index I was high in all forty two genotypes. The seeds were subjected to NaOH, $CuSO_4$, Na_2CO_3, KOH, $FeSO_4$ and GA_3 growth response test for differentiating the genotypes. Based on the NaOH test, the genotypes were grouped into dark yellow (8 genotypes), light yellow (19 genotypes) and no colour change (15 genotypes). Based on the $CuSO_4$ test, the genotypes were grouped into dark brown (28 genotypes) and no change (14 genotypes). Based on the Na2CO_3 test, the genotypes were grouped into dark brown (7 genotypes) and no colour change (35 genotypes). Based on the KOH test, the genotypes were grouped into dark brown (13 genotypes) and no change (29 genotypes). Based on the $FeSO_4$ test, the genotypes were grouped into black (16 genotypes) and no change (26 genotypes) groups. Based on GA_3 growth response test varied significantly among the genotypes and the GA_3 growth response test ranged from 19.32 cm (PG-219) to 54.53 cm (IPCK-13-163) with a mean of 38.58 cm.

Key words : *Chickpea, characterization, quality parameters, chemical tests.*

Introduction

Kabuli chickpea or white gram (*Cicer arietinum* L.), in this group the colour of the seed is usually white grains are bold and attractive. Yield potential of this group is poor as compared to desi or brown gram. Plants are generally taller than the desi gram stand more or less erect. Chickpea (*Cicer arietinum* L.) is a self-pollinated true diploid (2n = 2x = 16) crop, belongs to genus *Cicer,* tribe *cicereae, Fabaceae* family and subfamily *Papilionacea* (1).

Chickpea is the fourth largest grain legume crop in the world with a total production of 13.12 million tons from an area of 13.57 million hectare with productivity of 967 kg/ha. Major chickpea producing countries include India, Australia, Pakistan, Myanmar, Ethiopia, Turkey, Iran, Mexico, USA, Canada, Russian Federation and Tanzania (Anon., 2019). About 90 per cent of chickpea in the world is grown under rain fed conditions, where drought is one of the major constraints, limiting its production (2, 3, 4). India is the largest producer of chickpea contributing more than 75 per cent of the world production. In India, chickpea was grown in an area of 9.67 million hectare with a production 10.09 million tonnes and productivity of 1043 kg/ha. Madhya Pradesh, Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Uttar Pradesh, Gujarat, Chhattisgarh and Jharkhand are the major chickpea producing states in the country. In Gujarat Chickpea was grown in area of 0.29 million hectare with a production 0.38 million tonnes and productivity 1285 kg/ha (5).

Maintenance of genetic purity of varieties is of primary importance for preventing varietal deterioration during successive regeneration cycles and for ensuring varietal performance at an expected level. The aspects of Distinctness, Uniformity and Stability (DUS) are fundamental for characterization of varieties. In countries having Plant Breeder's Right (PBR) in operation, a new variety is registered only, if it is distinct from other varieties, uniform in its characteristics and genetically stable. In the light of the above facts, the present study on the documentation of characters for kabuli chickpes genotypes was planned with the objective to identify stable diagnostic characteristics of plant morphology of kabuli chickpea genotypes.

Materials and Methods

The experiment was conducted in the Seed Testing Laboratory of the Department of Seed Science and Technology, Junagadh Agricultural University, Junagadh during 2019-20 to characterize the 42 genotypes of kabulichickpea (*Cicer arietinum* L.) *viz.,*GJGK-1824, BG-4009, RKGK-13-499, RLBGK-1, PG-219, HK-13-114, HK-16-30, GJGK-1823, RLBGK-3, IPCK-2009-145, GJGK-1825, PKV-4, GNG-2399, RKGK-18-414, NBeG-723, CSJK-142, IPCK-11-37, CSJK-134, RKV-4, RLVGK-3, JGK-1, ICCV-181314, GLK-17316,

Received : October-2021; Revised : November-2021; Accepted : November-2021

GLK-17301, GNG-2446, GJGK-1827, CSJK-174, BG-4008, Phule-G-16318, IPCK-13-163, RVSSG-78, GJGK-1828, GNG-2453, RVSSG-77, ICCV-171318, Phule-G-0517, RLBGK-2, RVSSG-62, JGK-2017-32, GJGK-1826, ICCV-171310 and ICCV-181308based on quality seed parameters and chemical tests. The experiment was conducted as per Completely Block Design with four repetitions. The observations viz., seed germination, shoot length, root length, seedling dry weight, seedling vigour index I, seedling vigour index II, NaOH test, Modified phenol test A, Modified phenol test B, KOH test, $FeSO_4$ test and GA_3 growth response test. The data obtained from laboratory experiment conducted in CRD were analyzed as per standard method suggested by (6).

Results and Discussion

Based on seed germination and seedling characters, kabuli chickpea genotypes were categorized into different groups (Table-1 and 2). The seed germination percentage varied among the genotypes due to the quality parameters and could be attributed to better development of seeds. Significantly highest seed germination percentage was observed in HK-16-30 (100%) and the lowest was observed in RLBGK-3 (78.74%). Shoot length varied significantly among the forty two genotypes and the shoot length ranged from 5.76 cm (GLK-17301) to 20.57cm (HK-13-114) with a mean of 11.71 cm. Root length varied significantly among the forty two genotypes and the root length ranged from 5.66 cm (ICCV-181314) to 18.45 cm (HK-13-114) with a mean of 11.21cm. Seedling dry weight varied significantly among the forty two genotypes and the seedling dry weight ranged from 0.050 g (RLBGK-3) to 0.075 g (RLBGK-1) with a mean of 0.060 g. Seedling vigour index I varied significantly among the forty two genotypes and the seedling vigour index I ranged from 1246.42 (GLK-17301) to 3838.01 (HK-13-114) with a mean of 2068.01. Seedling vigour index II varied significantly among the forty two genotypes and the seedling vigour index II ranged from 3.94 (RLBGK-3) to 6.92 (RLBGK-1) with a mean of 5.34.

The chemical tests such as NaOH test, Modified phenol test A, Modified phenol test B, KOH test, $FeSO_4$ test and GA_3growth response test, which help for classifying the genotypes into different groups (Table-3 and 4). On the basis of chemical tests, genotype identification keys were prepared (Figure-1). The genotypes PG-219, GJGK-1823 and RLBGK-2 were having no colour in sodium carbonate test, dark brown colour in copper sulphate test, light yellow reaction with NaOH test, no colour in KOH, no colour in $FeSO_4$ test and low GA_3 growth response test. Genotype RLVGK-3 differed from above genotypes in respect to black colour in $FeSO_4$ test, while the genotypes NBeG-723 and ICCV-181314 were differed from above genotypes with respect to high GA_3 growth response test and black colour in $FeSO_4$ test.

The genotypes RLBGK-3, GJGK-1827, CSJK-174 and BG-4008 were having no colour in sodium carbonate test, dark brown colour in copper sulphate test, dark yellow colour reaction in NaOH test, dark brown colour change in KOH, no colour change in $FeSO_4$ test and high GA_3 growth response test.

The genotypes BG-4009, GJGK-1825, GNG-2446 and JGK-2017-32 were having no colour in sodium carbonate test and copper sulphate test, no colour reaction in NaOH test, no colour change in KOH and $FeSO_4$ test and high GA_3 growth response test, while the genotypes IPCK-13-163 and GNG-2453 differed from above genotypes with respect to light yellow colour reaction in NaOH test and genotype PKV-4 low GA_3 growth response test.

The genotypes RVSSG-77 and Phule-G-0517 were having no colour in sodium carbonate test, dark brown colour in copper sulphate test, light yellow reaction with NaOH test, dark brown colour in KOH, black colour in $FeSO_4$ test and high GA_3 growth response test.

The genotype RKGK-13-499 and GLK-17316 was having no colour in sodium carbonate test, dark brown colour in copper sulphate test, no colour reaction in NaOH test, no colour change in KOH test and no colour in $FeSO_4$ test and high GA_3 growth response test.

The genotypes IPCK-2009-145, IPCK-11-37 and GJGK-1828 were having no colour in sodium carbonate test, dark brown colour in copper sulphate test, no colour reaction in NaOH test, no colour change in KOH, black colour change in $FeSO_4$ test and low GA_3 growth response test, while the genotype RVSSG-62 and ICCV-171310 differed from above genotypes with respect to no colour change in $FeSO_4$ test (RVSSG-62) and low GA_3 growth response test (ICCV-171310).

The genotypes HK-16-30 and GNG-2399 were having no colour in sodium carbonate test, no colour in copper sulphate test, no colour reaction in NaOH test, KOH test, $FeSO_4$ test but differed with respect to low (HK-16-30) and high (GNG-2399) GA_3 growth response test, while the genotype ICCV-171318 differed from above genotypes with respect to black colour in $FeSO_4$ test and high GA_3 growth response test.

The genotype CSJK-134 and RVSSG-78 was having no colour in sodium carbonate test, no colour in copper sulphate test, light yellow colour reaction in NaOH test, no colour change in KOH test and black colour in

Table-1 : Identification and grouping of kabuli chickpea genotypes based on seed germination (%), shoot length (cm) and root length (cm).

Genotypes	Seed germination (%)	Shoot length (cm)	Root length (cm)
GJGK-1824	94.30	9.50	11.10
BG-4009	90.10	11.18	9.81
RKGK-13-499	86.76	8.97	7.71
RLBGK-1	92.25	10.16	12.51
PG-219	89.02	12.28	10.64
HK-13-114	98.36	20.57	18.45
HK-16-30	100.00	18.10	12.10
GJGK-1823	88.17	13.35	11.57
RLBGK-3	78.74	8.74	10.15
IPCK-2009-145	84.02	13.71	11.73
GJGK-1825	88.23	10.53	11.09
PKV-4	86.60	17.32	14.75
GNG-2399	83.61	11.92	9.72
RKGK-18-414	93.82	7.74	10.12
NBeG-723	83.62	9.03	11.62
CSJK-142	90.08	9.05	11.43
IPCK-11-37	87.16	17.65	14.88
CSJK-134	97.11	11.97	10.87
RKV-4	86.35	8.89	11.15
RLVGK-3	91.00	17.03	15.16
JGK-1	99.18	15.60	13.40
ICCV-181314	87.36	8.77	5.66
GLK-17316	81.39	7.02	10.49
GLK-17301	85.43	5.76	8.83
GNG-2446	93.97	13.11	15.26
GJGK-1827	94.17	10.46	10.55
CSJK-174	83.75	7.91	9.73
BG-4008	87.12	11.54	9.88
Phule-G-16318	93.49	17.73	15.18
IPCK-13-163	98.40	11.52	9.68
RVSSG-78	99.36	15.33	13.18
GJGK-1828	96.82	16.38	14.66
GNG-2453	84.61	7.77	9.19
RVSSG-77	93.42	10.03	8.75
ICCV-171318	86.21	12.08	10.62
Phule-G-0517	92.18	14.82	12.45
RLBGK-2	94.94	8.49	6.44
RVSSG-62	98.27	6.97	9.36
JGK-2017-32	95.31	11.50	9.79
GJGK-1826	92.12	9.55	9.02
ICCV-171310	88.95	8.04	7.01
ICCV-181308	83.71	13.80	11.90
Mean	90.46	11.71	11.21
S.Em ±	0.95	0.18	0.31
C.D. at 5%	2.66	0.50	0.87

$FeSO_4$ test but differed with respect to high (CSJK-134) and low (RVSSG-78) GA_3 growth response test.

The genotype HK-13-114 and GLK-17301 was having dark brown colour in sodium carbonate test, dark brown colour in copper sulphate test, light yellow colour reaction in NaOH test, no colour in $FeSO_4$ test, but differed with respect to no (HK-13-114) and dark brown (GLK-17301) colour change in KOH test and low (HK-13-114) and high (GLK-17301) GA_3 growth response test.

The genotype GJGK-1826 and ICCV-181308 was having dark brown colour in sodium carbonate test, dark brown colour in copper sulphate test, dark yellow colour reaction in NaOH test, dark brown colour change in KOH test and no colour in $FeSO_4$ test and high GA_3growth response test.

The genotype RLBGK-1 was having no colour in sodium carbonate test, dark brown colour in copper sulphate test, no colour reaction in NaOH test, no colour change in KOH test and black colour in $FeSO_4$ test and low GA_3 growth response test. The genotype RKGK-18-414 was having similar dark brown colour in sodium carbonate test, no colour in copper sulphate test, light yellow colour reaction in NaOH test, no colour change in KOH test and no colour in $FeSO_4$ test and high GA_3 growth response test. The genotype CSJK-142 was having similar dark brown colour in sodium carbonate test, dark brown colour in copper sulphate test, light yellow colour reaction in NaOH test, no colour change in KOH test and black colour in $FeSO_4$ test and high GA_3 growth response test. The genotype RKV-4 was having no colour in sodium carbonate test, dark brown colour in copper sulphate test, light yellow colour reaction in NaOH test, dark brown colour change in KOH test and no colour in $FeSO_4$ test and high GA_3 growth response test. The genotype JGK-1 was having no colour in sodium carbonate test, dark brown colour in copper sulphate test, dark yellow colour reaction in NaOH test, dark brown change in KOH test and black colour in $FeSO_4$ test and low GA_3 growth response test. The genotype Phule-G-16318 was having similar no colour in sodium carbonate test, no colour in copper sulphate test, light yellow colour reaction in NaOH test, dark brown change in KOH test and no colour in $FeSO_4$ test and low GA_3 growth response test.

Similar observations and grouping was made based on the seed germination and seedling characters by (7) in chickpea; (8) in groundnut; (9) in french bean; (10) in finger millet; (11) in pearl millet; (12) in wheat; (13) in green gram; (14) in urdbean.

Table-2 : Identification and grouping of kabuli chickpea genotypes based on seedling dry weight (g), seedling vigour indexI and seedling vigour index II.

Genotypes	Seedling dry weight (g)	Seedling vigour index I	Group	Seedling vigour index II
GJGK-1824	0.070	1942.58	High vigorous	6.60
BG-4009	0.066	1891.20	High vigorous	5.95
RKGK-13-499	0.052	1447.16	High vigorous	4.51
RLBGK-1	0.075	2091.31	High vigorous	6.92
PG-219	0.060	2040.34	High vigorous	5.34
HK-13-114	0.065	3838.01	High vigorous	6.39
HK-16-30	0.057	3020.00	High vigorous	5.70
GJGK-1823	0.053	2197.20	High vigorous	4.67
RLBGK-3	0.050	1487.40	High vigorous	3.94
IPCK-2009-145	0.054	2137.47	High vigorous	4.54
GJGK-1825	0.052	1907.53	High vigorous	4.59
PKV-4	0.062	2777.26	High vigorous	5.37
GNG-2399	0.060	1809.32	High vigorous	5.02
RKGK-18-414	0.071	1675.63	High vigorous	6.66
NBeG-723	0.068	1726.75	High vigorous	5.69
CSJK-142	0.054	1844.84	High vigorous	4.86
IPCK-11-37	0.052	2835.31	High vigorous	4.53
CSJK-134	0.065	2217.99	High vigorous	6.31
RKV-4	0.060	1730.45	High vigorous	5.18
RLVGK-3	0.055	2929.29	High vigorous	5.01
JGK-1	0.059	2876.22	High vigorous	5.85
ICCV-181314	0.072	1260.60	High vigorous	6.29
GLK-17316	0.062	1425.14	High vigorous	5.05
GLK-17301	0.067	1246.42	High vigorous	5.72
GNG-2446	0.061	2665.93	High vigorous	5.73
GJGK-1827	0.053	1978.51	High vigorous	4.99
CSJK-174	0.056	1477.35	High vigorous	4.69
BG-4008	0.064	1866.11	High vigorous	5.58
Phule-G-16318	0.072	3076.76	High vigorous	6.73
IPCK-13-163	0.053	2086.08	High vigorous	5.22
RVSSG-78	0.060	2832.75	High vigorous	5.96
GJGK-1828	0.066	3005.29	High vigorous	6.39
GNG-2453	0.063	1434.99	High vigorous	5.33
RVSSG-77	0.072	1754.43	High vigorous	6.73
ICCV-171318	0.055	1956.97	High vigorous	4.74
Phule-G-0517	0.067	2113.75	High vigorous	6.18
RLBGK-2	0.052	1417.45	High vigorous	4.94
RVSSG-62	0.055	1604.75	High vigorous	5.40
JGK-2017-32	0.051	2029.15	High vigorous	4.86
GJGK-1826	0.065	1710.67	High vigorous	5.99
ICCV-171310	0.073	1338.70	High vigorous	6.49
ICCV-181308	0.064	2151.35	High vigorous	5.36
Mean	0.060	2068.01		5.34
S.Em ±	0.0011	22.38		0.09
C.D. at 5%	0.0033	62.64		1.37
CV %	3.93	2.16		3.36

Note : Seedling vigour index-I = Less vigorous < 500, High vigorous > 500

Table-3 : Identification and grouping of kabuli chickpea genotypes based on sodium hydroxide test (NaOH), modified phenol test A ($CuSO_4$) and modified phenol test B (Na_2CO_3).

Genotypes	Sodium hydroxide test (NaOH)	Modified phenol test A ($CuSO_4$)	Modified phenol test B (Na_2CO_3)
GJGK-1824	Dark yellow	Dark brown	Dark brown
BG-4009	No colour reaction	No change	No change
RKGK-13-499	No colour reaction	Dark brown	No change
RLBGK-1	No colour reaction	Dark brown	No change
PG-219	Light yellow	Dark brown	No change
HK-13-114	Light yellow	Dark brown	Dark brown
HK-16-30	No colour reaction	No change	No change
GJGK-1823	Light yellow	Dark brown	No change
RLBGK-3	Dark yellow	Dark brown	No change
IPCK-2009-145	No colour reaction	Dark brown	No change
GJGK-1825	No colour reaction	No change	No change
PKV-4	Light yellow	No change	No change
GNG-2399	No colour reaction	No change	No change
RKGK-18-414	Light yellow	No change	Dark brown
NBeG-723	Light yellow	Dark brown	No change
CSJK-142	Light yellow	Dark brown	Dark brown
IPCK-11-37	No colour reaction	Dark brown	No change
CSJK-134	Light yellow	No change	No change
RKV-4	Light yellow	Dark brown	No change
RLVGK-3	Light yellow	Dark brown	No change
JGK-1	Dark yellow	Dark brown	No change
ICCV-181314	Light yellow	Dark brown	No change
GLK-17316	No colour reaction	Dark brown	No change
GLK-17301	Light yellow	Dark brown	Dark brown
GNG-2446	No colour reaction	No change	No change
GJGK-1827	Dark yellow	Dark brown	No change
CSJK-174	Dark yellow	Dark brown	No change
BG-4008	Dark yellow	Dark brown	No change
Phule-G-16318	Light yellow	No change	No change
IPCK-13-163	Light yellow	No change	No change
RVSSG-78	Light yellow	No change	No change
GJGK-1828	No colour reaction	Dark brown	No change
GNG-2453	Light yellow	No change	No change
RVSSG-77	Light yellow	Dark brown	No change
ICCV-171318	No colour reaction	No change	No change
Phule-G-0517	Light yellow	Dark brown	No change
RLBGK-2	Light yellow	Dark brown	No change
RVSSG-62	No colour reaction	Dark brown	No change
JGK-2017-32	No colour reaction	No change	No change
GJGK-1826	Dark yellow	Dark brown	Dark brown
ICCV-171310	No colour reaction	Dark brown	No change
ICCV-181308	Dark yellow	Dark brown	Dark brown

Table-4 : Identification and grouping of kabuli chickpea genotypes based on potassium hydroxide (KOH), ferrous sulphate test ($FeSO_4$) and GA_3 growth response test.

Genotypes	Potassium hydroxide test (KOH)	Ferrous sulphate test ($FeSO_4$)	GA_3 growth response test Seedling length (cm)	Group
GJGK-1824	Dark brown	Black	33.20	High response
BG-4009	No change	No change	42.29	High response
RKGK-13-499	No change	No change	33.44	High response
RLBGK-1	No change	Black	27.45	Low response
PG-219	No change	No change	19.32	Low response
HK-13-114	No change	No change	32.32	Low response
HK-16-30	No change	No change	35.09	Low response
GJGK-1823	No change	No change	24.04	Low response
RLBGK-3	Dark brown	No change	45.83	High response
IPCK-2009-145	No change	Black	35.02	Low response
GJGK-1825	No change	No change	34.03	High response
PKV-4	No change	No change	40.00	Low response
GNG-2399	No change	No change	44.65	High response
RKGK-18-414	No change	No change	38.73	High response
NBeG-723	No change	Black	50.08	High response
CSJK-142	No change	Black	38.16	High response
IPCK-11-37	No change	Black	42.37	Low response
CSJK-134	No change	Black	41.02	High response
RKV-4	Dark brown	No change	44.88	High response
RLVGK-3	No change	Black	33.09	Low response
JGK-1	Dark brown	Black	40.48	Low response
ICCV-181314	No change	Black	29.18	High response
GLK-17316	No change	No change	38.26	High response
GLK-17301	Dark brown	No change	46.53	High response
GNG-2446	No change	No change	40.99	High response
GJGK-1827	Dark brown	No change	36.01	High response
CSJK-174	Dark brown	No change	43.92	High response
BG-4008	Dark brown	No change	49.26	High response
Phule-G-16318	Dark brown	No change	33.56	Low response
IPCK-13-163	No change	No change	54.53	High response
RVSSG-78	No change	Black	32.62	Low response
GJGK-1828	No change	Black	27.92	Low response
GNG-2453	No change	No change	40.77	High response
RVSSG-77	Dark brown	Black	37.63	High response
ICCV-171318	No change	Black	45.04	High response
Phule-G-0517	Dark brown	Black	48.51	High response
RLBGK-2	No change	No change	36.83	High response
RVSSG-62	No change	No change	32.94	High response
JGK-2017-32	No change	No change	33.66	High response
GJGK-1826	Dark brown	No change	44.07	High response
ICCV-171310	No change	Black	48.40	High response
ICCV-181308	Dark brown	No change	44.15	High response
Mean			38.58	
S.Em ±			0.97	
C.D. at 5%			2.77	
CV %			4.36	

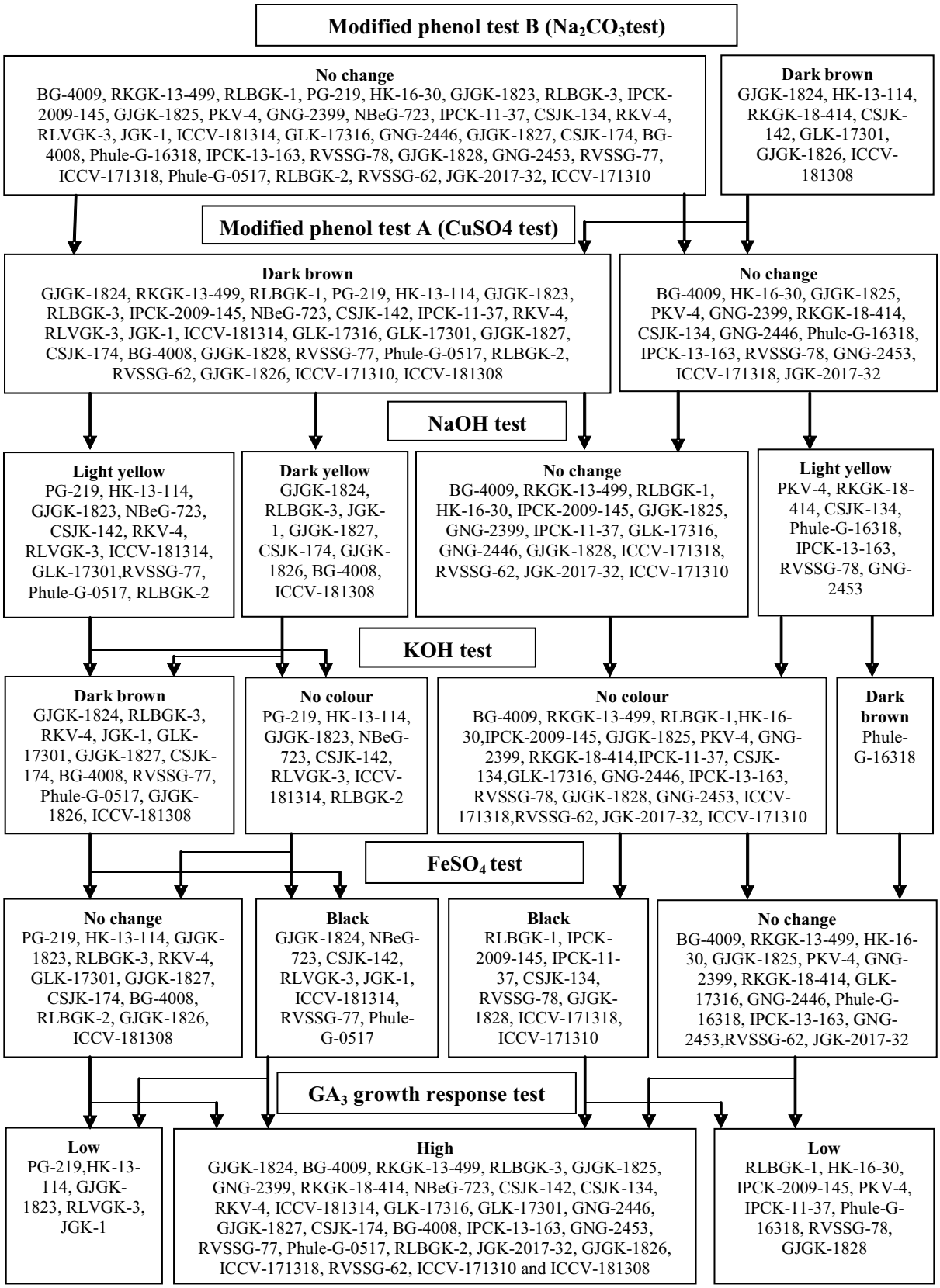

Figure-1 : Kabulichickpea genotypes identification keys on the basis of chemical tests.

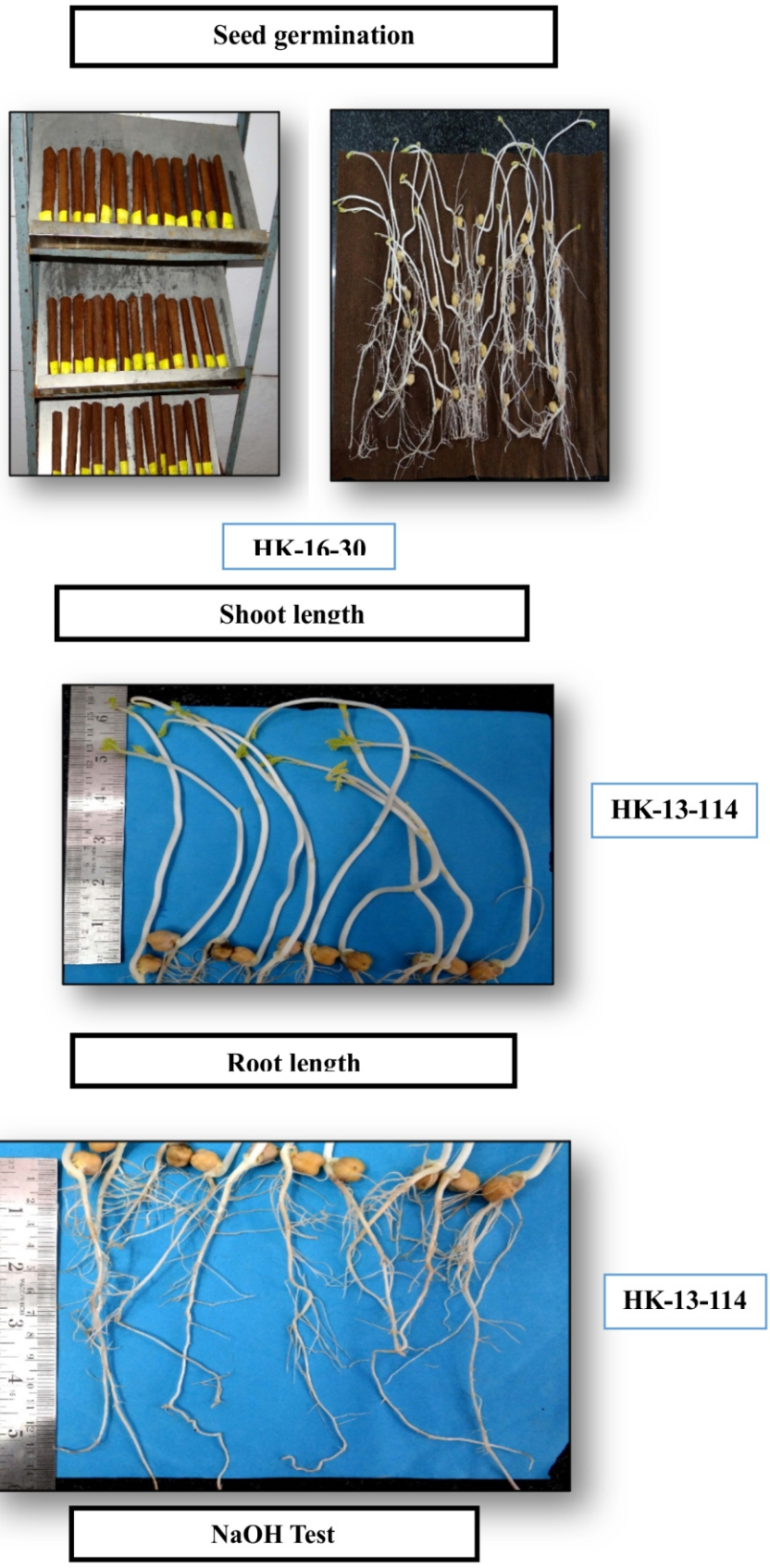

Figure-2 : Seed germination, shoot length and root length of kabuli chickpea genotypes.

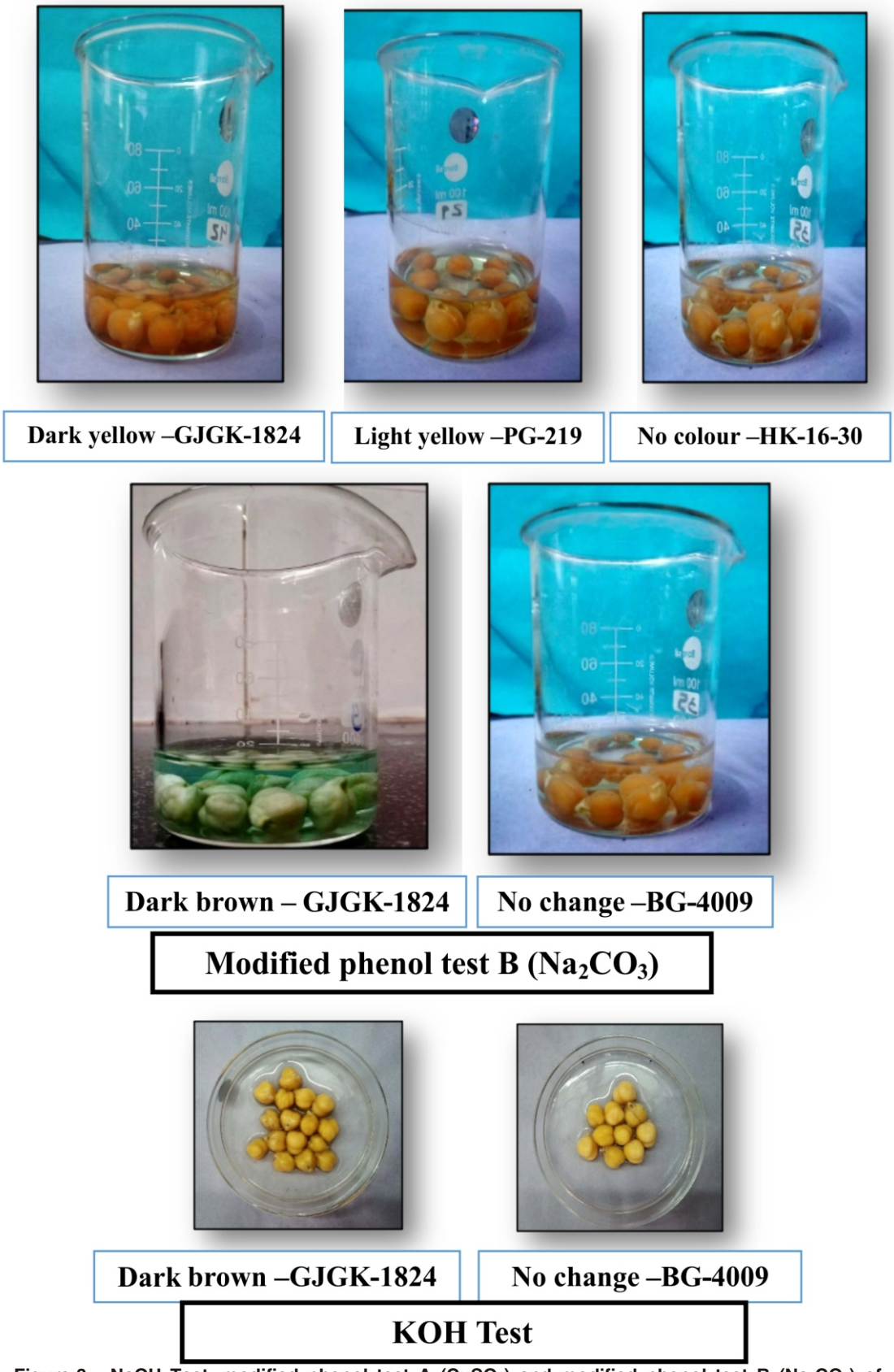

Figure-3 : NaOH Test, modified phenol test A ($CuSO_4$) and modified phenol test B (Na_2CO_3) of kabulichickpea genotypes.

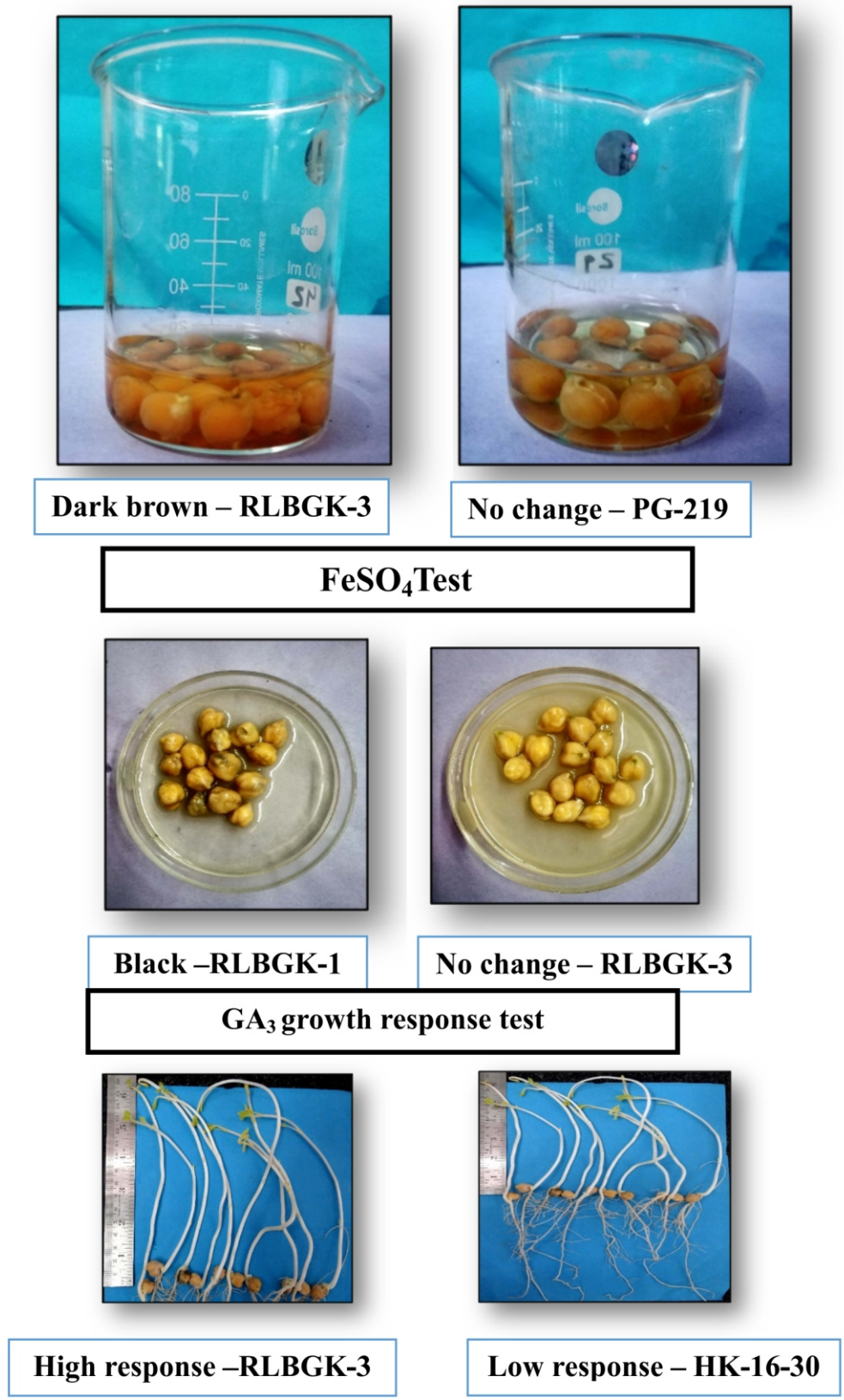

Figure-4 : KOH test, $FeSO_4$ test and GA_3 growth response test of kabulichickpea genotypes.

Conclusions

Assessment of genetic purity is an important criterion in seed production programme. Therefore, simple and reliable techniques need to be developed for genetic purity assessment and genotype characterization. The study suggested that seed quality parameters and chemical test, were found to be useful in broad classification of kabuli chickpea genotypes.

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