

CHARACTERIZATION OF CHICKPEA VARIETIES (*Cicer arietinum* L.) BASED ON PLANT MORPHOLOGY AND YIELD TRAITS

HIRPARA, ANJITA J.; PATEL, J. B.; KATARIYA, G. K. AND PATEL, KOMAL D.

**DEPARTMENT OF SEED SCIENCE AND TECHNOLOGY
COLLEGE OF AGRICULTURE
JUNAGADH AGRICULTURAL UNIVERSITY
JUNAGADH – 362 001, GUJARAT, INDIA**

E-MAIL: anjitahirpara311@gmail.com

ABSTRACT

*The investigation entitled “Characterization of chickpea varieties (*Cicer arietinum* L.) based on plant morphology and yield traits” was conducted in rabi 2014-15 at Sagdividi Farm, Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh. The experiment was laid out as per randomized block design with four replications. Five varieties, Dahod yellow, GG 1, GG 2, GJG 3 and GG 5 were characterized based on seed, seedling and plant morphological characters and yield traits. Based on the seed coat colour, varieties Dahod yellow and GJG 3 were grouped in yellow colour groups, whereas GG 5 into brown and GG 1 and GG 2 into dark brown colour groups. The seeds of varieties Dahod yellow and GG 5 were of angular shape, while of GG 1 was pea shape and GG 2 and GJG 3 were of owls head shape. The seeds of varieties Dahod yellow and GG 2 were having rough surface, GG 1 was having smooth surface and GJG 3 and GG 5 were having tuberculate surface. Mottles on testa was absent in all the five varieties tested. Based on seed length, varieties Dahod yellow was grouped into small length, whereas GG 1, GG 2, GJG 3 and GG 5 were grouped into medium length groups, while based on seed breadth. Dahod yellow and GG 1 were grouped into small breadth groups, while GG 2, GJG 3 GG 5 were grouped into medium seed breadth groups. All the five chickpea variety had green colour hypocotyl and yellow colour cotyledon with dence (hairy) types pubescence. Dahod yellow, GG 1 and GG 2 were categorized into short plant height group (< 50 cm), while GJG 3 into medium (50-60 cm) and GG 5 into tall plant height group (> 50 cm). All the five chickpea varieties were grouped under less (< 20 branches) branches category. The stem colour of variety Dahod yellow was yellow, while it was brown in GG 1, GG 2, GJG 3 and GG 5. The dense hairiness on stem was seen in all five varieties. The foliage colour of variety GG 2 was dark green in colour, while of GG 1, GG 2, GJG 3 and GG 5, it was green in colour. Based on days to flower initiation and days to 50 per cent flowering, GG 5 was grouped under early group, while Dahod yellow, GG 2 and GG 5 were grouped under medium group and GG 1 was grouped under late group. The flower colour of all five varieties was pink in colour. Based on days to pod initiation and days to pod maturity, the variety GG 5 was grouped under early group, while Dahod yellow, GG 2 and GG 5 were grouped under medium group and GG 1 was grouped under late group. Based on pod length variation, Dahod yellow was grouped under small group, while GG 1, GG 2 and GJG 3 were grouped under medium and GG 5 was grouped under large group. All the varieties were grouped under medium pod breadth group. All the five chickpea variety did not show any pigmentation on pods, but had dence hairs on their pods. Dahod yellow variety was having yellow colour pods at harvest, while GG 1, GG 2, GJG 3 and GG 5 had brown pod colour pod at maturity. Based on number of pods per plant,*

Dahod yellow, GG 1 and GG 2 were grouped under medium and GJG 3 and GG 5 were grouped under high number of pods per plant group. Significantly the highest (31.23 g) and the lowest (16.16 g) seed yield per plant were recorded in GG 5 and Dahod yellow, respectively. The five chickpea varieties evaluated for seed yield per plant were grouped as less (<12 g), medium (12-13 g) and high (>13 g) yielding groups. All the five varieties were grouped under high yielding group.

KEY WORDS: Characterization, chickpea, plant morphology

INTRODUCTION

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 and a productivity of 967 kg/ha. Major chickpea producing countries include India, Australia, Pakistan, Myanmar, Ethiopia, Turkey, Iran, Mexico, USA, Canada, Russian Federation and Tanzania (Anonymous, 2016). About 90 per cent of chickpea in the world is grown under rainfed conditions, where drought is one of the major constraints, limiting its production (Randhawa *et al.*, 2014). India is the largest producer of chickpea contributing more than 75 per cent of the world production. In India, during 2013-14 chickpea was grown in an area of 9.93 million hectare with a production 9.53 million tons and productivity of 960 kg/ha. Madhya Pradesh, Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Uttar Pradesh, Gujarat, Chhattisgarh and Jharkhand are the major chickpea producing states in the country. It was grown in area of 0.25 million hectare with a production 0.31 million tons and productivity of 1251 kg/ha in Gujarat during 2013-14 (Anonymous, 2016).

Two types of chickpea cultivars are recognized globally – *kabuli* and *desi*. The *kabuli* types are generally grown in the Mediterranean region including Southern Europe, Western Asia and Northern Africa, and the *desi* types are grown mainly in Ethiopia and Indian subcontinent. *Desi* chickpeas are characterized by flowers of varying colours, angular to round seeds with dark seed coat, anthocyanin pigmentation on stem or other plant parts, rough seed

surface and with erect, semi erect or semi spreading growth habit, whereas *kabuli* types generally have owl- or ram-shaped beige coloured seeds, white flowers, smooth seed surface, lack of anthocyanin pigmentation and semi spreading to erect growth habit (Pundir *et al.*, 1985).

In recent past years, several high yielding varieties of chickpea are being released by many private and public sectors. Hence, there is a need for maintenance of genetic purity of chickpea varieties. The morphological study includes the study of seed to the whole plant characterization. Seed, seedlings and full grown plant could be taken into account for morphological characterization. Identification and characterization of varieties based on simple distinct seed and seedling morphological characters for grow-out-test of genetic purity in chickpea varieties have become most essential. Such diagnostic characterization studies in chickpea varieties are very limited.

Characterization and identification of plant varieties are thus, fundamental to the development, release and popularization of the crop varieties. In this context, varietal description for identification of crop variation has attained a critical importance in national and international seed programmes and there is considerable need for the development of reliable methods and identifiable characters for identification purpose. Plant morphological characters have been recognized as the universally undisputed descriptors for protection and varietal characterization of crop varieties. Use of morphological descriptors in sequential fashion is useful and convenient to

discriminate the different varieties (Joshi *et al.*, 2011). Characterization has done by using morphological descriptors have traditional significance and one can immediately accessible on the spot without the need of equipment. Although has its limitations like environmental influence and time consuming but this has been universally adopted as classical taxonomic approach. On the other hand, any new crop variety is registered if it is distinct from other varieties, uniform in its characteristics and genetically stable. Identification of variety serves an important role in seed production. Keep all these in view, five *desi* chickpea varieties released for general cultivation in Gujara were characterized based on distinct seed, seedling and plant diagnostic morphological characters and yield traits.

MATERIALS AND METHODS

A field trial was conducted in *rabi* 2014-15 at Sagdividi Farm, Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh to characterize the five chickpea varieties, Dahod yellow, GG 1, GG 2, GJG 3 and GG 5 based on seed, seedling and plant morphological characters and yield traits. The experiment was laid out as per randomized block design with four replications with spacing of 45 cm x 10 cm. The plant protection measures were adopted as and when required. The recommended dose of fertilizers (20:40:00 kg NPK/ha) was applied as basal dose for each plots in the form of Urea and Diammonium phosphate and incorporated well into the soil. All the five chickpea varieties were characterized and grouped based on seed characters [seed coat colour, seed shape, surface of seed, mottles on testa, seed length (mm), seed breadth (mm), seeds per pod and 100 seed weight (g).], seedling characters [hypocotyl colour, cotyledon colour and pubescence on hypocotyl], plant growth characters [plant height (cm), number of branches per plant, stem colour, hairiness on stem and foliage colour], flower

characters [flower colour, days to flower initiation and days to 50 per cent flowering], pod characters [days to pod initiation, days to pod maturity, pod length (cm), pod breadth (cm), pigmentation on pod, hairiness on pod and pod colour at harvest], and yield traits [number of pods per plant and seed yield per plant (g)].

RESULTS AND DISCUSSION

Seed morphological characters

The seed colour is one of the important parameter useful in varietal identification. Seed coat colour of five chickpea varieties differed distinctly. Among the varieties, Dahod yellow and GJG 3 were grouped in yellow colour groups, whereas GG 5 was grouped into brown and GG 1 and GG 2 were grouped into dark brown colour groups (Table 1 and Plate 1). The marked variation in seed colour was observed by Gnyandev (2009) in chickpea; Basavaraj *et al.* (2012) and Kumar and Shrikant (2016) in cowpea; and Singh *et al.* (2014) in mungbean. The seeds of varieties Dahod yellow and GG 5 were of angular shape, while of GG 1 was pea shape and GG 2 and GJG 3 were of owls head shape (Table 1 and Plate 1). The seeds of varieties Dahod yellow and GG 2 were having rough surface, GG 1 was having smooth surface and GJG 3 and GG 5 were having tuberculate surface (Table 1 and Plate 1). The variation in seed shape and surface noticed in the present study may be accounted for genetic factor (Pundir *et al.*, 1985; Upadhyaya *et al.*, 2002 and Gnyandev, 2009) in chickpea. Mottles on testa was absent in all the five chickpea varieties tested (Table 1). However, Upadhyaya *et al.* (2002) and Gnyandev (2009) observed marked variation with respect to mottles on testa in chickpea.

Significantly the highest seed length was recorded in GG 2 (9.36 mm) and the lowest seed length was recorded in Dahod yellow (6.35 mm) (Table 2). On the basis of seed length, varieties were grouped into two categories viz., Dahod yellow was grouped into small length (<

7.00 mm), whereas GG 1, GG 2, GJG 3 and GG 5 were grouped into medium length (7-10 mm) groups. Significantly the highest seed breadth was recorded in GG 5 (8.48 mm) and the lowest seed breadth was recorded in Dahod yellow (6.30 mm) (Table 2). On the basis of seed breadth, varieties were grouped into two categories, viz., Dahod yellow and GG 1 were grouped in to small (< 7 mm), whereas GG 2, GJG 3 and GG 5 were grouped in to medium (7-10 mm) breadth groups. Similar reports were made in chickpea (Gnyandev, 2009); in frenchbean (Chandrashekhar, 2005 and 2008; and Das *et al.*, 2014); and in mungbean (Singh *et al.*, 2014). The seeds per pod varied significantly among different chickpea varieties (Table 2). Significantly the highest seeds per pod (1.50) were observed in GG 5, whereas the lowest seeds per pod (1.29) were observed in the GG 2. Hundred seed weight varied significantly among different chickpea varieties (Table 2). The variations observed with respect to seed size may be due to bigger size of endosperm and embryo and were indicated to be specific to varieties (Chandrashekhar, 2005). The mean 100 seed weight of the varieties was 22.17 g. Significantly the highest 100 seed weight (26.77 g) was observed in variety GG 2, whereas the lowest 100 seed weight (16.34 g) was observed in the variety Dahod yellow. Similar reports with respect to seed weight and size were made in chickpea (Gnyandev, 2009); and in mungbean (Singh *et al.*, 2014).

Seedling morphological characters

The seedling morphological characters are widely used as key diagnostic characters for varietal identification in most of the crops. All the five chickpea varieties had green colour hypocotyl and yellow colour cotyledon (Table 3 and Plate 2). Therefore, no variation was observed with respect to hypocotyl colour and cotyledon colour and as such no groups for hypocotyl colour and cotyledon colour were made. All the five

varieties of chickpea were of dence (hairy) types on the basis of pubescence on hypocotyl (Table 3). The similar varietal characterization based on seedling morphology was made by Gnyandev (2009) in chickpea, Basavaraj *et al.* (2012) in cowpea, and Singh *et al.* (2014) in mungbean.

Plant growth characters

In field conditions, varietal variations on plant morphological characters such as plant height at harvest, number of branches per plant, stem colour, hairiness on stem and foliage colour, *etc.* are widely taken as basis of varietal identification by breeders. In the present study, varieties showed marked variations in plant height. Significantly the highest plant height was recorded in GG 5 (60.83 cm) and the lowest plant height was recorded in Dahod yellow (47.29 cm). Based on plant height, chickpea varieties were grouped into three categories. Dahod yellow, GG 1 and GG 2 were categorized into short plant height group (< 50 cm), GJG 3 was categorized into medium plant height group (50-60 cm) and GG 5 was categorized under tall plant height group (> 50 cm) (Table 4 and Plate 2). Similarly, significantly the highest number of branches per plant was recorded in GG 5 (11.40) and the lowest was noted in Dahod yellow (8.13). Based on the number of branches per plant, all the chickpea varieties were grouped under less (< 20 branches) branches category (Table 4 and Plate 3). The results are in akin to those reported by Gnyandev (2009) in chickpea for plant height and number of branches per plant, Basavaraj *et al.* (2013) in cowpea for number of branches, Das *et al.* (2014) in frenchbean for plant height and number of branches per plant, and Kumar and Shrikant (2016) in cowpea for plant height.

Similarly, variations in the other characteristics like stem colour, hairiness on stem and foliage colour were evident among chickpea varieties. The stem colour of variety Dahod yellow was yellow, while

it was brown in all the remaining four varieties viz., GG 1, GG 2, GJG 3 and GG 5 (Table 5 and Plate 3). The dense hairiness on stem was seen in all five varieties and hence no categories were made (Table 5 and Plate 4). The foliage colour of variety GG 2 was dark green in colour, while of GG 1, GG 2, GJG 3 and GG 5, it was green in colour (Table 5 and Plate 4). Similar results were reported in chickpea by Gnyandev (2009) for stem colour and Joshi and Yasin (2014) for hairiness on stem. Similar results were also observed in other pulses crops by Chavan (2010) in soybean for leaf colour, and Singh *et al.* (2014) in mungbean and Kumar and Shrikant (2016) in cowpea for stem colour.

Flower characteristics

In the present study, days to flower initiation, days to 50 per cent flowering and flower colour differed significantly in chickpea varieties (Table 1). The flower colour of all five varieties was pink colour (Table 6 and Plate 5). Significantly the highest days to flower initiation (52.94 days) was recorded in GG 1 variety, whereas it was noted the lowest (39.92 days) in GG 5 variety. Based on days to flower initiation, the five chickpea varieties were grouped into early (30-40 days), medium (40.50 days) and late (>50 days) category. The variety GG 5 was grouped under early group, while Dahod yellow, GG 2 and GG 5 were grouped under medium group, and GG 1 was grouped under late group (Table 6). Similarly, significantly the highest days to 50 per cent flowering (60.39 days) was recorded in GG 1 variety, whereas the lowest days to 50 per cent flowering (44.22 days) was recorded in GG 5. The chickpea varieties were grouped into three groups based on the days required to 50 per cent flowering, as early (< 45 days), medium (45-50 days) and late (>50 days). The variety GG 5 was grouped under early flowering, Dahod yellow, GG 2 and GG 5 were grouped under medium group and GG 1 was grouped under late group (Table

6). Similar results were observed by Gnyandev (2009) in chickpea, and Basavaraj *et al.* (2013) and Kumar and Shrikant (2016) in cowpea.

Pod characteristics

The days to pod initiation and days to pod maturity varied significantly among the varieties (Table 7). Significantly the highest days to pod initiation (71.25 days) was recorded in GG 1 variety, while it was noted significantly the lowest (53.25 days) in GG 5 variety. Three different groups were made based on days to pod initiation in chickpea varieties into early (< 50-60 days) medium (60-70 days) and late (>70 days). The variety GG 5 was grouped under early days to pod initiation group, while Dahod yellow, GG 2 and GG 5 were grouped under medium group and GG 1 was grouped under late group of days to pod initiation. Significantly the highest days to pod maturity (120.75 days) was recorded in GG 1 variety, while days to maturity were noted significantly the lowest (97.50 days) in GG 5 variety. Based on the days to pod maturity of chickpea varieties, they were grouped as early (< 90-100 days), medium (100-120 days) and late (> 120 days) varieties. The variety GG 5 was grouped under early pod maturity, while Dahod yellow, GG 2 and GG 5 were grouped under medium group and GG 1 was grouped under late group of days to pod maturity. Similar results were reported by Gnyandev (2009) in chickpea and Kumar and Shrikant (2016) in cowpea for days to pod maturity.

Pod length and breadth varied significantly among the chickpea varieties. Significantly the highest (2.51 cm) and lowest (1.70 cm) pod length were recorded in GG 5 and Dahod yellow, respectively. Based on pod length variation in five chickpea varieties, they were grouped as small (< 2 cm), medium (2-2.5 cm) and large (> 2.5 cm). Dahod yellow was grouped under small group, while GG 1, GG 2 and GJG 3 were grouped under medium group and GG 5 was grouped under large group (Table 8 and Plate 5).

Significantly the highest (1.53 cm) and lowest (1.15 cm) pod breadth were recorded in GG 5 and Dahod yellow, respectively. Based on pod breadth variation in five chickpea varieties, they were grouped as small (< 2 cm), medium (2-2.5 cm) and large (> 2 cm). All the chickpea varieties were grouped under small pod breadth group (Table 8). Similar results were reported by Gnyandev (2009) in chickpea for these traits.

All the five chickpea variety did not show any pigmentation on pods and as such no groups were made (Table 9). All the five varieties of chickpea showed dense hairs on their pods and hence, no groups were made for this character (Table 9 and Plate 4). Dahod yellow variety was having yellow colour pods at harvest, while GG 1, GG 2, GJG 3 and GG 5 had brown colour pods at maturity. Similar results were reported by Gnyandev (2009) in chickpea for pod colour at harvest (Table 9 and Plate 5).

Yield traits

Number of pods per plant and seed yield per plant varied significantly among the chickpea varieties (Table 10). Significantly the highest (71.25) and the lowest (45.00) number of pods per plant were recorded in GG 5 and Dahod yellow, respectively. The chickpea varieties were grouped as less (< 40), medium (40-50) and high (> 50) for number of pods per plant. Varieties Dahod yellow, GG 1 and GG 2 were grouped under medium and GJG 3 and GG 5 were grouped under high number of pods per plant group. Significantly the highest (31.23 g) and the lowest (16.16 g) seed yield per plant were recorded in GG 5 and Dahod yellow, respectively. The five chickpea varieties evaluated for seed yield per plant were grouped as less (<12 g), medium (12-13 g) and high (>13 g) yielding groups. All the five varieties were grouped under high yielding group. The similar varietal characterization based on number of pods per plant and seed yield per plant were

made by Gnyandev (2009) and Bayahi and Rezgui (2015) in chickpea.

CONCLUSION

From the results and discussion, It can be concluded that five varieties evaluated in the present investigation can easily be identified based on the various morphological characters (seed, seedling, plant, flower and pod) and these morphological characters were found more reliable for varietal characterization. These morphological characters can be effectively utilized for rouging during seed production to safe guard genetic purity, identification and characterization of chickpea varieties in DUS testing and helpful in GOT conducted by seed certification agencies.

REFERENCES

- Anonymous. (2016). E-pulses data book, Indian Institute of Pulses Research, Kanpur (www.iipr.res.in) Accessed on 29-10-2016.
- Randhawa, N.; Kaur, J.; Singh, S. and Singh, I. (2014). Growth and yield in chickpea (*Cicer arietinum* L.) genotypes in response of water stress. *African J. Agril. Res.*, **9**(11): 982-992.
- Basavaraj, M.; Deshpande, V. K. and Vyakaranahal, B. S. (2013). Characterization of cowpea genotypes based on quantitative descriptors. *The Bioscan*, **8**(4): 1183-1188.
- Basavaraj, M.; Deshpande, V. K.; Deshpande, S. K. and Jaba, J. (2012). Characterization of cowpea genotypes based on the morphological characters of seed and seedling. *Bioinfolet*, **9**(4B): 656-660.
- Bayahi, K. and Rezgui, S. (2015). Agromorphological characterization and genetic study of new improved lines and cultivars of chickpea (*Cicer arietinum* L.). *J. Plant Breed. Genet.*, **3**(3): 59-65.
- Chandrashekhar, S. S. (2005). Influence of the age of the seed on plant growth,

- seed yield and quality and characterization of frenchbean genotypes. M.Sc. (Agri.) Thesis (Unpublished) Submitted to University of Agricultural Sciences, Dharwad, Karnataka (India).
- Chandrashekhara, S. S. (2008). Seed technological studies in frenchbean. Ph.D. Thesis (Unpublished) Submitted to University of Agricultural Sciences, Dharwad, Karnataka (India).
- Chavan, N. G. (2010). Characterization of soybean genotypes [*Glycine max* (L.) Merrill] through morphological, chemical, molecular markers and image analyzer. M.Sc. (Agri.) Thesis (Unpublished) Submitted to University of Agricultural Sciences, Dharwad, Karnataka (India).
- Das, R.; Thapa, U.; Debnath, S.; Lyngdoh, Y. A. and Mallick, D. (2014). Evaluation of frenchbean (*Phaseolus vulgaris* L.) genotypes for seed production. *J. Appl. Nat. Sci.*, **6**(2): 594-598.
- Gnyandev, B. (2009). Seed technological studies in chickpea varieties (*Cicer arietinum* L.). Ph. D. Thesis (Unpublished) Submitted to University of Agricultural Sciences, Dharwad, Karnataka (India).
- Joshi, A.; Agrawal, R. C. and Chawla, H. S. (2011). Assessment of distinctiveness, uniformity and stability of indigenous aromatic rice (*Oryza sativa*) varieties based on morphological descriptors. *Indian J. Agric. Sci.*, **81**(7): 595-601.
- Joshi. P. and Yasin, M. (2014). Characterization of diverse angular, owl's head and pea seed shapes germplasm of chickpea (*Cicer arietinum* L.). *J. Medi. Pharma. Allied Sci.*, **3**(6): 1-9.
- Kumar, S. and Shrikant. (2016). Evaluation of cowpea [*Vigna unguiculata* (L.) Walp.] cultivars using morphological indices. *Asian J. Multidisciplinary Studies*, **4**(6): 158-164.
- Pundir, R. P. S.; Rao, N. K. and van der Maesen, L. J. G. (1985). Distribution of qualitative traits in the world germplasm of chickpea (*Cicer arietinum* L.). *Euphytica*, **34**: 697-703.
- Singh, C. M.; Mishra, S. B.; Pandey, A. and Arya, M. (2014). Morphological characterization and discriminant function analysis in mungbean [*Vigna radiata* L. Wilczek] germplasm, *Elect. J. Plant Breed.*, **5**(1): 87-96.
- Upadhyaya, H. D.; Rodomiro, Q.; Paula, J. B. and Singh, S. (2002). Phenotypic diversity for morphological and agronomic characteristics in chickpea core collection. *Euphytica*, **123**: 333-342.

Table 1: Grouping of chickpea varieties based on seed coat colour, seed shape, surface of seed and mottles on testa

Varieties	Seed Coat Colour	Seed Shape	Surface of Seed	Mottles on Testa
Dahod yellow	Yellow	Angular	Rough	Absent
GG1	Dark brown	Pea shape	Smooth	Absent
GG2	Dark brown	Owls head	Rough	Absent
GJG3	Yellow	Owls head	Tuberculate	Absent
GG5	Brown	Angular	Tuberculate	Absent

Table 2: Grouping of chickpea varieties based on seed length (mm), seed breadth (mm), seeds per pod and 100 seed weight (g)

Varieties	Seed Length (mm)	Groups	Seed Breadth (mm)	Groups	Seeds per Pod	100 Seed Weight (g)
Dahod yellow	6.35	Small	6.30	Small	1.39	16.34
GG1	7.09	Medium	6.83	Small	1.34	20.00
GG2	9.36	Medium	8.48	Medium	1.29	26.77
GJG3	8.14	Medium	7.50	Medium	1.36	24.48
GG5	8.05	Medium	7.25	Medium	1.50	23.25
General mean	7.80		7.29		1.38	22.17
S.Em.±	0.23		0.33		0.04	0.59
C.D. at 5 %	1.01		1.07		0.15	2.30
C.V. %	6.66		7.56		5.58	5.29

Seed length(mm)

Small : < 7mm
Medium : 7-10 mm
Large : >10 mm

Seed breadth (mm)

Small : < 7 mm
Medium : 7-10 mm
Large : > 10 mm

Table 3: Grouping of chickpea varieties based on hypocotyl colour, cotyledon colour and pubescence on hypocotyls

Varieties	Hypocotyl Colour	Cotyledon Colour	Pubescence on Hypocotyl
Dahod yellow	Green	Yellow	Dense
GG1	Green	Yellow	Dense
GG2	Green	Yellow	Dense
GJG3	Green	Yellow	Dense
GG5	Green	Yellow	Dense

Table 4: Grouping of chickpea varieties based on plant height (cm) and number of branches per plant

Varieties	Plant Height (cm)	Groups	Number of Branches/Plant	Groups
Dahod yellow	47.29	Short	8.13	Less
GG1	48.57	Short	8.55	Less
GG2	45.65	Short	9.75	Less
GJG3	51.08	Medium	10.05	Less
GG5	60.83	Tall	11.40	Less
General mean	50.68		9.58	
S.Em.±	0.62		0.41	
C.D. at 5 %	2.45		1.63	
C.V. %	2.46		8.66	

Plant height (cm)
Short : < 50 cm
Medium : 50-60 cm
Tall : >60 cm

Number of branches per plant
Less : < 20
Medium : 20-25
More : >25

Table 5: Grouping of chickpea varieties based on stem colour, hairiness on the stem and foliage colour

Varieties	Stem Colour	Hairiness on Stem	Foliage Colour
Dahod yellow	Yellow	Dense	Green
GG1	Brown	Dense	Green
GG2	Brown	Dense	Dark green
GJG3	Brown	Dense	Green
GG5	Brown	Dense	Green

Table 6: Grouping of chickpea varieties based on days to flower initiation, days to 50 per cent flowering and flower colour

Varieties	Days to Flower Initiation	Groups	Days to 50 Per Cent Flowering	Groups	Flower Colour
Dahod yellow	43.48	Medium	49.74	Medium	Pink
GG1	52.94	Late	60.39	Late	Pink
GG2	41.41	Medium	47.60	Medium	Pink
GJG3	43.43	Medium	49.27	Medium	Pink
GG5	39.92	Early	44.22	Early	Pink
General mean	44.24		50.24		
S.Em.±	0.72		0.69		
C.D. at 5 %	2.82		2.73		
C.V. %	3.24		2.76		

Days to flower initiation
Early : <30-40 days
Medium : 40-50 days
Late : >50 days

Days to 50 per cent flowering
Early : <45 days
Medium : 45-50 days
Late : >50 days

Table 7: Grouping of chickpea varieties based on days to pod initiation and days to pod maturity

Varieties	Days to Pod Initiation	Groups	Days to Pod Maturity	Groups
Dahod yellow	62.25	Medium	106.75	Medium
GG1	71.25	Late	120.75	Late
GG2	60.25	Medium	102.50	Medium
GJG3	61.50	Medium	100.75	Medium
GG5	53.25	Early	97.50	Early
General mean	61.70		105.65	
S.Em.±	0.43		1.51	
C.D. at 5 %	1.70		5.914	
C.V. %	1.40		2.85	

Days to pod initiation

Early : < 50-60 days
 Medium : 60-70 days
 Late : > 70 days

Days to pod maturity

Early : < 90-100 days
 Medium : 100-120 days
 Late : > 120 days

Table 8: Grouping of chickpea varieties based pod length (cm) and pod breadth (cm)

Varieties	Pod Length (cm)	Groups	Pod Breadth (cm)	Groups
Dahod yellow	1.70	Small	1.15	Small
GG1	2.03	Medium	1.29	Small
GG2	2.42	Medium	1.40	Small
GJG3	2.26	Medium	1.33	Small
GG5	2.51	Large	1.53	Small
General mean	2.18		1.34	
S.Em.±	0.08		0.03	
C.D. at 5 %	0.32		0.13	
C.V. %	7.57		4.80	

Pod length (cm)

Small : < 2 cm
 Medium : 2-2.5 cm
 Large : >2.5 cm

Pod breadth (cm)

Small : <2 cm
 Medium : 2-2.5 cm
 Large : >2.5 cm

Table 9: Grouping of chickpea varieties based on pigmentation on pod, hairiness on pod and pod colour at harvest

Varieties	Pigmentation on Pod	Hairiness on Pod	Pod Colour at Harvest
Dahod yellow	Absent	Dense	Yellow
GG1	Absent	Dense	Brown
GG2	Absent	Dense	Brown
GJG3	Absent	Dense	Brown
GG5	Absent	Dense	Brown

Table 10: Grouping of chickpea varieties based on number of pod per plant and seed yield per plant

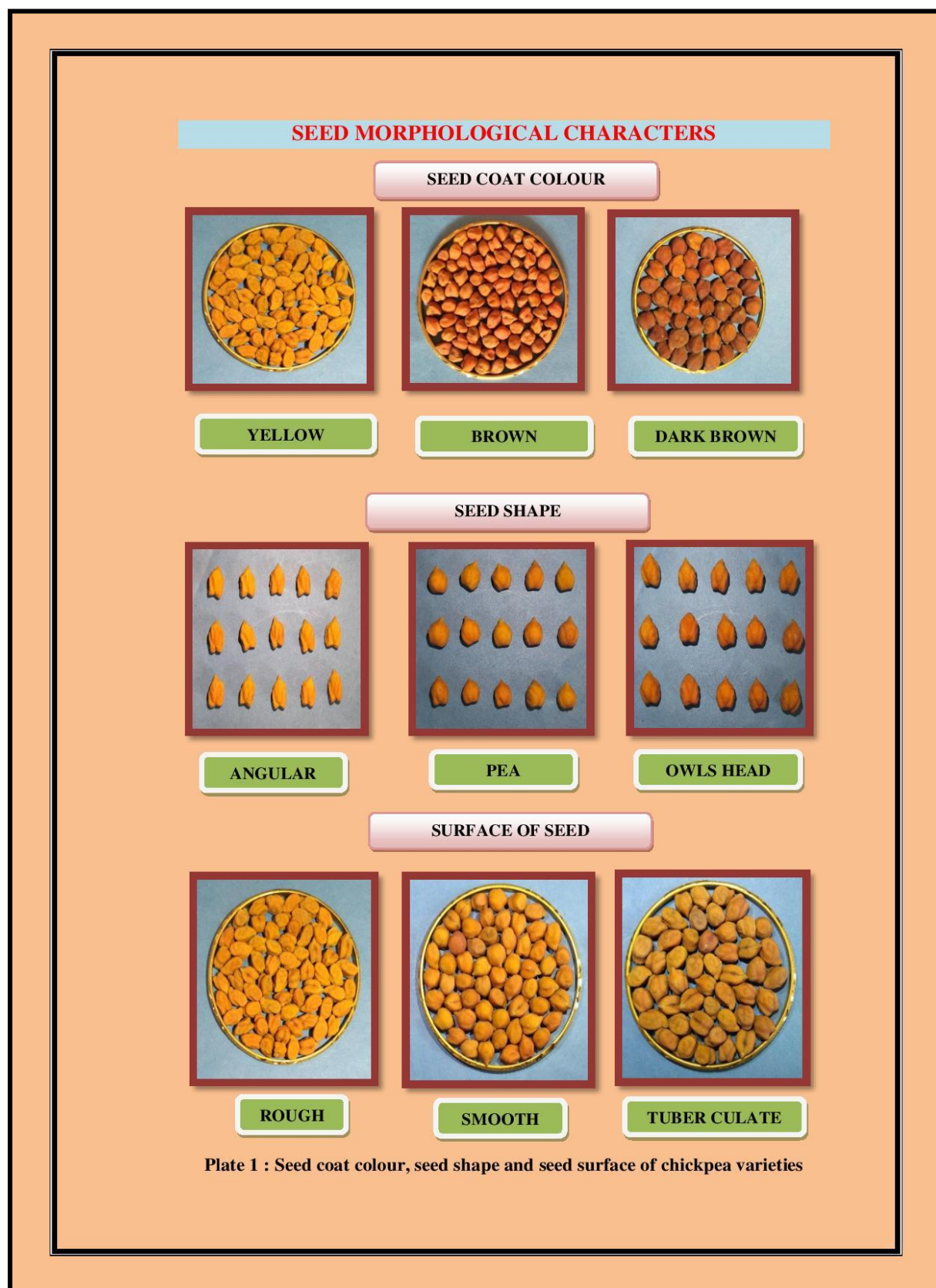
Varieties	Number of Pods Per Plant	Groups	Seed Yield Per Plant (g)	Groups
Dahod yellow	45.00	Medium	16.16	High
GG1	46.50	Medium	21.38	High
GG2	49.75	Medium	23.47	High
GJG3	60.50	More	25.98	High
GG5	71.25	More	31.23	High
General mean	54.60		23.64	
S.Em.±	1.76		0.60	
C.D. at 5 %	6.91		2.35	
C.V. %	6.45		5.06	

Pods per plant (cm)

Less : < 40
 Medium : 40-50
 High : > 50

Seed yield per plant

Less : < 12 g
 Medium : 12-13 g
 High : > 13 g



SEEDLING MORPHOLOGICAL CHARACTERS

HYPCOTYLE COLOUR



GREEN

COTYLEDON COLOUR



YELLOW

PLANT MORPHOLOGICAL CHARACTERS

PLANT HEIGHT

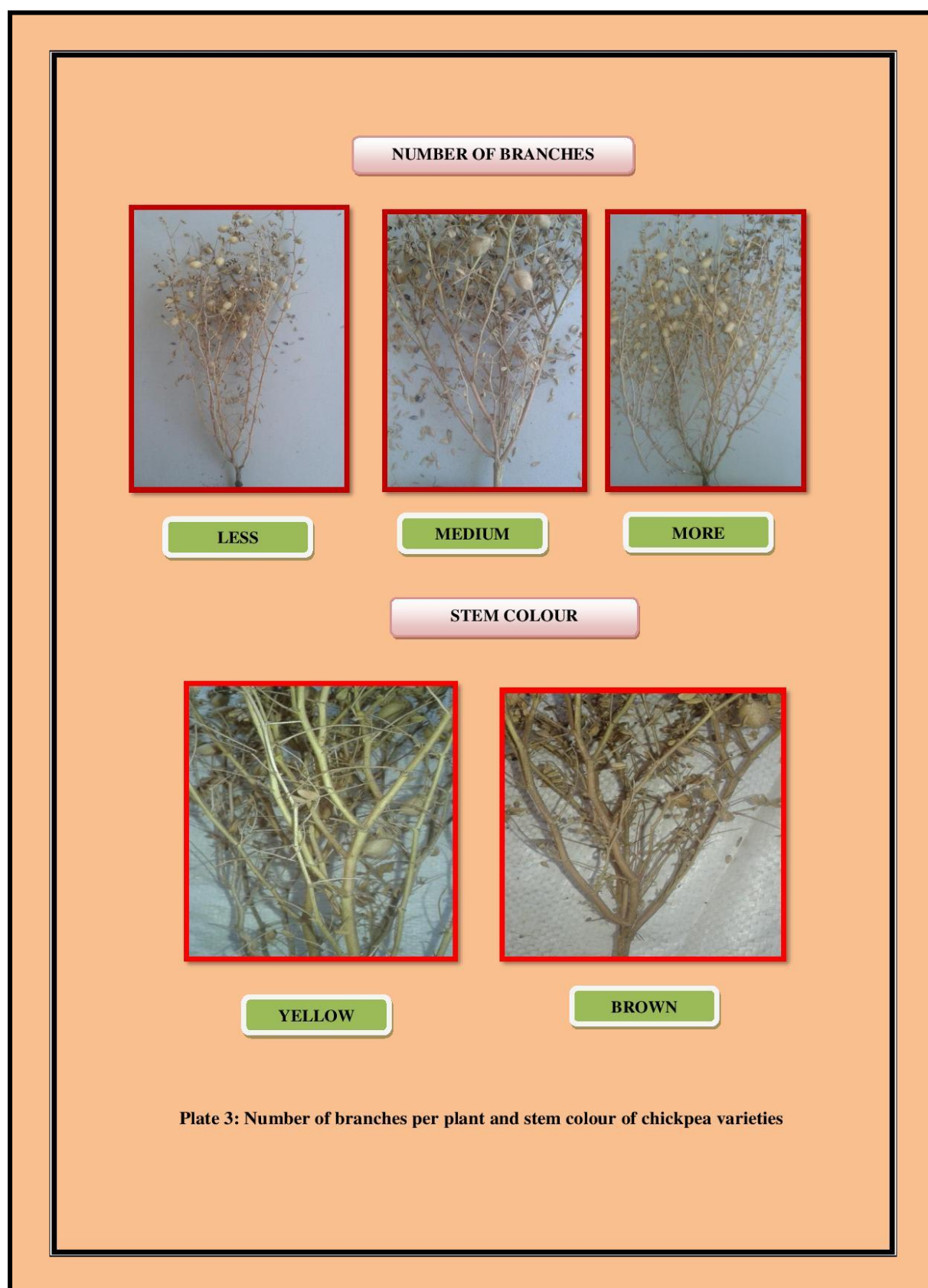


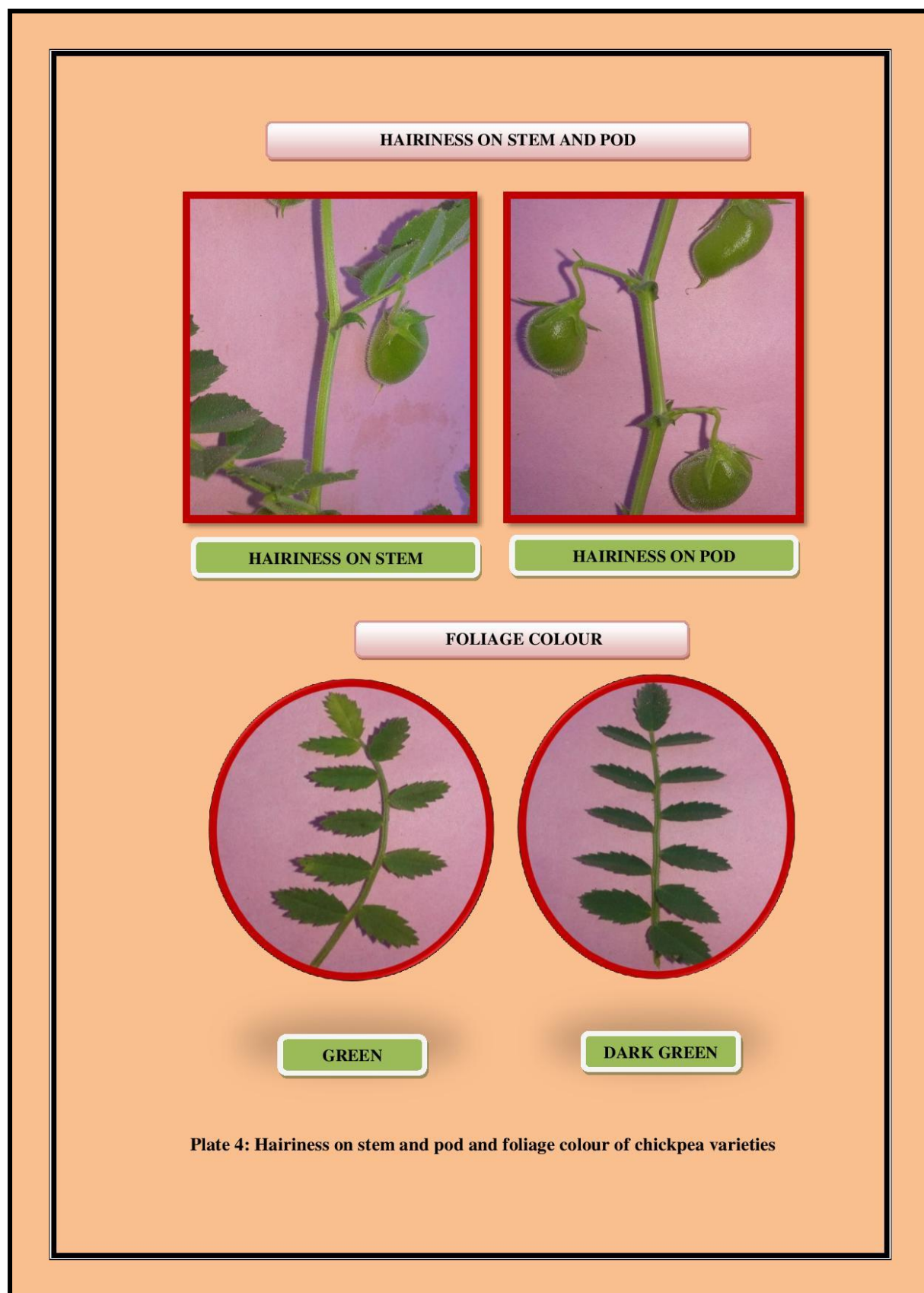
SHORT

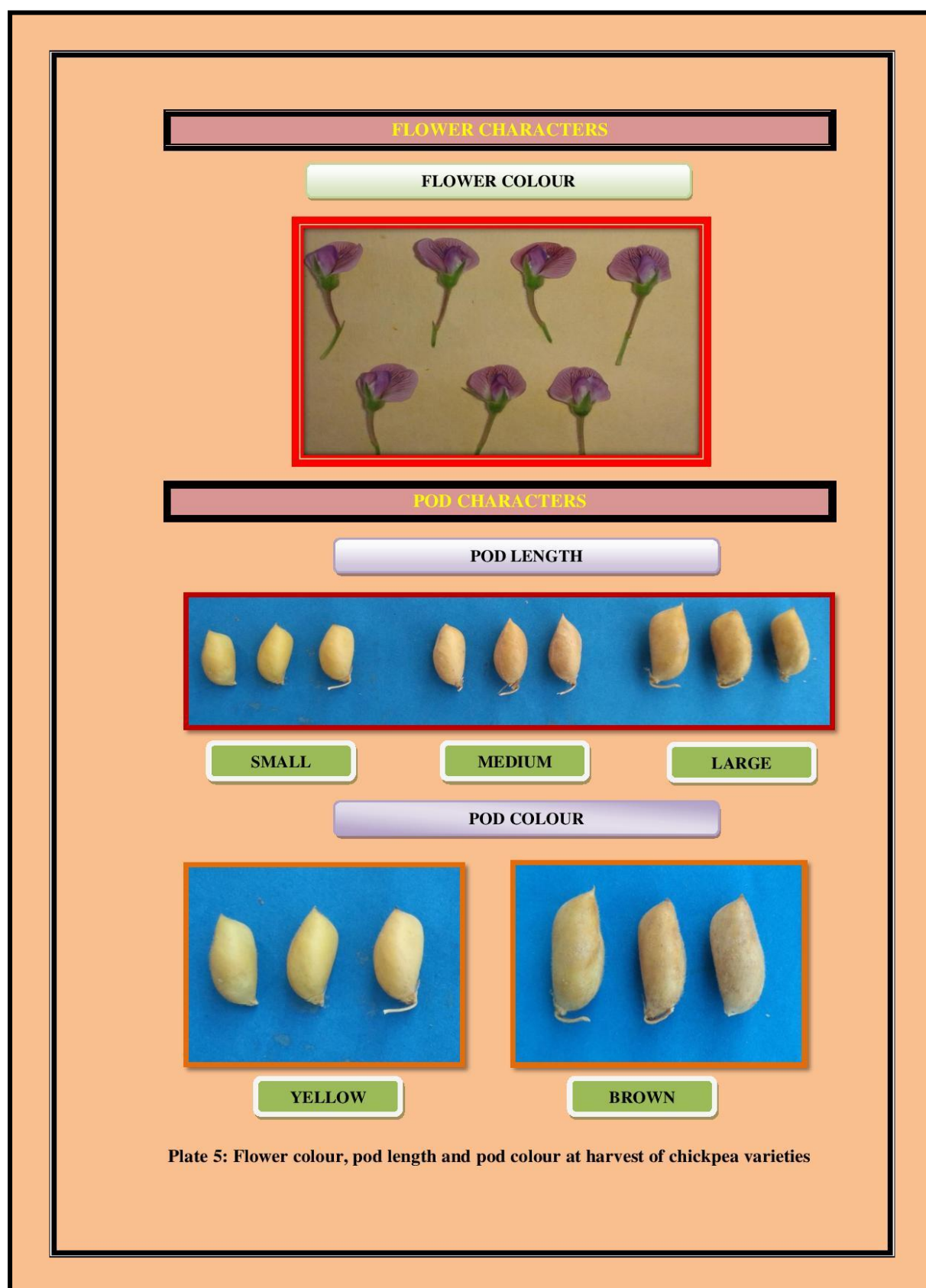
MEDIUM

TALL

Plate 2: Hypocotyl colour, cotyledon colour and plant height of chickpea varieties







[MS received : May 14, 2017]

[MS accepted : May 21, 2017]