International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2020; 8(1): 1712-1717

Received: 07-11-2019
Accepted: 09-12-2019

Trisha Sinha
Department of Plant Physiology
Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya
West Bengal, India

Subhasis Mondal
Department of Plant Physiology
Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya
West Bengal, India

Rajib Nath
Department of Agronomy,
Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya,
West Bengal, India

Suryakant Hembram
Department of Plant Physiology
Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya
West Bengal, India

Corresponding Author:
Trisha Sinha
Department of Plant Physiology
Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya
West Bengal, India

Morphological traits and growth studies of some promising chickpea [*Cicer arietinum* (L.)] genotypes

Trisha Sinha, Subhasis Mondal, Rajib Nath and Suryakant Hembram

DOI: https://doi.org/10.22271/chemi.2020.v8.i1y.8508

Abstract
The morphological traits and growth studies of crop varieties are important feature that may help to better understand their inherent capacity or energy to stand as well as to know their pattern of growth. With this target, a field experiment was conducted in order to study the morphological traits and growth patterns of nine promising chickpea genotypes namely, AGBL-184, IPC-2010-94, IPC-2011-70, ICCV-13107, RSG-888, 24001-4-1, 24004-3-1, 24034-4-1 and 24017-1-1. Following randomized complete block design with four replications, the observations on several growth parameters were taken at fortnight intervals, starting from 15 DAS to 60 DAS. The parameters taken were plant height, leaf number, leaf area, leaf dry weight, shoot dry weight and total plant dry weight. The pattern of growth based on the morphological traits of the genotypes was different in respect of their pattern of stem elongation, leaf area expansion, dry matter accumulation in leaf, shoot as well as whole plant. However, some common points were also noticed. The result revealed that, major proportion of stem elongation occurred within 30 DAS, whereas, leaf expansion in early growth stage was nominal but made a huge jump around flowering stage for all the genotypes. A huge enhancement in dry matter production in leaf, shoot and total plant was observed at post flowering stage. Correlation analysis showed that the parameters leaf area, leaf dry weight, shoot dry weight as well as total plant dry weight were found to be strongly associated with the seed yield. The highest yielder was genotype AGBL-184 that also maintained highest leaf and total plant dry weight irrespective of the growth stages. In terms of leaf area and shoot dry weight also, AGBL-184 was among the top-ranking genotypes.

Keywords: Chickpea, growth, morphology

Introduction
Chickpea is a hardy, dryland crop sown on marginal lands. It can grow to full maturity in conditions that would be unsuitable for most of the crops (Singh and Reddy, 1991) [10]. Globally it is grown over an area of 13.57 million ha producing 13.11 million tons with a productivity of 966 kg/ha (FAO STAT 2013). It accounts for the 20% of the global pulse production. India is the largest chickpea producing country accounting for 67% of the global chickpea production. India shares 90.75 lakh tones of chickpea production from an area of 95.39 lakh ha with the productivity of 951.36 kg/ha (DES, 2017) [1]. Even though India is the largest producer of chickpea; it still imports chickpea from other countries. Keeping in view, the ever-increasing demand for this legume crop; it is essential to improve the productivity and area under cultivation, at the same time minimizing the stress on this crop plant. The present yield is 951.36 kg/ha that is far below its potential yield (5000 kg/ha).
Plant growth study is widely considered as an explanatory, holistic and integrative approach to interpreting plant form and function. It is a fundamental technique used to quantify the growth components, represents the first step in the analysis of primary production and is the most practical method for assessing net photosynthetic production (Nogueira *et al.*, 1994) [7]. It uses simple primary data in the form of weights, areas, volumes and contents of plant components to investigate processes within and involving the whole plant (Evans, 1972) [3]. It is still considered as the most simple and precise method to evaluate the contribution of the different physiological processes in plant development. The purpose of growth study is the determination of the increase in dry matter referred to a suitable basis (Ali *et al.*, 2004; Gupta and Gupta, 2005; Alam and Haider, 2006 and Yasari and Patwardhan, 2006).

In this background the present investigation has been taken up with following objective:

- To study the growth pattern of chickpea genotypes on the basis of morphological traits.

Materials and Methods

The present investigation with nine newly bred promising chickpea lines was conducted in the District seed farm, AB block, Kalyani Simanta, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India during the *Rabi* season of 2015-2016. The geographical location of the experimental site is at latitude 22°58' N and the longitude 88°32' E. It belongs to the agro-climatic zone of new alluvial zone of West Bengal. Its soil is highly fertile with the sandy loam texture and pH of 6.90-7.00.

The details of the materials used, experiments procedures followed and the techniques adopted during the course of investigation are given below.

Result and Discussion

The plant height, leaf area, leaf dry weight, shoot dry weight and total plant dry weight of the chickpea genotypes were measured at their different growth stages i.e. 15 DAS, 30 DAS, 45 DAS and 60 DAS, then statistically analyzed and presented in the table-1, table-3, table-5 and table-7 respectively. The variations among the chickpea genotypes in all these traits at all growth stages were found to be statistically significant indicating considerable difference among them. At 15 DAS, ICCV-13107 was tallest (21.09 cm) and 24004-3-1 was the shortest (17. 46 cm) genotype. The genotypes with above average plant height were IPC-2010-94 (19.17 cm), 24001-4-1 (19.25 cm) and 24017-1-1 (20.18 cm) whereas the genotypes with below average height at this stage were AGBL-184 (18.70 cm), IPC-2011-70 (17.87), RSG-888 (18.34 cm) and 24034-4-1 (18.69 cm) (from table-1, column-2). The highest and the lowest leaf area at 15 DAS was observed in the genotype 24017-1-1 (32.65 sq.cm) and RSG-888 (10.54 sq. cm) respectively. At this stage, the genotypes like AGBL-184 (26.06 sq.cm), IPC-2010-94 (30.00 sq. cm), ICCV-13107 (25.09 sq. cm) and 24004-3-1 (19.00 sq. cm) were found to have above average leaf area and genotypes like IPC-2011-70 (19.06 sq. cm), 24004-3-1 (19.00 sq. cm) and 24034-4-1 (17.14 sq. cm) were recorded to have below average leaf area (table-1, column-3).

The above average leaf dry weight was registered by the genotypes like IPC2010-94 (0.49 g), ICCV-13107 (0.46 g) and 24034-4-1 (0.44 g) and the below average leaf dry weight was recorded by genotypes like IPC-2011-70 (0.30 g), RSG-888 (0.36 g), 24001-4-1 (0.36 g) &24017-1-1 (0.35 g) (from table-1, column-4). However, the highest and lowest leaf dry weight was observed in AGBL-184 (0.49 g) and 24004-3-1 (0.28 g). In respect of shoot dry weight at 15 DAS, the genotypes like IPC-2010-94 (0.77 g), 24017-1-1 (0.83 g) and ICCV-13107 (0.78 g) were with above average values and the genotypes like IPC-2011-70 (0.59 g), RSG-888 (0.56 g) and 24004-3-1 (0.57 g) and 24034-4-1 (0.64 g) were with below average values (from table-1, column-5). However, the highest and lowest shoot dry weights were obtained in AGBL-184 (0.88 g) and 24001-4-1 (0.53 g).

Total plant dry weight at 15 DAS stage was above average in the genotypes like IPC-2010-94 (1.20 g), ICCV-13107 (1.24 g), 24034-4-1 (1.08 g) & 240171-1 (1.18 g) and below average in the genotypes like IPC-2011-70 (0.89 g), RSG-888 (0.92) & 24001-4-1 (0.89) (from table-1, column-6). However, highest plant dry weight at this stage was registered by AGBL-184 (1.37 g) and lowest plant dry weight was recorded by 24004-3-1 (0.89 g).

At 30 DAS, AGBL-184 was tallest (33.19 cm) and 24034-4-1 was the shortest (27.48 cm) genotype. The genotypes with above average height were IPC-2010-94 (32.51 cm), IPC-2011-70 (32.16 cm), ICCV-13107 (30.58 cm), 24001-4-1 (30.41 cm), 24004-3-1 (31.05 cm) whereas the genotypes with below average height at this stage were RSG-888 (28.52 cm) and 24017-1-1 (27.59 cm) (from table-2, column-2).

The highest and the lowest leaf area at 30 DAS was observed in the genotype IPC-2010-94 (119.71 cm^2) and RSG-888 (39.34 cm^2) respectively. At this stage, the genotypes like AGBL-184 (96.82 cm^2), IPC-2011-70 (97.60 cm^2), 24001-4-1 (79.99 cm^2) and 24017-1-1 (105.10 cm^2) were found to have above average leaf area and genotypes like were ICCV-13107 (73.83 cm^2), 24004-3-1 (42.47 cm^2) and 24034-4-1 (43.63 cm^2) recorded below average leaf area (from table-2, column-3). The above average leaf dry weight at 30 DAS was registered by the genotypes like IPC-2010-94 (1.60g), IPC-2011-70 (1.30 g) and ICCV-13107 (1.30 g) and the below average leaf dry weight was recorded by genotypes like RSG-888 (0.95 g), 24001-4-1 (0.72 g), 24034-4-1 (0.79 g) and 24017-1-1 (0.94 g) (from table-2, column-4). However, the highest and lowest leaf dry weights were observed in AGBL-184 (1.68 g) and 24004-3-1 (0.64 g).

In respect of shoot dry weight at 30 DAS, the genotypes like IPC-2010-94 (1.84 g), ICCV-13107 (1.70 g), 24017-1-1 (1.78 g) & 24034-4-1 (1.66 g) were with above average values and the genotypes like IPC-2011-70 (1.55 g), RSG-888 (1.63 g) & 24004-3-1 (1.42 g) were with below average values (from table-2, column-5). However, the highest and lowest shoot dry weight was obtained in AGBL-184 (1.91 g) and 24001-4-1 (1.40 g) respectively.

Total plant dry weight at 30 DAS stage was above average in the genotypes like IPC-2010-94 (3.44 g), IPC-2011-70 (2.85 g) & ICCV-13107 (3.00 g) and below average in the genotypes like 24034-4-1 (2.45 g), 24001-4-1 (2.12 g), 24017-1-1 (2.74 g) and RSG-888 (2.58 g) (from table-2, column-6). However, highest plant dry weight at this stage was registered by AGBL-184 (3.59 g) and lowest plant dry weight was recorded by 24004-3-1 (2.06 g).

At 45 DAS, AGBL-184 was tallest (48.18 cm) and 24017-1-1 was the shortest (36.20 cm) genotype. The genotypes with above average height were IPC- 2010-94 (46.54 cm) & 24001-4-1 (41.30 cm) whereas the genotypes with below average height at this stage were ICCV-13107 (39.15 cm), RSG-888 (38.59 cm), 24004-3-1 (39.77), 24034-4-1 (38.45 cm) & 24001-4-1 (41.30 cm) (table-3, column-2).

The highest and the lowest leaf area at 45 DAS was observed in the genotype IPC-2010-94 (285.77 cm^2) and 24004-3-1 (84.64 cm^2) respectively. At this stage, the genotypes like AGBL-184 (246.06 cm^2), IPC-2011-70 (223.44 cm^2), 24001-4-1 (220.89 cm^2) 24017-1-1 (191.26 cm^2) were found to have above average leaf area and genotypes like ICCV-13107 (170.02 cm^2), RSG- 888 (120.52 cm^2) & 24034-4-1 (109.67 cm^2) were recorded with below average leaf area (table-3, column-3).

The above average leaf dry weight was registered by the genotypes like IPC- 2010-94 (3.01 g), IPC-2011-70 (2.74 g), ICCV-13107 (2.47 g), RSG-888 (2.01 g), 24004-3-1 (1.79 g) and 24034-4-1 (1.81 g) and the below average leaf dry weight was recorded by genotype like 24017-1-1 (1.57 g) (from table-3, column-4). However, the highest and lowest leaf dry weight was observed in AGBL-184 (3.09 g) and 24004-3-1 (1.72 g). In respect of shoot dry weight at 45 DAS, the

genotypes like IPC-2010-94 (4.16 g), IPC-2011-70 (4.00 g) & ICCV-13107 (4.13 g) were with above average values and the genotypes like RSG-888 (3.32 g), 24001-4-1 (3.13 g), 24034-4-1 (3.22 g) & 24017-1-1 (3.43 g) were with below average values (table-3, column-5). However, the highest and lowest shoot dry weight was obtained in AGBL-184 (4.48 g) and 24004-3-1 (3.07 g). Total plant dry weight at 45 DAS stage was above average in the genotypes like IPC-2010-94 (7.19 g), IPC-2011-70 (5.58 g) & ICCV-13107 (6.37 g) and below average in the genotypes like RSG-888 (4.68 g), 24001-4-1 (4.78 g), 24004-3-1 (5.03 g) & 24034-4-1 (5.23 g) (table-3, column-6). However, highest plant dry weight at this stage was registered by AGBL-184 (8.03 g) and lowest plant dry weight was recorded by 24017-1-1 (4.53 g). At 60 DAS, AGBL-184 was tallest (60.01 cm) and 24017-1-1 was the shortest (44.25 cm) genotype. The genotypes with above average height were IPC-2010-94 (59.17 cm), IPC-2011-70 (53.33 cm) & ICCV-13107 (52.86 cm) whereas the genotypes with below average height at this stage were RSG- 888 (49.17 cm), 24001-4-1 (51.17 cm), 24004-3-1 (48.35 cm) & 24034-4-1 (50.22 cm) (from table-4, column-2).

The highest and the lowest leaf area at 60 DAS was observed in the genotypes IPC-2010-94 (524.89 cm2) and 24004-3- (308.75 cm2) respectively. At this stage, the genotypes like AGBL-184 (460.40 cm2) & IPC- 2011-70 (455.09 cm2) were found to have above average leaf area and genotypes like ICCV-13107 (364.88 cm2), RSG-888 (316.17 cm^2), 24001-4-1 (369.95 cm^2), 24034-4-1 (348.95 cm^2) & 24017-1-1 (371.18 cm^2) were recorded with below average leaf area (from table-4, column-3). The above average leaf dry weight at 60 DAS was registered by the genotypes like IPC-2010-94 (4.58g), ICCV-13107 (4.28 g) & IPC-2011-70 (4.64 g) and the below average leaf dry weight was recorded by genotypes like 24017-1-1 (2.78 g), 24034-4-1 (3.69 g), 24004-3-1 (3.55 g) & RSG-888 (3.88 g) (table-4, column-4). However, the highest and lowest leaf dry weight was observed in AGBL-184 (5.15 g) and 24001-4-1 (2.69 g). In respect of shoot dry weight at 60 DAS, the genotypes like AGBL-184 (7.30 g), IPC-2010-94 (7.86 g), IPC-2011-70 (7.20 g) & 24017-1-1 (7.50 g) were with above average values and the genotypes like RSG-888 (6.71 g), 24004- 3-1 (6.64 g) & 24034-4-1 (6.76 g) were with below average values (table-4, column-5). However, the highest and lowest shoot dry weight was obtained in ICCV-13107 (8.02 g) and 24001-4-1 (6.42 g). Total plant dry weight at 60 DAS stage was above average in the genotypes like IPC-2010-94 (12.44 g), IPC-2011-70 (11.84 g) & ICCV-13107 (12.30 g) and below average in the genotypes like RSG-888 (10.54g), 24004-3-1(10.19 g), 24017-1-1 (10.28 g) and 24034-4-1 (10.45 g) (table-4, column-6). However, highest plant dry weight at this stage was registered by AGBL- 184 (12.45 g) and lowest plant dry weight was recorded by 24001-4-1 (9.17 g).

Growth Pattern

The growth patterns of the chickpea genotypes in respect of plant height (table-5), leaf area (table-6), leaf dry weight (table-7), shoot dry weight (table-8), total plant dry weight (table-9) are not similar. The attainment of plant height in the first fortnight of crop duration of the genotypes ranged between 15.25% in ICCV-13107 to 45.60% in 24017-1-1, in the second fortnight from as low as 16.75% in 24017-1-1 to as high as 68.63% in ICCV- 13107. Similar difference in percentage of height attainment in the third fortnight also but it was more uniform in the fourth fortnight. Plant height and number of branches are important morphological parameters that are mainly governed by the genetic make-up of the plant and the environmental factors (Girisha, 2010) [5]. In our experiment, huge variation in plant height among chickpea genotypes was observed that was supported by Yohe and Poehlman (1972) [13].

In case of leaf area expansion, attainment among the genotypes in the first fortnight varied between 3.74% to 8.80. These results are in par with those of Srivastava and Singh, 1980; Ghosh and Singh, 1998 [4]. In the second fortnight, it was 7.60% to 19.52%. These findings are in agreement with that of Ghosh and Singh, 1998 [4]. Sun *et al.*, 1999. In the third fortnight from 13.66% to 38.09% which was nearly similar with the results of work done by Meadley and Milbourn (1971) and in the fourth fortnight from 40.29% to 72.59%. Leaf and stem dry weight continuously increased up to 60 DAS. Similar results were obtained by Girisha (2010) [5]. More dry matter production ultimately reflects higher grain yield. In this study, the genotypes which recorded more plant dry weight were found to yield more. This is similar to the findings of Thakur and Patel (1998) [12]. Data on crop total weight clearly witnessed that the total dry weight increased continuously up to maturity stage (Samant, 2014) [9]. Similar kinds of results were reported by Pramanick *et al.* (2013) [8]. Girisha (2010) [5] also concluded that plant growth, development and economic yield depend on dry matter accumulation and its distribution at various growth stages. Therefore, dry matter production at each growth stage and its partitioning to reproductive organs during maturity period has immense importance in determining the productivity.

Summary and Conclusion

AGBL-184 was all along highest producer of total plant dry weight along with leaf dry weight and shoot dry weight with an exception only in shoot dry weight at 60 DAS. It was tallest genotype since 45 DAS. IPC-2010-94 was all along highest in leaf area per plant since 30 DAS.

The pattern growth of the genotypes were not similar in terms of their rhythm of stem elongation, leaf area expansion, dry matter enhancement in leaf, shoot as well as whole plant. However, some common points also was there. In case all genotypes major proportion of stem elongation occurred within 30 DAS whereas leaf expansion in early phase of growth was nominal but made a huge jump around flowering stage of the genotypes. Dry matter production was hugely boosted up at post flowering stage. AGBL-184 was highest yielder among the genotypes. Finally, it may be concluded that physiological growth parameters are good indicator of high yield. They may be used as selection criteria for breeding genotypes.

Future Scope of Research

This small work may in future be planned more elaborately to study the growth pattern, dry matter production and partitioning in plants. It will be helpful to accommodate more number of chickpea genotypes with disparate growth habits that may throw light into the intrinsic nature of the types in this aspect and produce useful information for breeding improved lines.

Table 1: Values of morphological parameters of chickpea genotypes at 15 DAS

Genotype	Plant height (cm)	Leaf area (cm^2)	Leaf dry weight (g)	Shoot dry weight (g)	Total dry weight (g)
AGBL-184	18.70	26.06	0.49	0.88	1.37
IPC-2010-94	19.17	30.00	0.43	0.77	1.20
IPC-2011-70	17.87	19.06	0.30	0.59	0.89
ICCV-13107	21.09	25.09	0.46	0.78	1.24
RSG-888	18.34	10.54	0.36	0.56	0.92
24001-4-1	19.25	24.43	0.36	0.53	0.89
24004-3-1	17.46	19.00	0.28	0.57	0.85
24034-4-1	18.69	17.14	0.44	0.64	1.08
24017-1-1	20.18	32.65	0.35	0.83	1.18
Mean	18.97	22.66	0.39	0.68	1.07
S.Em(±)	0.03	0.89	0.02	0.02	0.07
C.D. at 5%	0.08	2.59	0.05	0.06	0.15

Table 2: Values of morphological parameters of chickpea genotypes at 30 DAS

Genotype	Plant height (cm)	Leaf area (cm^2)	Leaf dry weight (g)	Shoot dry weight (g)	Total dry weight (g)
AGBL-184	33.19	96.82	1.68	1.91	3.59
IPC-2010-94	32.51	119.71	1.60	1.84	3.44
IPC-2011-70	32.16	97.60	1.30	1.55	2.85
ICCV-13107	30.58	73.83	1.30	1.70	3.00
RSG-888	28.52	39.34	0.95	1.63	2.58
24001-4-1	30.41	79.99	0.72	1.40	2.12
24004-3-1	31.05	42.47	0.64	1.42	2.06
24034-4-1	27.48	43.63	0.79	1.66	2.45
24017-1-1	27.59	105.10	0.94	1.78	2.72
Mean	30.39	77.61	1.10	1.66	2.76
S.Em(±)	0.02	7.48	0.10	0.04	0.13
C.D. at 5%	0.07	21.85	0.28	0.13	0.39

Table 3: Values of morphological parameters of chickpea genotypes at 45 DAS

Genotype	Plant height (cm)	Leaf area (cm^2)	Leaf dry weight (g)	Shoot dry weight (g)	Total dry weight (g)
AGBL-184	48.18	246.06	3.09	4.48	7.57
IPC-2010-94	46.54	285.77	3.01	4.16	7.17
IPC-2011-70	40.22	223.44	2.74	4.00	6.74
ICCV-13107	39.15	170.02	2.47	4.13	6.60
RSG-888	38.59	120.52	2.01	3.32	5.33
24001-4-1	41.30	220.89	1.74	3.13	4.87
24004-3-1	39.77	84.64	1.12	3.07	4.19
24034-4-1	38.45	109.67	1.81	3.22	5.03
24017-1-1	36.20	191.26	1.57	3.43	5.00
Mean	40.93	183.58	1.72	3.66	5.83
S.Em(±)	0.38	16.96	0.17	0.13	0.30
C.D. at 5%	1.12	49.49	0.50	0.39	0.91

Table 4: Values of morphological parameters of chickpea genotypes at 60 DAS

Genotype	Plant height (cm)	Leaf area (cm^2)	Leaf dry weight (g)	Shoot dry weight (g)	Total dry weight (g)
AGBL-184	60.01	460.40	5.15	7.30	12.45
IPC-2010-94	59.17	524.89	4.58	7.86	12.44
IPC-2011-70	53.33	455.09	4.64	7.20	11.84
ICCV-13107	52.86	364.88	4.28	8.02	12.30
RSG-888	49.17	316.17	3.83	6.71	10.54
24001-4-1	51.17	369.95	2.69	6.42	9.11
24004-3-1	48.35	308.75	3.55	6.64	10.19
24034-4-1	50.22	348.95	3.69	6.76	10.45
24017-1-1	44.25	371.18	2.78	7.50	10.28
Mean	52.06	391.14	3.91	7.16	11.07
S.Em(±)	0.06	8.54	0.07	0.09	0.84
C.D. at 5%	0.14	24.93	0.22	0.27	2.46

Table 5: Fortnight-wise increase in plant height of the chickpea genotypes

Genotype	Increase in plant height (cm)			
	First fortnight	Second fortnight	Third fortnight	Fourth fortnight
AGBL-184	18.70 (31.16%)	14.49 (24.15%)	14.99 (24.98%)	11.83 (19.71%)
IPC-2010-94	19.17 (32.40%)	13.34 (22.55%)	14.03 (23.71%)	12.63 (21.35%)
IPC-2011-70	17.87 (33.51%)	14.29 (26.80%)	8.06 (15.11%)	13.11 (24.58%)
ICCV-13107	21.09 (15.25%)	9.49 (17.95%)	8.57 (6.20%)	13.71 (9.92%)
RSG-888	18.34 (37.30%)	10.18 (20.70%)	10.07 (20.48%)	10.58 (21.52%)
24001-4-1	19.25 (37.62%)	11.16 (21.81%)	10.89 (21.28%)	9.87 (19.29%)
24004-3-1	17.46 (36.10%)	13.59 (28.10%)	8.72 (18.03%)	8.58 (17.75%)
24034-4-1	18.69 (37.10%)	8.89 (17.67%)	10.97 (21.80%)	11.77 (23.39%)
24017-1-1	20.18 (45.60%)	7.41 (16.75%)	8.61 (19.46%)	8.05 (18.26%)

Table 6: Fortnight-wise increase in leaf area of the chickpea genotypes

Genotype	Increase in leaf area (cm^2)			
	First fortnight	Second fortnight	Third fortnight	Fourth fortnight
AGBL-184	26.06 (5.66%)	70.76 (15.37%)	149.24 (32.42%)	214.34 (46.56%)
IPC-2010-94	30.00 (3.91%)	89.71 (11.68%)	166.06 (21.62%)	482.42 (62.80%)
IPC-2011-70	19.06 (4.19%)	78.54 (17.26%)	125.84 (27.65%)	231.65 (50.90%)
ICCV-13107	25.09 (6.43%)	73.83 (18.93%)	96.19 (24.67%)	194.86 (49.97%)
RSG-888	18.34 (37.30%)	55.56 (16.20%)	81.18 (23.67%)	195.65 (57.05%)
24001-4-1	10.54 (3.74%)	55.56 (15.02%)	140.90 (38.09%)	149.06 (40.29%)
24004-3-1	19.00 (6.15%)	23.47 (7.60%)	42.17 (13.66%)	224.11 (72.59%)
24034-4-1	17.14 (4.91%)	26.49 (7.59%)	66.04 (18.93%)	239.28 (68.57%)
24017-1-1	32.65 (8.80%)	72.45 (19.52%)	86.16 (23.21%)	179.92 (48.47%)

Table 7: Fortnight-wise increase in leaf dry weight of the chickpea genotypes

Genotype	Increase in leaf dry weight (g)			
	First fortnight	Second fortnight	Third fortnight	Fourth fortnight
AGBL-184	0.49 (9.51%)	1.19 (23.11%)	1.41 (27.38%)	2.06 (40.00%)
IPC-2010-94	0.43 (9.39%)	1.17 (25.55%)	1.41 (30.79%)	1.57 (34.28%)
IPC-2011-70	0.30 (6.47%)	1.00 (21.55%)	1.44 (31.03%)	1.90 (40.95%)
ICCV-13107	0.46 (10.75%)	0.84 (19.63%)	1.17 (27.34%)	1.81 (42.29%)
RSG-888	0.36 (9.40%)	0.59 (15.40%)	1.06 (27.68%)	1.82 (47.52%)
24001-4-1	0.36 (13.38%)	0.36 (13.38%)	1.02 (37.92%)	0.95 (35.32%)
24004-3-1	0.28 (7.89%)	0.36 (10.14%)	0.48 (13.52%)	2.43 (68.45%)
24034-4-1	0.44 (11.92%)	0.35 (9.49%)	1.02 (27.64%)	1.88 (50.95%)
24017-1-1	0.35 (12.59%)	0.59 (21.22%)	0.63 (27.66%)	1.21 (43.53%)

Table 8: Fortnight-wise increase in shoot dry weight of the chickpea genotypes

Genotype	Increase in shoot dry weight (g)			
	First fortnight	Second fortnight	Third fortnight	Fourth fortnight
AGBL-184	0.88 (12.05%)	1.03 (14.12%)	2.57 (34.52%)	214.34 (46.56%)
IPC-2010-94	0.77 (7.26%)	1.07 (10.09%)	2.32 (21.89%)	482.42 (62.80%)
IPC-2011-70	0.59 (8.19%)	0.96 (13.33%)	2.45 (34.23%)	231.65 (50.90%)
ICCV-13107	0.78 (9.73%)	0.92 (11.47%)	2.43 (30.30%)	194.86 (49.97%)
RSG-888	0.56 (8.35%)	1.07 (15.95%)	81.18 (23.67%)	195.65 (57.05%)
24001-4-1	0.53 (8.26%)	0.87 (13.55%)	1.69 (25.19%)	149.06 (40.29%)
24004-3-1	0.57 (8.58%)	0.85 (12.80%)	1.65 (24.85%)	224.11 (72.59%)
24034-4-1	0.64 (9.47%)	1.02 (15.09%)	1.56 (23.08%)	239.28 (68.57%)
24017-1-1	0.83 (11.07%)	0.95 (12.67%)	1.65 (22.00%)	179.92 (48.47%)

Table 9: Fortnight-wise increase in total dry weight of the chickpea genotypes

Genotype	Increase in total dry weight (g)			
	First fortnight	Second fortnight	Third fortnight	Fourth fortnight
AGBL-184	1.37 (11.00%)	2.22 (17.83%)	4.44 (35.66%)	4.42 (35.55%)
IPC-2010-94	1.20 (9.65%)	2.24 (18.01%)	3.75 (30.14%)	5.25 (42.20%)
IPC-2011-70	0.89 (7.52%)	1.96 (16.55%)	2.73 (23.06%)	6.26 (52.87%)
ICCV-13107	1.24 (10.08%)	1.76 (14.31%)	3.37 (27.40%)	5.93 (48.21%)
RSG-888	0.92 (7.39%)	1.66 (13.33%)	2.10 (16.87%)	7.77 (62.41%)
24001-4-1	0.89 (7.15%)	1.23 (9.89%)	2.66 (21.38%)	7.66 (61.58%)
24004-3-1	0.85 (7.18%)	1.21 (10.22%)	2.97 (25.08%)	6.81 (57.52%)
24034-4-1	1.08 (8.78%)	1.37 (11.14%)	2.78 (22.603%)	7.07 (57.48%)
24017-1-1	1.18 (11.20%)	1.56 (14.80%)	1.79 (16.98%)	6.01 (57.02%)

Reference

1. Directorate of Economics and Statistics (DES): Based on 2nd Advanced Estimates for, 2016-17.
2. Dodwad IS. Genetic variation for morpho-physiological traits influencing seed yield in greengram (*Vigna radiata* L. Wilczek). M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad, 1997.
3. Evans ML. Promotion of Cell Elongation in *Avena* Coleoptiles by Acetylcholine. Plant Physiology. 1972; 50:414-416.
4. Ghosh DC, Singh BP. Crop growth modeling for wetland rice management. Environ. And Ecol. 1998; 16(2):446-449.
5. Girisha PS. A comparative study on growth promoting and retarding compounds on dry matter production and yield in black gram during *rabi.* M.Sc. (Agri.) Thesis, Acharya N.G. Ranga Agricultural University, 2010.
6. Kour R, Sharma BC, Kumar A, Kour P, Nandan B. Study of physiological growth indices of chickpea in chickpea (*Cicer arietinum*) + mustard (*Brassica juncea*) intercropping system under different weed management practices. Legume Research. 2016; 39(3):453-458.
7. Nogueira SSS, Nagai V, Braga NR, Novo M, DO CSS, Camargo MBP. Growth analysis of chickpea (*Cicer arietinum* L.). Sci. Agric. (Piracicaba, Braz.). 1994; 51(3):430-435.
8. Pramanick B, Brahmachari K, Ghosh A. Effect of seaweed saps on growth and yield improvement of green gram. African Journal of Agricultural Research. 2013; 8(13):1180-1894.
9. Samant TK. Evaluation of growth and yield parameters of green gram (*Vigna radiata* L.). Agric. Update. 2014; 9(3):427-430.
10. Singh KB, Reddy MV. Advances in disease resistance breeding in chickpea. Advances in Agrononomy. 1991; 45:191-222.
11. Srivastava BK, Singh RP. Morpho-physiological response of garden pea (*Pisum sativum* L.) to sowing dates. II- Growth analysis. Indian Journal of Horticulture, 1980; 382-389.
12. Thakur DS, Patel SR. Growth and sink potential of rice as influenced by the split application of potassium with FYM in inceptisols of eastern central India. Journal of Potassium Research. 1998; 14(1/4):73-77.
13. Yohe JM, Poehlman JM. Genetic variability in the mungbean, (*Vigna radiata* (L.) Wilezek). Crop Science 1972; 12:461-464.