Dry Matter Accumulation, its Partioning and Growth Analysis Studies in Pigeonpea Genotypes Growing on Rice Bunds

P. B. Bankar[1], *A. K. Shinde*[1] *and V. G. Magar*[1]

Abstract: *A field experiment consisted fifteen pigeonpea genotypes laid out in randomized block design with three replications. Among the genotypes, the genotype AKTE-11-1 recorded significant difference on dry matter accumulation, its partioning pattern and various growth parameters as compared to other genotypes. The genotype AKTE-11-1 recorded significantly highest dry matter of leaves, stem, root and total dry matter per plant (16.03, 109.96, 25.28 and 151.27 g) respectively as compared to other genotypes at harvest. The magnitude of various growth parameters viz., leaf area, LAI, SLW, SLA, AGR, RGR, NAR and LAR was also recorded significantly highest in genotype AKTE-11-1 at harvest of crop.*

Keywords: *Pigeonpea, Dry matter accumulation, leaf area, growth parameters*

INTRODUCTION

Pigeonpea is an important pulse crop in India and semi-arid tropics of Andhra Pradesh and Maharashtra States. Pigeonpea forms a vital part in Indian diet as a protein source. Protein content is 21% compares well with that of other important grain legumes. Pigeon pea contains high level of protein and the important amino acids methionine, lysine, and tryptophan (Ariraman *et al*, 2014). It is a versatile crop and ideally suited for drought-prone areas. It is a fast growing crop with extensive root system. Its tap root system allows optimum utilization of soil moisture and soil nutrients. It is endowed with diverse useful characteristics and is a multipurpose crop. It is used as food, feed and fuel. It is grown across slopes to reduce soil erosion; with its high protein content. Its area and production, however, are highly fluctuating year after year on account of erratic, scanty and uneven rainfall; high infestation of pests and diseases and highly varying market prices. In *konkan* region of Maharashtra pigeon pea is grown mainly on rice bunds. This crop is sown during *kharif* in month of June-July after transplanting of rice. Crop comes to maturity in the month of November-December. This crop is also grown in rice fallows after harvest of rice on residual moisture during the month of October and matures in the month of February-March. The farmers are using the seed material of any pigeonpea variety and therefore yield is less. It is necessary to identify the pigeonpea variety for growing on rice bunds. In Konkan region of Maharashtra rice is grown on about 4.2 lakh ha. area. The rice bunds have more residual moisture than the field, the growing of pigeon pea on rice bund increase the total cropped area and this crop grows very well and produces a good yield. Hence the present studies on growth analysis of pigeon pea genotypes was carried out with to study the growth and yield attributes of pigeon pea genotypes by growing on rice bunds.

MATERIAL AND METHODS

A field experiment was conducted during *Kharif* 2013 with 15 genotypes at the experimental field of

[1] Research Scholar, Department of Agricultural Botany, College of Agriculture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli-415712 (M.S.) India, *E-mail id: pankajbankar0207@gmail.com*

Received: 9 September 2020 • Revised: 15 September 2020 • Accepted 29 September 2020

Department of Agricultural Botany and Agronomy, College of Agriculture, Dapoli, Dist: Ratnagiri (M.S). The experiment laid out in a Randomised block design with three replications. The selection of the site was considered on the basis of availability of the bunds for cultivation of pigeon pea. Sowing of seeds was done in June, 2013 in plastic bags. About 2 seeds were dibbled at each bag. To retain only one healthy seedling per hill, thinning was done ten days after sowing. Fourteen day's old seedlings were transplanted on bund of rice field at 30cm distance. Total 33 plants of each genotype were planted on 10m bund length. After transplanting on bunds two weeding's were done at 20 days interval. At the time of transplanting FYM was incorporated in soil and fertilizer dose of 25:50:00 N:P:K (kg/ha) was given as per recommendations. The recommended practices followed as and when required. The observations were recorded of five randomly selected plants from each variety in each replication. The sampling was done at 30 days interval for recording the observations. The mean value of five plants for each characters was calculated and recorded and was considered for statistical analysis. Five plants randomly selected from each genotypes and uprooted without destroying its root system and dried separately in hot air oven until constant dry weight was attained and recorded. Summing up the weight of the stem, root and leaves of the same plant gave the total dry matter per plant. Percentage distribution of dry matter in different plant parts i.e. stem, root and leaves was calculated by considering total dry matter as 100 percent. At harvest pod dry weight of randomly selected five plants was calculated and mean value recorded. Periodical data obtained from dry matter studies was used for computing the various growth parameters. Relative growth rate was calculated by the formula given by Briggs et al. (1920), Net assimilation rate was calculated by the formula as suggested by Gregory (1917). Absolute growth rate, Leaf area ratio, Specific leaf weight was determined by the formulas given Radford (1967) and the inverse of the specific leaf weight is the specific leaf area was calculated. Leaf area index was calculated by leaf area per plant by ground area per plant. The data obtained during the course of investigation was subjected to analysis of variance as described method by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

In the present study, significant genotypic differences were observed with respect to dry matter accumulation, its partioning, leaf area and various growth parameters. Dry matter production and its partitioning is an important yield contributing character. Knowledge of the periodical pattern of dry matter production and its distribution in different plant parts would give a better understanding of the genotype in relation, to its economic productivity.

The recorded data revealed the pattern of accumulation and partitioning of total dry matter amongst the various plant parts throughout the crop growth period.

The data on mean dry matter of leaf (g) per plant showed an increasing trend up to 120 DAS and decreased thereafter, probably due to leaf drying, shedding and senescence. The genotypes differed significantly for mean dry matter of leaf (g)/plant. The genotypes AKTE-11-1 and ICPL-87 recorded the highest (16.03 g) and lowest (7.58 g) mean dry matter of leaves (g) per plant at harvest respectively. These results derived support from Wallis *et al*. (1975), who reported that leaf dry matter accumulation reached a peak in all the accessions studied at 140 days after sowing.

The data on mean dry matter of stem (g) and root per plant revealed that there was continuous increase in dry matter of stem and root per plant from 30 DAS to till at harvest. There were significant differences in mean dry matter of stem (g) and root (g) per plant at all the growth stages. The genotype AKTE-11-1 recorded the highest mean dry matter of stem per plant (109.96 g) while the genotype ICPL-87 recorded lowest mean dry matter of stem per plant (77.15 g) at harvest. Similar results were reported by Chopra *et al.* (1979) who revealed that early, medium and late duration varieties of pigeonpea viz., Prabhat, DL 74-1 and No. 148 sown in the field gave increasing total biomass with increasing duration of the variety. The genotypes AKTE-11-1 and ICPL-87 recorded the highest (25.28

g) and lowest (16.24 g) mean dry matter of root (g) per plant at harvest respectively. Similar results were reported by Khatra *et al*. (1997) and Johanson *et al*. (1980).

The genotypes differed significantly for mean total dry matter (g) per plant at all crop growth stages. It was noticed that total dry matter accumulation increased with the advancement of age of the crop. Among all the genotype, the genotype AKTE-11-1 and genotype ICPL-87 had recorded significantly highest (151.27 g) and lowest (100.97 g) mean total dry matter (g) per plant at harvest respectively. These results were in conformity with the findings of Dalal (1980) and Tayo (1982).

The data recorded on the mean leaf area per plant shows that genotypes differed significantly and rapid increased trend up to 120 DAS and decreased thereafter. The genotype AKTE-11-1 recorded significantly highest mean leaf area (31.53 dm^2/plant) while genotype V15 ICPL-87 recorded the lowest mean leaf area (19.49 dm^2/plant) at harvest. Similar results were reported by Sinha (1977), Sheldrake and Narayanan (1979). Also Balakrishnan and Natarajarathanam (1987) revealed that the longer crop duration resulted in bigger canopy size and thus higher light interception in pigeonpea.

The data on mean leaf area index (LAI) from revealed that the rate of increase in mean leaf area index (LAI) was rapid up to 90-120 DAS and decreased thereafter till harvest (1.0510). Similar results were reported by Hughes *et al*. (1980), Marda (1983), Nanda and Saini (1989). The data on mean specific leaf weight (SLW) revealed declined trend at harvest stage of crop. The genotype AKTE-8811 recorded the highest SLW at harvest (0.6163g dm^{-2}). Similar findings were reported by Nandwal *et al*. (1994) noted that Specific leaf weight (SLW) was highest at 90 DAS. Mean specific leaf area (SLA) was highest at 30 DAS and decreased thereafter in all genotypes till harvest. The genotype BDN-711 recorded the highest SLA at harvest 2.6820 dm^2 g^{-1} while the genotype AKTE-8811 recorded lowest SLA at harvest 1.6278 dm^2 g^{-1}. Similar findings were reported by Brown *et al*. (1985) and Baker *et al*. (1983) that SLA varies with growth stage and carbon supply/demand ratio of the plant.

The data regarding mean absolute growth rate indicated that it was higher in between the period of 90-120 DAS and declined thereafter in all genotypes. Similar results were reported by Kasole *et al*. (1984) who observed increased AGR from 30 days after sowing and reached its maximum at 105 days of crop growth in pigeonpea and thereafter it sharply declined, probably because of senescence of leaves. The genotype ICPL-87119 recorded significantly highest mean absolute growth rate (AGR) i.e. 0.3904 g/day while the genotype UPAS-120 recorded lowest mean absolute growth rate at 150 DAS – harvest (0.1343 g/day).

Relative growth rate expresses the dry weight increase in a unit time interval in relation to initial dry weight. The mean RGR (g/g/day) was significant at all the stages of crop growth in all genotypes. The mean RGR increased in the period between 30-60 DAS and decreased thereafter till harvest. Similar result was observed by Nandwal *et al.* (1994) who reported that RGR in both the cultivars i.e. H-77-216 (indeterminate) and ICPL 151 (determinate) was maximum at 30-60 DAS. The genotypes ICPL-87119 recorded the highest mean RGR in the period between 150 DAS-harvest (0.0028 g/g/day) while the genotype UPAS-120 recorded the lowest RGR at the period between 150 DAS-harvest (0.0013 g/g/day). The results were in agreement with those of Ahlawat and Saraf (1983) and Khapre *et al.* (1993).

Net assimilation rate is a measure of source activity and efficiency of dry matter production. Results revealed that maximum net assimilation rate was at 30-60 DAS and decreased thereafter till at harvest. At harvest mean NAR ranged between 0.0056-0.0124 g/dm^2/day. Similar findings were reported by Pandey *et al.* (1978) and Singh *et al.* (1983). The data on mean leaf area ratio (LAR) revealed that LAR was maximum at 30-60 DAS and decreased thereafter till harvest of crop. At harvest genotype BDN-711 recorded significantly highest LAR 0.2975 dm^2/g/day over other genotypes. Similar results were reported by Tayo (1982) and Ahlawat and Saraf (1983).

Table 1
Variation in dry matter partioning in leaves, stem, root and total dry weight in different pigeonpea genotypes

Genotypes	*Leaf dry wt. (g/plant)*	*stem dry wt. (g/plant)*	*root dry wt. (g/plant)*	*Total dry wt. (g/plant)*
AKTE-11-1	16.03	109.96	25.28	151.27
BSMR-853	13.14	103.48	24.00	140.62
VIPULA-1	12.52	101.75	22.72	136.99
T-VISHAKHA	9.28	81.32	17.94	108.54
BDN-711	9.79	83.59	19.22	112.60
PHULE RAJESHWARI	15.15	103.90	24.44	143.48
PKV-TARA	13.69	102.83	22.99	139.51
ICPL-87119	15.30	105.60	22.76	143.66
AKT-8811	14.47	106.43	23.96	144.86
UPAS-120	10.56	79.96	18.59	109.11
TAT-10	11.26	78.80	16.84	106.89
BDN-708	13.75	99.86	20.61	134.22
BSMR-736	14.12	102.94	23.32	140.38
KONKAN TUR	15.35	106.75	24.49	146.59
ICPL-87	7.58	77.15	16.24	100.97
MEAN	12.80	96.29	21.56	130.65
SE ±	0.37	0.69	0.27	0.92
CD at 5%	1.08	2.01	0.79	2.67

Table 2
Growth parameter studies of different pigeonpea genotypes

Genotypes	*Leaf Area (dm^2)*	*AGR (g/day)*	*RGR (g/g/day)*	*NAR ($g/dm^2/day$)*	*LAR ($dm^2/g/day$)*	*SLW (g/dm^2)*	*SLA (dm^2/g)*	*LAI*
AKTE-11-1	31.53	0.3297	0.0023	0.0091	0.2478	0.5085	1.9672	1.0510
BSMR-853	28.97	0.3464	0.0026	0.0109	0.2325	0.4528	2.2191	0.9658
VIPULA-1	27.89	0.2099	0.0016	0.0067	0.2345	0.4508	2.2452	0.9298
T-VISHAKHA	21.89	0.2592	0.0025	0.0102	0.2429	0.4253	2.3614	0.7297
BDN-711	26.24	0.2754	0.0025	0.0085	0.2975	0.3729	2.6820	0.8748
PHULE RAJESHWARI	29.47	0.2821	0.0020	0.0082	0.2466	0.5148	1.9470	0.9822
PKV-TARA	27.79	0.2063	0.0015	0.0062	0.2417	0.4937	2.0303	0.9264
ICPL-87119	26.20	0.3904	0.0028	0.0124	0.2302	0.5890	1.7149	0.8733
AKT-8811	23.58	0.3416	0.0024	0.0109	0.2240	0.6163	1.6278	0.7860
UPAS-120	19.76	0.1343	0.0013	0.0056	0.2247	0.5361	1.8776	0.6588
TAT-10	24.95	0.2076	0.0020	0.0073	0.2755	0.4514	2.2175	0.8318
BDN-708	25.07	0.1950	0.0015	0.0069	0.2157	0.5487	1.8250	0.8358
BSMR-736	28.09	0.2891	0.0021	0.0092	0.2296	0.5032	1.9919	0.9362
KONKAN TUR	29.94	0.2626	0.0018	0.0075	0.2443	0.5126	1.9514	0.9981
ICPL-87	19.49	0.1639	0.0017	0.0073	0.2256	0.3898	2.5835	0.6498
MEAN	26.06	0.2596	0.0020	0.0085	0.2409	0.4911	2.0828	0.8686
SE ±	0.77	0.0355	0.0003	0.0012	0.0051	0.0229	0.0942	0.0255
CD at 5%	2.22	0.1028	0.0008	0.0034	0.0149	0.0664	0.2728	0.0744

References

Ahlawat, I.P.S. and Saraf, C. S. (1983), Growth analysis in pigeonpea (*Cajanus cajan* L. Millsp.) under different management conditions. Indian J. Agron. 28: 263-269.

Ariramana M., S. Gnanamurthy., D. Dhanavelb., T. Bharathi and S. Murugan. (2014), Mutagenic effect on seed germination, seedling growth and seedling survival of Pigeon pea (*Cajanus cajan* (L.) Millsp). *International Letters of Natural Sciences Vol.* 21. pp 41-49.

Baker,D.N., Lambert, J. R. and Mekinion, J. M. (1983), Gossym: A simulator of cotton crop and yield. South Carolina Agri. Exp. Stn. Tech. Bull. 1089.

Balakrishnan, K., Vangamudi, K., Mallika and Natarajaratnam, N. (1984), Seed development and maturation studies in pigeonpea. Madras Agric. J. 71 (6): 387-390.

Briggs, G. E., Kidd. F. and West, C. (1920), Quantitative analysis of growth. Ann. Appl. Biol. 7: 203-223.

Brown, L. G., Jones, J. W., Hartsong., J. D., Whister, F.D. and Harris, F.A. (1985), Computer simulation of cotton growth and yield. Exp. Stn. Info. Bull. 69.

Chopra, R., Khanna, K. R. and Sinha, S. K. (1979), Response of pigeonpea to water availability, legumes in the Tropics. pp. 227-230.

Dalal, R. C. (1980), Nutrient element concentration and dry matter production by field grown pigeonpea (*Cajanus cajan* L. Millsp). Trop. Agric. 57: 107-108.

Gregory, P. G. (1917), Analysis of agricultural yield. In Crop Physiology, Ed. Evans, L.T., Cambridge University Press, London, pp. 327-355.

Hughes, G., Keatinge, J.D.H. and Scott, S.P. (1980), Planting density effects on the dry season productivity of short pigeonpeas in the West Indies. I. Growth and development Proceedings of the International Workshop on pigeonpea, Patancheru, Hyderabad, India, ICRISAT, pp. 235-240.

Johnson, H. W., Borthwick, H. A. and Leffel, R. C. (1980), Effect of photoperiod and time of planting on rates of development of the soybean in various stages of life angle. Bot.Gaz. 122: 77-95.

Kasole, K. E. (1984), Response of genotypes of pigeonpea to methods of N application in split doses of off season. M.Sc. (Agri.) Thesis, MPKV, Rahuri.

Khapre, P.R., Nerkar, Y.S. and Salunke, M.R. (1993), Relationship between physiological parameters and grain yield in pigeonpea under different cropping systems. International Pigeonpea Newsletter.18:18-19.

Khatra, S., Kaur, A. and Singh, G. (1997), Comparison of seed quality at physiological maturity and harvest maturity of two pigeonpea (*Cajanus cajan* (L.) Millsp.) Cultivars. Acta Agro-botanica. 50(1-2):49-52.

Marda, K. (1983), Pigeonpea trials in temperate Japan. International Pigeonpea Newsletter. 2: 8-9.

Nanda, R. and Saini, A. D. (1989), Influence of leaf area index and temperature of pod number of green gram. Indian J. Agril. Sci. 59(8):514-515.

Nandwal, A.S., Bharti, S., Kundu, B.S. and Kuhad, M.S. (1994), Growth and acquisition pattern in two genotypes of pigeonpea. Indian J.Pl. Physiol. 37(4):279-281.

Pandey, R. K., Saxena, M. C. and Singh, V. B. (1978), Growth analysis of urdbean. Genotypes under humid subtropical conditions of pantnagar. Legume Res. 1(2): 112-114.

Panse, V.G. and Sukhatme, P.V. (1985), Statistical Methods for Agricultural Workers, Indian Council of Agricultural Research, New Delhi.

Radford, P. J. (1967), Growth analysis formulae, their use and abuse. Crop. Sci. 7: 171-175.

Sheldrake, A. R. and Narayanan, A. (1979), Growth, development and nutrient uptake in pigeonpea (*Cajanus cajan*). J. agric. Sci., UK. 92(3): 513-526.

Singh A., Prasad, R. and Saraf, C. S. (1983), Physiological analysis of yield variation in short duration pigeonpea varieties in relation to varying row spacing and phosphorus levels under rainfed conditions. Indian J. Agron. 28:248-253.

Sinha, S. K. (1977), Food legume: Distribution, adoptability and Biology of yield. FAO plant products and protection paper 3. Food and Agriculture Organisation of the United Nations, Rome.

Tayo, T.O. (1982), Growth, development and yield of pigeonpea in low land tropics. II. Effect of reduced assimilatory capacity. J. Agric. Sci.98:71-77.

Wallis, E.S., Whiteman, P. C. and Akinala, J. O. (1975), Pigeonpea (*Cajanus cajan* L. Millsp.) research in Australia. Proc. International Workshop on Grain Legumes. Uni. West Indies, June, 1975 and 1st Augustine, Trinidad: 149-166.