J. Soils and Crops 28 (2) 289-294, December 2018

ISSN 0971-2836
NAAS Rating - 4.46
Scientific Journal Impact Factor - 6.736

CROP GROWTH AND YIELD PERFORMANCE OF PIGEONPEA AS INFLUENCED BY TRANSPLANTING, PLANTING GEOMETRY AND INTERCROPPING SYSTEMS

H. T. Sujatha[1], H. B. Babalad[2], H. T. Chandranath[3] and P. L. Patil[4]

ABSTRACT

A field experiment was conducted to study the "Crop growth and yield performance of pigeonpea as influenced by transplanting, planting geometry and intercropping systems" at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka on medium deep black soil under rainfed condition during 2016. The experiment was laidout using RCBD with twelve treatment combinations replicated thrice. The treatments consisted of transplanted pigeonpea at 120 cm x 60 cm planting geometry, direct sown pigeonpea at 120 cm x 60 cm and 90 cm x 30 cm planting geometries, intercropped with soybean, greengram and blackgram at 1:2 row proportion and compared with sole treatments of transplanted and direct sown pigeonpea for their system productivity and profitability. Sole transplanted pigeonpea at 120 cm × 60 cm geometry produced significantly higher growth, yield and yield parameters of piegonpea mainly plant height, number of primary and secondary branches, total dry matter production, number of pods plant^{-1}, seed weight plant^{-1} and yield as compared to intercropped transplanted pigeonpea (120 cm × 60 cm) and direct sown sole pigeonpea as well as intercropping systems at 120 cm × 60 cm and 90 cm × 30 cm geometry. The next best systems which recorded significantly higher yield and yield parameters were transplanted pigeonpea at 120 cm × 60 cm geometry with soybean and greengram intercropping systems. Among the intercropping systems, transplanted pigeonpea (120 cm x 60 cm) with soybean, greengram and blackgram recorded significantly higher growth, yield and yield parameters of pigeonpea as compared to direct sown pigeonpea intercropping systems both at 120 cm x 60 cm and 90 cm x 30 cm planting geometries and they found on par with sole transplanted pigeonpea (120 cm x 60 cm) with respect to yield and yield parameters.

(Key words: Direct sowing, growth, pigeonpea, transplanting, yield)

INTRODUCTION

The greatest challenge of the 21st century in many developing countries are to produce more and more basic necessities namely food, fodder, fuel and fiber for ever increasing human and animal population from the limited available land. The availability of land for agriculture is shrinking every day as it is increasingly utilized forenoon-agricultural purposes. Under this situation, one of the important strategies to increase agricultural productivity and intensive land use is to adopt best agronomic measures and development of high intensity cropping systems including intercropping system.

Pigeonpea is one of the major grain legume crops of the tropical and subtropical regions and it is grown predominantly under rainfed conditions. In dry farming areas of northern Karnataka, the rainfall is not only scanty but also erratic. Thus, soil moisture becomes the most limiting factor in pigeonpea production. In order to ensure timely sowing under delayed onset of monsoon, the transplanting of pigeonpea seedlings will be one of the best agronomic measures to overcome delayed sowing (Rajesh *et al*., 2013). Apart from this transplanting technology known to improve plant architecture, improve its growth and yield. This technique involves raising of seedlings in the polythene bags in nursery and transplanting these seedlings in the main field after certain age. As established seedlings, these pick up growth quickly under field condition and can be more competitive. The initial slow growth rate and deep root system of pigeonpea offers good scope for intercropping with fast growing, early maturing and shallow

1. Ph.D.Scholar, Deptt. of Agronomy, University of Agricultural Sciences, Dharwad - 580 005; Email: sujathaagri.1060@gmail.com
2. Professor and Head, Deptt. of Agronomy, College of Agriculture, Vijayapur -586101; Email: hbbabalad@gmail.com
3. Professor, Deptt. of Agronomy, College of Agriculture, UAS, Dharwad - 580 005
4. Professor, Deptt. of Soil Science and Agticultural Chemistry, College of Agriculture, UAS, Dharwad - 580 005

rooted crops (Ramamoorthy *et al*., 2004). Several short duration crops mainly greengram, blackgram, soybean, groundnut and pearlmillet could be grown as intercrop in long duration pigeonpea for increasing productivity and maintaining soil fertility. The competitive ability of transplanted pigeonpea may be better than the direct sown pigeonpea with fast growing above intercrops. Hence, there is a need to evaluate the performance of pigeonpea transplanted vis-à-vis direct sown under different planting geometries and intercropping systems. In this context, a field trial was carried out to study the growth and yield of pigeonpea as influenced by planting methods, planting geometries and intercrops.

MATERIALS AND METHODS

The experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka on *Typic Hapstaurt* soil under rainfed condition during *kharif* 2016. During the crop growth period, a total rainfall of 563.1 mm was received which was optimum for good growth and higher yield. The soil of the experimental site was clay with pH of 7.1 and electrical conductivity of 0.32 dS m^{-1}. The soil was medium in organic carbon (0.52%) and low in available nitrogen (243 kg ha^{-1}) and medium in available P (27 kg ha^{-1}) and available K (283 kg ha^{-1}). The experiment was laid out in a randomized complete block design (RCBD) involving 12 treatment combinations replicated thrice. The treatments include transplanting and direct sowing pigeonpea at 120 cm x 60 cm planting geometry and direct sown pigeonpea at 90 cm x 30 cm planting with intercropping of soybean, greengram and blackgram at 1:2 row proportion compared with sole pigeonpea transplanted and direct sown (120 cm x 60 cm and 90 cm x 30 cm).

Pigeonpea variety 'TS 3R', soybean variety 'JS 335', greengram variety 'DGGV 2' and blackgram variety 'DBGV 5' were used. Pigeonpea and intercrops seeds were dry seed dressed with trichoderma @ 4 g kg^{-1} seeds and later treated with Rhizobium and *Pseudomonas fluroscence* P solubilizing culture @ 500 g ha^{-1} seed. Healthy pigeonpea seedlings were raised in black polythene bags (size 15 cm x 6 cm) filled with soil and vermicompost by sowing seeds during last week of May and regular watering was done for 4 weeks in the nursery. Transplanting of pigeonpea seedlings was done with soaking of rains during last week of June along with direct sowing of pigeonpea and intercrops. Marking with the help of marker was done as per the row and intra row spacing of respective treatments and at each hills small pits were opened with the help of picax to a depth of 15-20 cm and then pigeonpea seedlings were transplanted after removing the polythene cover without disturbing the soil at the root zone of the pigeonpea seedling. The row spacing followed for intercrops in transplanted and direct sown pigeonpea at 120 cm x 60 cm spacing was 40 cm x 7.5 cm and in intercrops with direct sown pigeonpea at 90 cm x 30 cm spacing was 30 cm x 10 cm. The recommended quantity of FYM (6 t ha^{-1}) was applied two weeks before sowing and transplanting of the crop. The entire quantity of recommended dose of fertilizer for pigeonpea (25:50 kg $N:P_2O_5$ ha^{-1}) and 2/3rd of recommended dose of fertilizer for soybean (26.6:53.3:16.6 kg $N:P_2O_5:K_2O$ ha^{-1}), greengram (16.6:33.3 kg $N:P_2O_5$ ha^{-1}) and blackgram (16.6:33.3 kg $N:P_2O_5$ ha^{-1}) in the form of urea, diammonium phosphate (DAP) and muriate of potash were applied at the time of sowing and transplanting as basal dose at 5 cm deep and 5 cm away from the seeds and seedlings, then covered with soil. Observations on growth components like plant height (cm), number of primary and secondary branches $plant^{-1}$, leaf area (dm^2 $plant^{-1}$), leaf area index and total dry matter production (g $plant^{-1}$) and yield and yield parameters like number of pods $plant^{-1}$, number of grains pod^{-1}, grain weight $plant^{-1}$ (g), grain yield (kg ha^{-1}) and stalk + husk yield (kg ha^{-1}) were recorded. The five tagged plants were pulled out at the time of harvesting from the net plot area and pods were separated from each plant and then the above observations were recorded.

RESULTS AND DISCUSSION

Growth performance

The transplanting method utilizes the natural resources in a better way and establish well with the developed root system. Transplanting of pigeonpea performed well both as sole crop as well as with intercropping of short duration legumes and recorded significantly higher growth parameters, yield and yield parameters as it has advantage of early planting as well as transplanting with better utilization of available resources.

At 90 and 120 days after transplanting (DAT)/days after sowing (DAS), sole transplanted pigeonpea with planting geometry of 120 cm × 60 cm recorded significantly higher total dry matter production $plant^{-1}$ (609.66 g and 860.73 g, respectively) (Figure 1), plant height (162.75 cm and 178.58 cm, respectively), number of primary branches $plant^{-1}$ (8.73 and 9.33, respectively), secondary branches $plant^{-1}$ (19.87 and 27.13, respectively), leaf area (198.31 dm^2 $plant^{-1}$ and 318.94 dm^2 $plant^{-1}$, respectively) and leaf area index (2.75 and 4.43, respectively) compared to direct sown sole pigeonpea as well as intercropping systems both at 120 cm × 60 cm and at 90 cm × 30 cm spacings (Table 1). However, it was on par with transplanted pigeonpea at 120 cm × 60 cm spacing with greengram intercropping system with respect to leaf area and leaf area index. This might be due to the advantage of early planting of 3 weeks grown up pigeonpea seedlings with well established root system and exposed to relatively longer days available, provide higher photoperiod required for growth of plant. In transplanted pigeonpea, the seedlings were raised earlier (May last week) in the polythene bags for a certain period (3 weeks), after planting it develops vigorous root system and improves the utilization of natural resources mainly solar radiation, soil moisture, space and nutrients more efficiently as compared to direct sown pigeonpea. These results are in

accordance with the findings of Malik *et al.* (2009) where planting of 28 days old pigeonpea seedling recorded significantly higher plant height (230.00 cm) as compared to hand dibbled (162.00 cm) in 90 cm inter row spacing. Salakinkoppa and Patil (2010) also reported that, among the different planting geometry of pigeonpea, the pigeonpea transplanted at the spacing of 150 cm x 60 cm was recorded higher plant height (156.0 cm), number of branches (27.9 plant^{-1}) and stem girth (3.72 cm) as compared to dibbled pigeonpea at the row spacing of 90 cm x 20 cm (122 cm, 17.7 plant^{-1} and 2.95 cm, respectively). Pavan *et al*. (2011) also found that, transplanted pigeonpea at the spacing of 150 cm x 30 cm recorded significantly higher plant height (197.0 cm). Transplanted pigeonpea at the row spacing of 120 cm x 90 cm recorded significantly higher number of primary branches plant^{-1} (37.40) at harvest which was significantly superior when compared to the row spacing of 90 cm x 20 cm dibbled pigeonpea (28.27).

Among all the intercropping treatments, transplanted pigeonpea at planting geometry of 120 cm × 60 cm spacing intercropped with greengram, soybean and blackgram produced significantly higher growth attributes as compared to direct sown pigeonpea intercropping with soybean, greengram and blackgram at both 120 cm × 60 cm and 90 cm × 30 cm geometry. Better acquisition of growth resources by well established transplanted seedlings therefore had less competition by intercrops might have resulted in higher growth parameters of transplanted pigeonpea as compared to direct sown pigeonpea plots which experienced more competition by fast growing intercrops for the growth resources. Murali *et al.* (2014) also revealed that, transplanting of 5 weeks old seedlings of pigeonpea as intercrop with finger millet produced significantly higher pigeonpea plant height (177 cm) and number of primary branches plant^{-1} (17.2) as compared to direct sowing of pigeonpea as intercrop (163 cm plant height and 9.2 primary branches).

Yield and yield parameters

Sole transplanted pigeonpea with planting geometry of 120 cm × 60 cm recorded significantly higher pigeonpea grain yield (2662 kg ha^{-1}) as compared to transplanted pigeonpea (120 cm x 60 cm) with blackgram intercropping and direct sown pigeonpea sole as well as intercropping systems both at 90 cm × 30 cm and 120 cm × 60 cm planting geometries. However, it was on par with transplanted pigeonpea at 120 cm × 60 cm spacing with greengram (2550 kg ha^{-1}) and soybean (2537 kg ha^{-1}) intercropping systems (Table 2). Higher pigeonpea grain yield in sole transplanted pigeonpea at planting geometry of 120 cm × 60 cm spacing over sole direct sown pigeonpea at planting geometry of 90 cm × 30 cm spacing (34 %) and 120 cm × 60 cm spacing (56 %) was mainly attributed to higher number of pods plant^{-1} (1138) and grain weight plant^{-1} (212.5 g) which were significantly superior to direct sown pigeopea. This is mainly due to higher vegetative growth parameters in transplanted pigeonpea which might have resulted in better growth and accumulation of photosynthates in sink mainly pods and seeds which ultimately resulted in higher yield of the crop. Several research studies under various soil and climatic conditions, reported higher grain yield of pigeonpea with transplanted than direct sown was mainly due to improved growth and yield contributing parameters. Mallikarjun *et al.* (2014) also recorded significantly higher grain yield (1899 kg ha^{-1}) in transplanted hybrid pigeonpea (ICPH-2671) as compared to dibbled hybrid pigeonpea (1376 kg ha^{-1}). Praharaj *et al*. (2015) also found that, seedlings transplanted at an early age of 3 weeks recorded higher seed yield of 4851 kg ha^{-1} due to higher number of pods plant^{-1} (416) and seeds pod^{-1} (3.8) compared to direct seeded pigeonpea which recorded lower seed yield (3699 kg ha^{-1}), number of pods plant^{-1} (258) and seeds pod^{-1} (3.3). Mohanadas (2016) also reported the superiority of transplanting of pigeonpea with respect to grain (2.39 t ha^{-1}) of pigeonpea as compared to direct dibbling (2.13 t ha^{-1}) and drill sown pigeonpea (1.69 t ha^{-1}).

Among the intercropping systems, transplanted pigeonpea at planting geometry of 120 cm × 60 cm spacing intercropped with greengram, soybean and blackgram recorded significantly higher pigeonpea grain yield (2550 kg ha^{-1}, 2537 kg ha^{-1} and 2334 kg ha^{-1}, respectively) as compared to direct sown pigeonpea intercropping with soybean, greengram and blackgram at both 120 cm × 60 cm and 90 cm × 30 cm geometry. Increase in grain yield was 102 %, 110 % and 108 % in transplanted pigeonpea with intercropping soybean, greengram and blackgram respectively as compared to direct sown pigeonpea at 120 cm × 60 cm with soybean, greengram and blackgram intercropping systems respectively and 51 %, 43 % and 24 % increase over direct sown pigeonpea at 90 cm × 30 cm with soybean, greengram and blackgram intercropping systems respectively. This could be due to higher number of pods, grain weight and lower competition, which is because of early maturity and senescence of intercrops. Further, it was attributed to better plant development resulting in more uniform distribution of plants over cropped area which was coupled with greater light interception, efficient utilization of moisture, nutrients and solar energy under lower degree of inter and intra plant competitions. These findings are in conformity with the findings of Poornima *et al*. (2009) where transplanted pigeonpea + finger millet (2:8) intercropping with transplanting of 4 weeks old seedlings produced significantly higher pigeonpea grain yield (1347 kg ha^{-1} with finger millet grain yield of 1880 kg ha^{-1}) compared to direct sown pigeonpea + finger millet (391 kg ha^{-1} with finger millet grain yield of 1992 kg ha^{-1}). Goud and Andhalkar (2012) also recorded higher pigeonpea grain yield in soybean + transplanted pigeonpea (6:1) intercropping with transplanting of 4 weeks old seedlings (769 kg ha^{-1}) as compared to pigeonpea grain yield in soybean + direct sown pigeonpea (301 kg ha^{-1}).

The above results clearly showed that, sole transplanted pigeonpea found superior as compared to direct sown pigeonpea at 120 cm × 60 cm and 90 cm × 30 cm planting geometry with respect to growth, yield and yield

Table 1. Growth parameters of pigeonpea as influenced by planting methods, plant geometry and intercrops

Tr. No.	Treatments	Plant height (cm)		No. of primary branches plant^{-1}		No. of secondary branches plant^{-1}		Leaf area (dm^2 plant^{-1})		Leaf area index	
		90 DAT/ DAS	120 DAT/ DAS	90 DAT/ DAS	120 DAT/ DAS	90 DAT/ DAS	120 DAT/ DAS	90 DAT/ DAS	120 DAT/ DAS	90 DAT/ DAS	120 DAT/ DAS
T_1	Transplanted pigeonpea (120 cm × 60 cm) + soybean (1:2)	158.42	173.92	8.27	9.00	17.53	23.33	181.31	282.69	2.52	3.93
T_2	Transplanted pigeonpea (120 cm × 60 cm) + greengram (1:2)	159.08	174.42	8.33	9.07	18.13	24.13	182.25	289.90	2.53	4.03
T_3	Transplanted pigeonpea (120 cm × 60 cm) + blackgram (1:2)	157.92	173.75	8.20	8.93	16.93	22.60	174.48	269.80	2.42	3.75
T_4	Direct sown pigeonpea (120 cm × 60 cm) + soybean (1:2)	128.83	152.25	5.27	5.80	10.20	15.80	102.33	182.48	1.42	2.53
T_5	Direct sown pigeonpea (120 cm × 60 cm) + greengram (1:2)	127.33	151.33	5.13	5.73	9.53	14.93	99.55	175.31	1.38	2.43
T_6	Direct sown pigeonpea (120 cm × 60 cm) + blackgram (1:2)	125.17	151.25	5.20	5.60	10.13	15.00	95.54	165.44	1.33	2.30
T_7	Direct sown pigeonpea (90 cm × 30 cm) + soybean (1:2)	132.58	158.17	4.20	4.73	6.33	10.13	30.72	54.75	1.14	2.03
T_8	Direct sown pigeonpea (90 cm × 30 cm) + greengram (1:2)	134.92	159.17	4.27	4.80	6.53	10.60	31.27	58.90	1.16	2.18
T_9	Direct sown pigeonpea (90 cm × 30 cm) + blackgram (1:2)	131.50	160.08	4.27	4.87	7.20	11.20	31.55	60.85	1.17	2.25
T_{10}	Sole transplanted pigeonpea (120 cm × 60 cm)	162.75	178.58	8.73	9.33	19.87	27.13	198.31	318.94	2.75	4.43
T_{11}	Sole direct sown pigeonpea (120 cm × 60 cm)	131.08	154.75	5.80	6.13	11.47	16.53	117.65	201.09	1.63	2.79
T_{12}	Sole direct sown pigeonpea (90 cm × 30 cm)	136.08	163.08	5.07	5.60	8.87	12.13	42.93	66.78	1.59	2.47
	LSD (0.05)	2.45	2.27	0.24	0.29	0.86	1.30	17.48	29.74	0.28	0.47

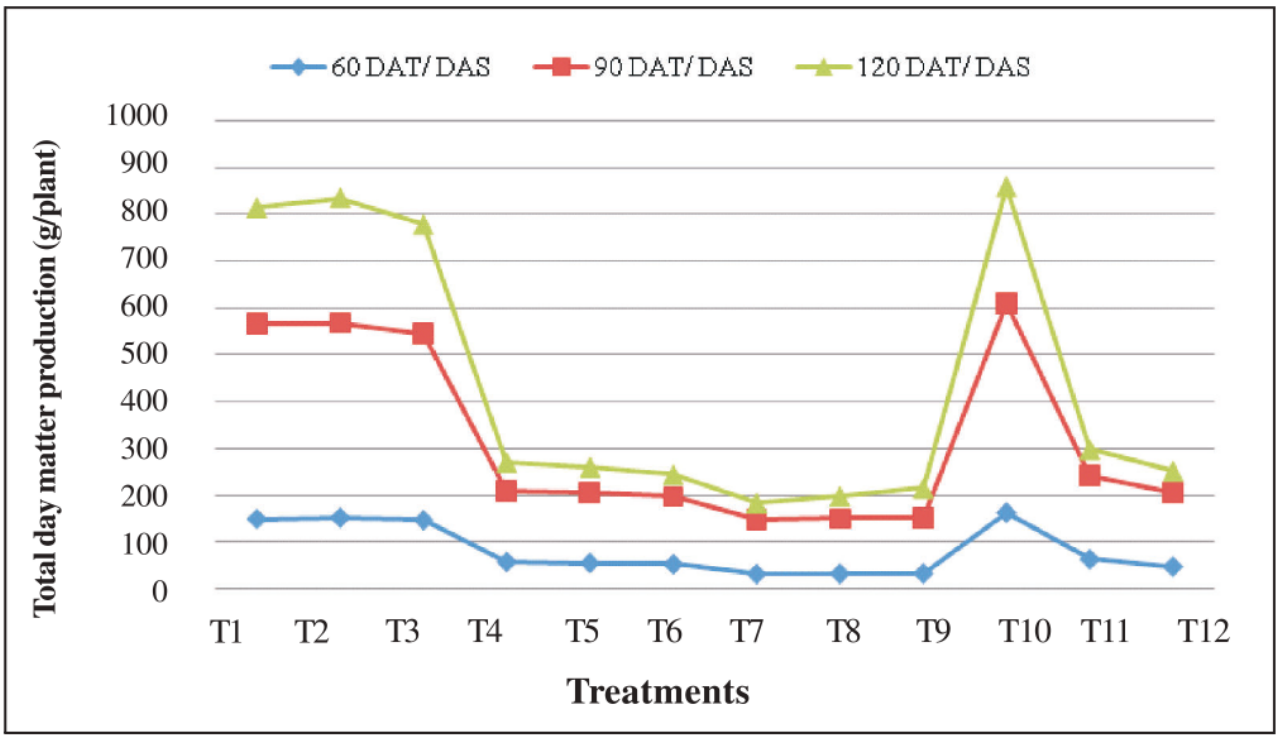

Figure 1. Total dry matter production of pigeonpea as influenced by planting methods, plant geometry and intercrops

Table 2. Yield and yield parameters of pigeonpea as influenced by planting methods, plant geometry and intercrops

Tr. No.	Treatments	No. of pods plant^{-1}	Grain weight plant^{-1}(g)	No. of grains pod^{-1}	Grain yield (kg ha^{-1})
T_1	Transplanted pigeonpea (120 cm × 60 cm) + soybean (1:2)	991	201.9	3.3	2537
T_2	Transplanted pigeonpea (120 cm × 60 cm) + greengram (1:2)	1071	206.7	3.3	2550
T_3	Transplanted pigeonpea (120 cm × 60 cm) + blackgram (1:2)	980	201.1	3.3	2334
T_4	Direct sown pigeonpea (120 cm × 60 cm) + soybean (1:2)	292	87.0	3.5	1254
T_5	Direct sown pigeonpea (120 cm × 60 cm) + greengram (1:2)	287	86.2	3.6	1213
T_6	Direct sown pigeonpea (120 cm × 60 cm) + blackgram (1:2)	279	84.1	3.5	1121
T_7	Direct sown pigeonpea (90 cm × 30 cm) + soybean (1:2)	157	54.8	3.4	1684
T_8	Direct sown pigeonpea (90 cm × 30 cm) + greengram (1:2)	158	55.0	3.4	1789
T_9	Direct sown pigeonpea (90 cm × 30 cm) + blackgram (1:2)	165	57.6	3.4	1877
T_{10}	Sole transplanted pigeonpea (120 cm × 60 cm)	1138	212.5	3.3	2662
T_{11}	Sole direct sown pigeonpea (120 cm × 60 cm)	328	103.9	3.6	1705
T_{12}	Sole direct sown pigeonpea (90 cm × 30 cm)	192	81.5	3.4	1988
	LSD (0.05)	63	13.7	0.18	205

parameters. Among the intercropping systems, transplanted pigeonpea (120 cm × 60 cm) intercropped with greengram, soybean and blackgram at 1:2 row proportion was superior as they recorded higher pigeonpea yield and pigeonpea equivalent yield with higher growth and yield parameters as compared to growing of intercrops in sole direct sown pigeonpea and sole pigeonpea.

REFERENCES

Goud, V. V. and A. S. Andhalkar, 2012. Feasibility studies in transplanted pigeonpea + soybean intercropping system. J. Food Legumes. **25**(2): 128-130.

Malik, J. K., R. Singh, O. V. S. Thenua and A. Kumar, 2013. Response of pigeonpea (*Cajanus cajan*) + mungbean (*Phaseolus radiatus*) intercropping system to phosphorus and biofertilizers. Legume Res. **36**(4): 323-330.

Mallikarjun, C., U. K. Hulihalli, G. Somanagouda, V. S. Kubsad and D. N. Kambrekar, 2014. Performance of hybrid pigeonpea (cv. ICPH-2671) under varied planting methods and planting geometries in northern dry zone of Karnataka. Karnataka J. Agric. Sci. **27**(3): 296-299.

Mohanadas, L., 2016. Performance of pigeonpea genotypes to planting methods and geometry under irrigation. M. Sc. (Agri.) Thesis, Univ. Agric. Sci. Dharwad, Karnataka (India).

Murali, K., T. Sheshadri, and M. Byregowda, 2014. Effect of pigeonpea transplanting on growth, yield and economics in sole and finger millet intercropping system under late sown conditions. J. Food Legumes. **27**(1): 28-31.

Pavan, A. S., V. P. Nagalikar, B. T. Pujari and A. S. Halepyati, 2011. Influence of planting geometry on the growth characters, seed yield and economics of transplanted pigeonpea. Karnataka J. Agric. Sci. **24**(3): 390-392.

Poornima, D. S., B. C. Shankaralingappa and T. Sheshadri, 2009. Studies on feasibility of transplanting pigeonpea in sole cropping and finger millet based intercropping system. M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Bangalore, Karnataka (India).

Praharaj, C. S., N. Kumar, U. Singh, S. S. Singh and J. Singh, 2015. Transplanting in pigeonpea - A contingency measure for realizing higher productivity in Eastern Plains of India. J. Food Legumes. **28**(1): 34-39.

Rajesh, N., V. K. Paulapandi and R. Duraisingh, 2013. Effect of transplanted pigeonpea and foliar nutrition improves the physiological characters. Paper presented in: Nationa. Sem., Ergonomics for Enhanced Producivity, TNAU, Madurai, pp. 12.

Ramamoorthy, K., A. L. Christopher, S. Alagudurai, O. S. Kandasamy and V. Murugappan, 2004. Intercropping pigeonpea (*Cajanus cajan*) in finger millet (*Eleusine coracana*) on productivity and soil fertility under rainfed condition. Indian J. Agron. **49**, 28-30.

Salakinkoppa, S. R. and H. Y. Patil, 2010, Enhancing the productivity of pogeonpea by transplanting technique in command area. Paper presented in: Nationa. Symp. on food security in context of changing climate, Kanpur, October 30 to November 01, pp. 113.

Rec. on 25.05.2018 & Acc. on 20.06.2018