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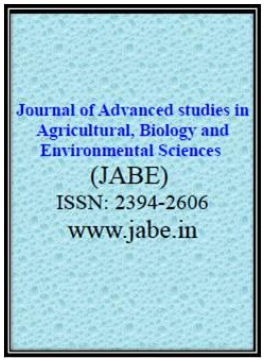
EFFECT OF DRIP FERTIGATION AND SOWING SEASON ON QUANTITATIVE TRAITS OF PIGEONPEA (*CAJANUS CAJAN* L.)

S. MANIKANDAN, K. SIVASUBRAMANIAM

Department of Seed Science and Technology, Agricultural College and Research Institute, Madurai, Tamil Nadu, India.

Corresponding author E-mail: vsmanister@gmail.com



ABSTRACT

An attempt was made to evaluate the effect of drip fertigation and sowing season on plant morphology and its relationship with yield components of pigeonpea at Agricultural college and research institute, Madurai, during Kharif, 2010 and Summer, 2011. The treatments consists of four main plots (F_1- 50% of SRDF through drip, F_2- 75% of SRDF through drip, F_3- 100% of SRDF through drip and F_4- 150% SRDF through drip) and three sub-plots (S_1- foliar spray of 0.5 per cent $ZnSO_4$, S_2 -foliar spray of 100 ppm succinic acid and S_3- foliar spray of 100 ppm humic acid) and control (surface irrigation with conventional method of fertilizer application). Results showed that the effect of drip fertigation on all quantitative traits was significant. It was noticed that all the morphological characters differed significantly between the seasons and also among the fertigation treatments F_3-100% of SRDF through drip + foliar spray of 0.5 per cent $ZnSO_4$ were found to be superior in both seasons. It was further noticed that plant height, stem diameter, number of branches plant^{-1}, number of flowers plant^{-1}, number of pods plant^{-1} and dry matter production have positive association, with pod yield plant^{-1} in kharif season only. Drip fertigated pigeonpea with 100 per cent seed recommended dose of fertilizer (SRDF) as water soluble fertilizer might prove appropriate for yield enhancement in pigeonpea.

Key Words: Pigeonpea, drip fertigation, season, kharif, summer, morphological traits.

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INTRODUCTION

Pigeon pea (*Cajanus cajan* (L.) Millsp. is a multipurpose legume with a long tradition of cultivation in India. Globally over a billion people in 82 countries rely on pigeon peas as a main source of protein, and it is grown as a cash crop by small farmers in India. In India alone, pigeon peas are grown in about 4 million hectares. Between 1976 and 2009, pigeonpea recorded a 57% increase in area (2.76 to 4.33 million ha) and 78% increase in production (2.14 to 3.8 million tons). The demand for pulses is increasing due to increasing population. Indian Council of Medical Research recommends about 60 g/ day/ person but the average intake is only 31 g/day [1]. To meet the demand, pigeonpea productivity has to be increased. Surface drip irrigation and

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fertigation are important key factors that will decide the seed production at larger extent in India and world in future water conservation and fertigation will result in saving of precious foreign exchange. Drip fertigation thus offers the scope to increase the seed yield per unit area, save time and result in quality seed production through precise application of water and fertilizers at the critical stages and prevent the vagaries caused by environmental stress. When fertilizer is applied through drip, it is observed that 30 per cent of the fertilizer could be saved as compared to broadcast or band placement [2]. In tropical regions, generally three seasons are recognized *viz.,* kharif, rabi and summer for growing crops. Environmental factors (soil fertility, wet or dry season, solar radiation and temperature during seed development) and crop management practices affect yield and seed quality of crop seeds [3]. Success of any crop is normally influenced by the genetic, edaphic and environmental factors during crop growth. Season is one of the major divisions of the year, generally based on yearly periodic changes in weather. The rise in atmospheric temperature causes detrimental effects on growth, yield, and quality of the pigeonpea crop by affecting its phenology, physiology, and yield components [4]. A growing season is a period during which a crop experiences favourable weather condition for its optimum growth, development and yield. As information on suitable season of seed production will be highly useful to the seed growers of pigeonpea under drip fertigation system. Hence, the objective of present study was conducted to evaluate the performance of the crop in two seasons *viz.,* kharif, 2010 and summer, 2011 to fix the optimum dose of drip fertigation and foliar spray treatments for realizing higher growth and yield attributing characters of pigeonpea cv. VBN 3.

MATERIALS AND METHODS

The research was conducted at Agricultural College and Research Institute, Madurai located at 9º 54' N Latitude 78 º 54' E Longitude and at Altitude of 147 MSL during the kharif, 2010 and summer, 2011. The experiment was laid out in split plot design and the treatments were replicated thrice. Field experiments were conducted with twelve treatments are furnished in Table 1.

Table 1

Treatment Details		
T_1 (F_1FS_1)	:	50% of SRDF through drip + Foliar spray of 0.5% $ZnSO_4$
T_2 (F_1FS_2)	:	50% of SRDF through drip + Foliar spray of 100 ppm succinic acid
T_3 (F_1FS_3)	:	50% of SRDF through drip + Foliar spray of 100 ppm humic acid
T_4 (F_2FS_1)	:	75% of SRDF through drip + Foliar spray of 0.5% $ZnSO_4$
T_5 (F_2FS_2)	:	75% of SRDF through drip + Foliar spray of 100 ppm succinic acid
T_6 (F_2FS_3)	:	75% of SRDF through drip + Foliar spray of 100 ppm humic acid
T_7 (F_3FS_1)	:	100% of SRDF through drip + Foliar spray of 0.5% $ZnSO_4$
T_8 (F_3FS_2)	:	100% of SRDF through drip + Foliar spray of 100 ppm succinic acid
T_9 (F_3FS_3)	:	100% of SRDF through drip + Foliar spray of 100 ppm humic acid
T_{10} (F_4FS_1)	:	150% of SRDF through drip + Foliar spray of 0.5% $ZnSO_4$
T_{11} (F_4FS_2)	:	150% of SRDF through drip + Foliar spray of 100 ppm succinic acid
T_{12} (F_4FS_3)	:	150% of SRDF through drip + Foliar spray of 100 ppm humic acid
Control	:	Surface irrigation with SRDF of 25:50:25 NPK kg ha^{-1} by two splits.

Abbreviations: SRDF: Seed recommended dose of fertilizers, F: Fertigation, FS: Foliar spray

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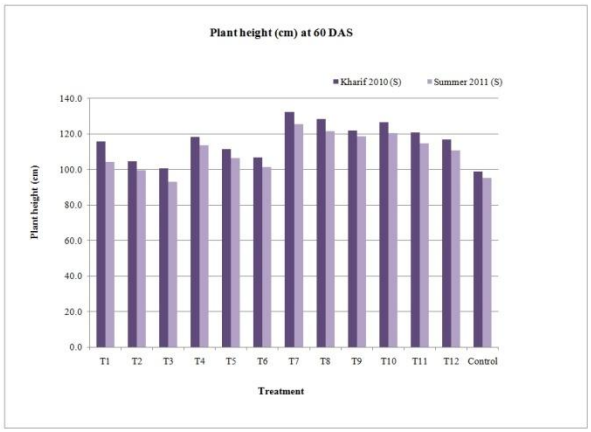

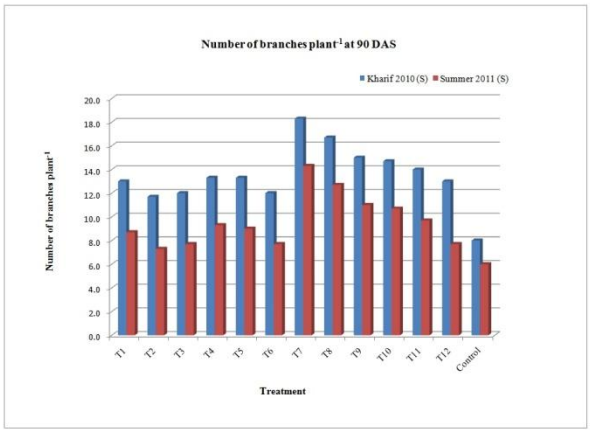

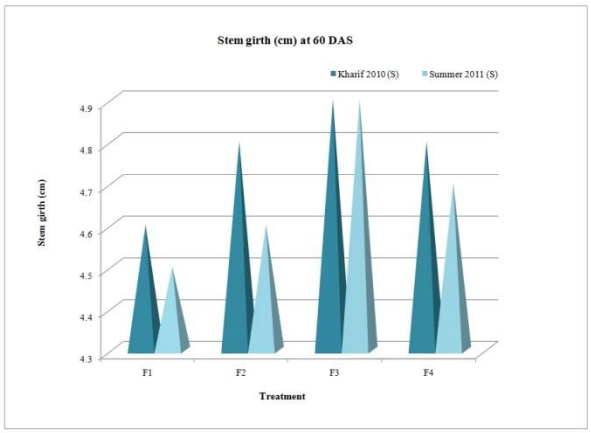

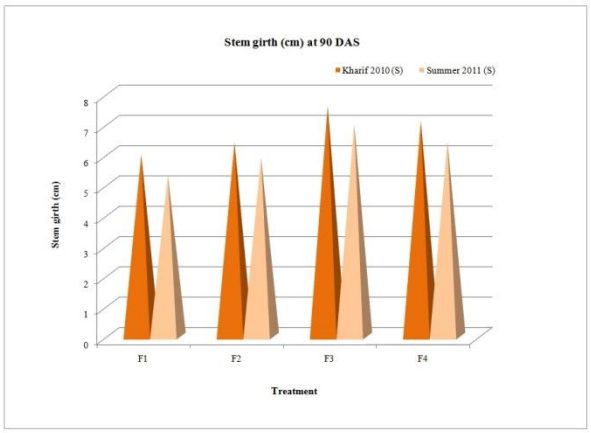

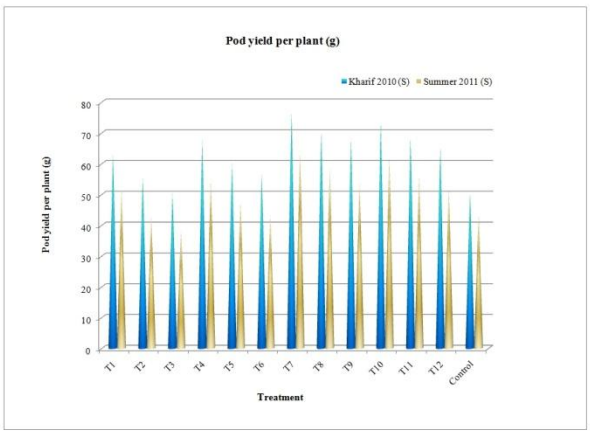

Fig.1. Influence of drip fertigation and season on quantitative characters of pigeonpea

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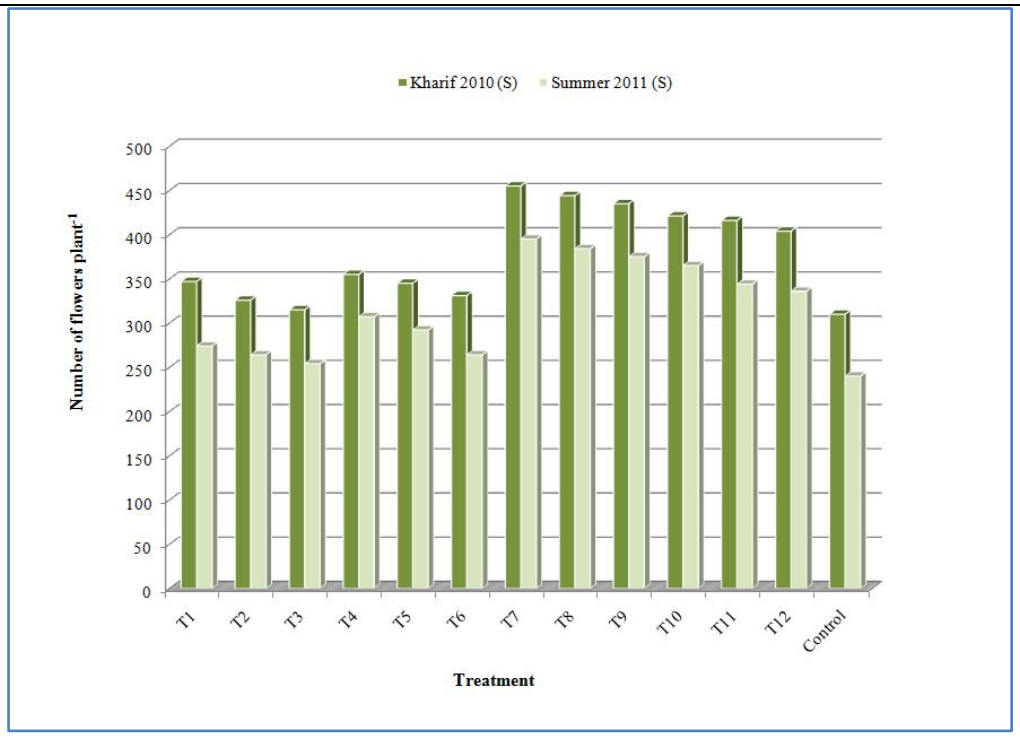

Fig. 2. Effect of drip fertigation and season on number of flowers plant^{-1}

Seeds were treated with carbendazim followed by bacterial inoculation with rhizobium and then sown in line over the raised bed of 90 cm width and furrows of 10 cm at the spacing of 45 x 30 cm. Surface drip fertigation with SRDF (25:50:25 NPK kg ha^{-1} in two splits, which was used as base for calculating the fertigation schedule. The fertigation was done once in six days starting from 15 DAS to 90 DAS in three consecutive steps such as wetting the root zone before fertigation, fertigating the field and flushing the nutrients with water. The assessment of growth characteristics was done in each experimental plot; ten plants were selected at random and tagged for recording biometric observations. Growth components were recorded at three stages of crop growth, *viz*., 60 DAS (flowering stage), 90 DAS and maturity stage. The observations on quantitative traits such as plant height (cm), number of branches plant^{-1}, stem girth plant^{-1} (cm), dry weight (g plant^{-1}), number of flower plant $^{-1,}$ pod yield per plant (g). The data pertaining to the experiment were subjected to statistical analysis by analysis of variance method as suggested by Gomez and Gomez [5]. Pooled analyses of the seasonal mean values were done for precise interpretation of the data.

RESULTS AND DISCUSSION

Plant height (cm)

As shown in Table 2&Figure 1, plant height demonstrated a significant response to drip fertigation and foliar spray treatments in both kharif and summer was highly significant. A linear increase of plant height was observed with fertigation using 100% of SRDF as WSF (F_3) and foliar feeding with 0.5% of $ZnSO_4$ that resulted in higher values of 132.2 cm at 60 DAS and 164.3 cm at harvest with 31.6% and 24.3 per cent increase over 50% of SRDF as WSF with 100 ppm humic acid foliar spray treatment and 34.2% and 23.3 per cent higher compared to control at 60 DAS and at harvest respectively in kharif crop. Whereas in summer, higher plant height was recorded with same treatment combinations with 32% and 23.6 per cent higher reading compared to control in summer crop. Kharif season revealed that 5.4% and 13.0 per cent higher observations over summer crop with same treatment combinations at 60 DAS and at harvest respectively. Higher frequency of

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irrigation and increased availability of soil moisture under drip irrigation might have led to effective uptake and utilization of available nutrients and better proliferation of roots resulting in quick canopy growth [6, 7].

Number of branches plant $^{-1}$

Branching is an important growth phase in cultivation of pigeonpea. The number of branches produced and their survival reflects on the total number of flowers initiated, pods at harvest which ultimately determine crop fecundity and seed yield. The results clearly indicated that the combination of 100% SRDF as WSF with 0.5% $ZnSO_4$ recorded maximum number of branches 18.3 in kharif and 14.3 in summer at 90 DAS with 52.5%, 85.7 per cent respectively higher compared to 50 % of SRDF as WSF with 100 ppm humic acid foliar spray treatment. The same trend was observed in control also (Table 3). The maximum number of branches (20.3) in kharif and (16.3) in summer at harvest was observed with 56% and 68 per cent higher over same treatment combination. However, in kharif season 24.5 per cent higher branches were noticed than summer season with same treatment combination (Figure 1). Similar results were found by Prabhu [8] who reported that drip fertigation of 100% RDF as water soluble fertilizer with micronutrients *viz.,* $ZnSO_4$, $FeSO_4$ as foliar spray registered the highest values for morphological characters.

Stem girth (cm)

Figure 1. Results revealed that seed yield responded significantly to drip fertigation treatments in both seasons. Stem girth is an indicator of robust growth and photosynthatate accumulation due to proper fertilization. The stem girth at 60 DAS, 90 DAS and at harvest as influenced by drip fertigation in both season. The higher stem girth was registered by kharif crop compared to summer crop. Among the fertigation treatments, application of 100 per cent of SRDF as WSF recorded higher stem girth of 4.9 cm in both seasons with 6.5% and 8.9% higher over 50% SRDF as WSF at 60 DAS in Kharif and summer respectively. Similarly, 7.6 cm and 7.0 cm with 26.6% and 32.0% higher at 90 DAS when compared to FS_3 and closely followed by control in both the crops during kharif and summer respectively. The same trend was experienced at harvest stage also. These results were supported by Shukla [9].

Dry matter production plant $^{-1}$ (g)

Whole plant dry matter production is a key indicator of photosynthetate accumulation. The maintenance of dry matter over a period of time and is essential for prolonged supply of photosynthates to the developing sink. Data illustrated in Table 4 shows the combination of 100% SRDF as WSF with 0.5% $ZnSO_4$ recorded maximum dry matter production in kharif 215.4g and in summer 193.2g and were higher by 38.7% and 47.6 per cent respectively, over 50% SRDF as WSF with 100 ppm humic Acid foliar sprayed plots in both crops. The same best treatment combination registered 40.3% and 48.1 per cent increase over control plot. Similar results were evidenced by Hebbar et al. [10] who reported WSF through fertigation recorded significantly higher total dry matter and LAI over drip irrigation in tomato.

Number of flowers plant^{-1}

The number of flowers also behaved similarly for seasons and fertigation treatments registered maximum numbers in kharif followed by summer season (Figure 2). Significant differences were noticed among the interaction effects between seasons, drip fertigation and foliar spray treatments on number of flowers.plant^{-1}. The combination of 100% SRDF as WSF with 0.5% $ZnSO_4$ recorded maximum number of flowers.plant^{-1} in kharif (455) and in summer (395). However, kharif crop recorded higher with 44.4 per cent as compared to treatment combination of 50% SRDF as WSF with 100 ppm humic acid and 47.6% higher over the control plot during Kharif. The same trend was experienced during summer season. Increase in flower numbers, which is ultimately improved pod set were influenced by application of water soluble fertilizers in pigeonpea. These results were corroborated with findings of Hebbar et al. [10] who arrived at significantly

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higher number of flowers per plant was recorded with 100% water soluble fertilizer applied through drip irrigation over control in tomato.

Number of pods plant^{-1}

Table 5. Shows the yield attributes of pigeonpea varied significantly among the different fertigation treatments and foliar spray treatments. Among the treatment combinations, number of pods plant $^{-1}$ was more with 100% SRDF as WSF + 0.5% $ZnSO_4$ foliar spray treatment recorded maximum in kharif (415) and in summer (368) with 55.4%, 64.3 per cent higher as compared to 50% SRDF as WSF with 100 ppm humic acid and 66.0%, 65.7 per cent higher over the control plot during kharif and summer respectively. Between the season kharif season obtained more number of pods 339 in kharif and 292 in summer with 16% increased over summer. Similar results were confirmed by Singh et al. [11]. in mung bean and Periaswamy [12] in pigeonpea.

Pod yield plant^{-1} (g)

Figure 1. Results revealed that pod yield plant^{-1} responded significantly to drip fertigation treatments in both seasons. Among the fertigation treatment, pod yield plant^{-1} was more with 100% of SRDF as WSF recorded maximum in kharif 72.0g and in summer 58.9g with 28.0%, 33.0 per cent higher compared to F_3 during kharif and summer respectively, followed by F_4 and F_2 in both season and was in accordance with the findings of Bhanu Rekha et al. [13] revealed that highest pod yield was recorded through drip fertigation with 120 kg Nha^{-1}.

Table 1. Effect of fertigation and foliar spray on plant height (cm) at harvest in pigeonpea during kharif and summer.

F-Fertigation Treatments	Plant height (cm) at harvest											
	FS - Foliar spraying treatments											
	Kharif 2010 (S)				Summer 2011 (S)				Pooled mean (S)			
	FS_1	FS_2	FS_3	Mean	FS_1	FS_2	FS_3	Mean	FS_1	FS_2	FS_3	Mean
F_1	148.0	136.8	132.2	139.0	124.8	119.0	113.1	119.0	136.4	127.9	122.7	129.0
F_2	150.5	143.7	138.9	144.4	135.9	126.5	121.3	127.9	143.2	135.1	130.1	136.1
F_3	164.3	160.8	153.5	159.5	145.3	141.3	136.8	141.1	154.8	151.1	145.2	150.3
F_4	159.0	152.9	148.3	153.4	140.2	135.7	129.6	135.2	149.6	144.3	139.0	144.3
Mean	155.5	148.6	143.2	149.1	136.6	130.6	125.2	130.8	146.0	139.6	134.2	139.9
	F	FS	F X FS	FS X F	F	FS	F X FS	FS X F		SEd	CD(P=0.05)	
SEd	0.933	0.644	1.405	1.287	0.552	0.446	0.913	0.891	S	0.419	0.922**	
CD(P=0.05)	2.283**	1.365**	3.182*	2.729*	1.350**	0.944**	2.045*	1.889*	F	0.542	1.181**	
Absolute Control	133.2 cm				117.5 cm				FS	0.391	0.796**	
									F X FS	0.837	1.706**	
									S X F	0.939	NS	
									S X FS	0.553	NS	
									S X F X FS	1.106	2.253**	

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Table 2. Effect of fertigation and foliar spray on number of branches at harvest in pigeonpea during kharif and summer.

F-Fertigation Treatments	Number of branches at harvest											
	FS - Foliar spraying treatments											
	Kharif 2010 (S)				Summer 2011 (S)				Pooled mean (S)			
	FS_1	FS_2	FS_3	Mean	FS_1	FS_2	FS_3	Mean	FS_1	FS_2	FS_3	Mean
F_1	13.7	13.3	13.0	13.3	11.0	10.0	9.7	10.2	12.3	11.7	11.3	11.8
F_2	16.0	15.0	13.3	14.8	11.3	11.0	9.7	10.7	13.7	13.0	11.5	12.7
F_3	20.3	19.7	17.7	19.2	16.3	15.0	13.0	14.8	18.3	17.3	15.3	17.0
F_4	16.7	16.7	15.3	16.2	12.3	11.7	10.0	11.3	14.5	14.2	12.7	13.8
Mean	16.7	16.2	14.8	15.9	12.7	11.9	10.6	11.8	14.7	14.0	12.7	13.8
	F	FS	F X FS	FS X F	F	FS	F X FS	FS X F		SEd	CD(P=0.05)	
SEd	0.412	0.090	0.224	0.180	0.067	0.052	0.108	0.103	S	0.175	0.384**	
CD(P=0.05)	0.625**	0.191**	0.516**	0.382**	0.164**	0.109**	0.242**	0.219**	F	0.091	0.197**	
									FS	0.052	0.106**	
									F X FS	0.124	0.253**	
Absolute Control	10.0				8.0				S X F	0.157	0.342**	
									S X FS	0.073	0.150*	
									S X F X FS	0.147	0.299**	

Table 3. Effect of fertigation and foliar spray on dry matter production (g) at harvest in pigeonpea during kharif and summer.

F-Fertigation Treatments	Dry matter production (g) at harvest											
	FS - Foliar spraying treatments											
	Kharif 2010 (S)				Summer 2011 (S)				Pooled mean (S)			
	FS_1	FS_2	FS_3	Mean	FS_1	FS_2	FS_3	Mean	FS_1	FS_2	FS_3	Mean
F_1	170.5	163.6	155.3	163.1	144.2	137.3	130.9	137.5	157.4	150.5	143.1	150.3
F_2	175.0	173.2	168.5	172.2	159.8	143.8	138.2	147.3	167.4	158.5	153.4	159.8
F_3	215.4	201.9	198.4	205.2	193.2	177.6	170.7	180.5	204.3	189.7	184.6	192.9
F_4	186.6	181.9	176.6	181.7	156.3	147.9	141.5	148.6	171.5	164.9	159.0	165.1
Mean	186.9	180.1	174.7	180.6	163.4	151.7	145.3	153.5	175.1	165.9	160.0	167.0
	F	FS	F X FS	FS X F	F	FS	F X FS	FS X F		SEd	CD(P=0.05)	
SEd	1.039	0.935	1.846	1.869	0.741	1.070	1.897	2.139	S	1.100	2.422**	
CD(P=0.05)	2.542**	1.981**	4.105**	3.962**	1.813**	2.268**	4.117**	4.535**	F	0.638	1.391**	
									FS	0.699	1.423**	
									F X FS	1.307	2.663**	
Absolute Control	153.5				130.4				S X F	1.105	2.408**	
									S X FS	0.988	2.012**	
									S X F X FS	1.976	4.025**	

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Table 5. Effect of fertigation and foliar spray on number of pods per plant in pigeonpea during kharif and summer.

F-Fertigation Treatments	Number of pods per plant											
	FS - Foliar spraying treatments											
	Kharif 2010 (S)				Summer 2011 (S)				Pooled mean (S)			
	FS_1	FS_2	FS_3	Mean	FS_1	FS_2	FS_3	Mean	FS_1	FS_2	FS_3	Mean
F_1	299	282	267	283	251	233	224	236	275	258	246	259
F_2	320	304	291	305	272	260	241	258	296	282	266	282
F_3	415	400	387	401	368	351	340	353	392	376	364	377
F_4	379	366	357	367	332	320	308	320	356	343	333	344
Mean	353	338	326	339	306	291	278	292	330	315	302	315
	F	FS	F X FS	FS X F	F	FS	F X FS	FS X F		SEd	CD(P=0.05)	
SEd	0.609	0.687	1.277	1.374	1.320	0.756	1.808	1.512	S	0.427	0.940**	
CD(P=0.05)	1.489**	1.457**	2.801**	2.914**	3.230**	1.603**	4.147**	3.206**	F	0.726	1.583**	
									FS	0.511	1.040**	
									F X FS	1.106	2.253**	
Absolute Control	250				222				S X F	1.258	NS	
									S X FS	0.722	NS	
									S X F X FS	1.444	2.942**	

CONCLUSION

Based on the present findings it is inferred that temperature has a decisive role in determining the morphological traits which inturn influence the yield attributing characters. Thus, the study highlighted that that the fertigation with 100% of SRDF as WSF (F_3) proved better than other treatments. Hence, the drip fertigation 100% SRDF as WSF with foliar spray with 0.5 per cent of $ZnSO_4$ (F_3FS_1) might prove appropriate for yield enhancement in pigeonpea under drip fertigation in both seasons. Kharif season, showed significant performances for most of the growth and yield attributing characters. Hence, it evidently indicated the feasibility of introducing drip fertigation in pigeonpea seed production.

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REFERENCES

[1] NNMB (2012) Diet and nutritional status of rural population, prevalence of hypertension and diabetes among adults and infant and young child feeding practices. In: National nutrition monitoring bureau Technical report. 2012, pp-11.

[2] Sivanappan R.K., Padmakumari O. and Kumar V. (1987) Drip Irrigation. Keerthi Publishing House, Coimbatore, India, pp. 75-80.

[3] Agrawal R.L. (1995) Seed Technology, Oxford and IBH Publishing Co. PVT. Ltd., New Delhi.

[4] Sheehy J.E., Elmido A., Centeno G. and Pablico P. (2005) Searching for new plant for climate change. *Journal of Agricultural Meteorology.* 60:463-468.

[5] Gomez K.A. and Gomez A.A. (1984) Statistical Procedures for Agricultural Research. John Wiley and Sons, New York

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A Peer Reviewed & Refereed, International Open Access Journal

Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

[6] Sivanappan R.K. and Ranghaswami M.V. (2005) Technology to take 100 tons per acre in sugarcane. *Kisan World*, 32: 35-38.

[7] Mahesh R. (2009) Evaluation of Planting Geometry and Methods of Planting for Sugarcane under Low Cost Subsurface Drip Fertigation System. M.Sc. (Ag.) Thesis. Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai.

[8] Prabhu T. (2006) Standardization of Fertigation Techniques in Paprika (*Capsicum annuum* var. *longum* L.) under open and coconut shade conditions. Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore.

[9] Shukla S. K. (2003) Tillering pattern, growth and productivity of promising sugarcane genotypes under various planting seasons and nitrogen levels in subtropical India. *Indian J. Agron.,* 48:312-315.

[10] Hebbar S.S., Ramachandrappa B.K, Nanjappa H.V. and Prabhakar M. (2004) Studies on NPK drip fertigation in field grown tomato (*Lycopersicon esculentum* Mill.). *Europ. J. Agron.,* 21:117–127.

[11] Singh J., Kavel J. N. and Brar Z. S. (1993) Compartmentation of canopy dry matter and seed yield of summer mungbean in relation to irrigation and cycocel regimes. *Indian J. Pulses Res.,* 6: 207-209.

[12] Periaswamy R. (1994) Seed Technological Studies in the Pigeonpea (*Cajanus cajan* (L.) Millsp.) Hybrid ICPH 8 and its parental lines. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

[13] Bhanu Rekha K., Govind Reddy M, and Mahavishnan K. (2005) Nitrogen and water use efficiency of bhendi (*Abelmoschus esculentus* L. Moench) as influenced by drip fertigation. *J. Tropical Agric.*, 43: 43-46.