IMPACT: International Journal of Research in Applied, Natural and Social Sciences (IMPACT: IJRANSS)
ISSN(E): 2321-8851; ISSN(P): 2347-4580
Vol. 3, Issue 3, Mar 2015, 125-132

EFFECT OF SEASON ON SEED YIELD AND QUALITY OF PIGEONPEA UNDER DRIP FERTIGATION

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ABSTRACT

Seasonal and drip fertigation effects on seed production were investigated at Agricultural College and Research Institute, Madurai, during *Kharif* 2010 and *Summer* 2011to study the effect of season under surface drip fertigation on the seed yield and quality of pigeonpea (*Cajanus cajan* L.) cv. VBN3 found that drip fertigation scheduled once in six days and foliar application provided at 45, 55 & 65 DAS, the growth and yield attributes were higher in 100 per cent SRDF as WSF with foliar feeding with 0.5 per cent Zinc Sulphate (F_3FS_1) and lowest with 50per cent SRDF as WSF through drip in both season. Between the seasons, *Kharif* crop recorded 15.2 per cent higher seed yield over *Summer*when compared to normal soil application of fertilizers. The increased in seed yield with 100 per cent SRDF as WSF with foliar feeding with 0.5 per cent Zinc Sulphate was mainly due to greater and consistent availability of nutrients, growth hormones and soil moisture which leads to better crop growth, seed yield components and eventually reflected on the seed yield. Seed production is greatest for the *Kharif* season.

KEYWORDS: Drip Fertigation, Season, Foliar Feeding, Pigeonpea

INTRODUCTION

Pigeonpea is the most widely grown crop in the country and has been under cultivation for over three thousand years. With 22 per cent protein, which is almost three times that of cereals, pigeonpea supplies a major share of protein requirement of the predominantly vegetarian population in the country. The biological value improves greatly, when wheat or rice is combined with pigeonpea because of the complementary relationship of the essential amino acids. It is particularly rich in lysine, riboflavin, thiamine, niacin and iron. Pigeonpea is cultivated in more than 25 tropical and sub-tropical countries, either as a sole crop or intermixed with cereals or with legumes. Being a legume, pigeonpea enriches soil through symbiotic nitrogen fixation.

Fertigation is a relatively new but revolutionary concept in applying fertilizer through irrigation as it helps to achieve both fertilizer-use efficiency and water-use efficiency. When fertilizer is applied through drip, it is observed that 30 per cent of the fertilizer could be saved (Sivanappan and Ranghaswami, 2005). The main cause for low seed multiplication rate is that pigeonpea is mainly grown under agro-ecological constraints compounded by paucity of nutrients and hormones. The environment interaction plays a very important role in desired seed production. At present, the knowledge regarding the effect of environmental factors on seed production is meager. Pigeon pea is known to be sensitive to photoperiod and temperature and the plant morphology changes with the environment, particularly the temperature. Hence, it is necessary to identify the best season which are suited to changes in the environment on sustained production.

An understanding of the plant morphology and its relationship with seed yield as influenced by seasons and drip fertigation for seed is an essential step towards identifying best season.Particularly input information on optimal schedules for drip fertigation is the need of the hour. Keeping this in view, an investigation was carried out to study the performance of drip fertigation in pigeonpea seed production.

MATERIAL AND METHODS

The present investigation on the influence of drip fertigation and season on the growth and seed yield of pigeonpea cv.VBN3 was carried out during *Kharif* 2010 and *Summer* 2011 at Agricultural College and Research Institute, Madurai. The soil of the study area was clayey with a pH of 7.4, available N, P, K status of 180, 10 and 312 N P K kg.ha^{-1} respectively. The organic carbon content was 0.48% and EC 0.42 dSm^{-1}. Seeds were treated and were sown in raised bed at the spacing of 45 x 30 cm as direct spot seeding on raised beds of 90 cm width and furrows of 10 cm. Adopting the drip fertigation as per the first crop fertigation schedule in the same area and all other agronomic and plant protection measures were carried out as and when required as per the Crop Production Guide. Ten plants were randomly tagged in each of the plot (replication and treatment wise). Growth components were recorded at three stages of crop growth, *viz.*, 60 DAS (flowering stage), 90 DAS and maturity stage and observed for the growth and yield attributes.

Lay Out of Drip System

Laterals (12mm) from sub main were fixed at a spacing of 120 cm and inline lateral emitters in fixed at 20 cm with a 16 mm tap at the head of each lateral. The drip irrigation system was well maintained by flushing and cleaning the filters. The quantity of water was calculated as follows: Volume (lit ha-1) = PE × Kp × Area (m2), PE = pan evaporation, K p= Pan Factor (0.80)

Time of operation of drip system to deliver the required volume of water per plot was computed based on the formula.

$$\text{Time of application} = \frac{\text{Volume of water required (l)}}{\text{Emitter discharge (lit ha}^{-1}\text{) x No. of emitters/ plot}}$$

The experiment was laid out in split plot design with three replications with spacing of 45 X 30 cm with treatment (main and sub) (given below) and compared with control.

Treatments	Details
F_1	50 per cent of SRDF through drip
F_2	75 per cent of SRDF through drip
F_3	100 per cent of SRDF through drip
F_4	150 per cent SRDF through drip

*SRDF = Seed crop Recommended Dose of Fertilizer (25:50:25 kg NPK ha^{-1})

Sub Plot Treatment: Foliar Spray at 45, 55 and 65 DAS

Treatments	Details
S_1	Foliar spray of 0.5 per cent Zinc sulphate
S_2	Foliar spray of 100 ppm Succinic acid
S_3	Foliar spray of 100 ppm Humic acid

Absolute control: Surface irrigation with SRDF of 25:50:25 NPK kg ha^{-1} by two splits. (Absolute control plot was maintained separately outside the experimental area and all recommended practices based on the Tamil Nadu Crop Production Guide) with foliar spray of DAP (twice).

Fertigation

The SRDF dose (25:50:25 NPK kg ha^{-1} in two splits) was used as base for calculating the fertigation schedule. Fertigation was done once in six days starting from 15 DAS to 90 DAS in three consecutive steps *viz.*, wetting the root zone before fertigation, fertigating the field and flushing the nutrients with water.

Statistical Analysis

The data pertaining to the experiment were subjected to statistical analysis by analysis of variance method as suggested by Gomez and Gomez (1984). Pooled analyses of the seasonal mean values were done for precise interpretation of the data.

RESULTS AND DISCUSSIONS

Drip fertigation; foliar spray treatments and season significantly influenced the morphological characters such as plant height, number of branches per plant, stem girth and physiological parameters like leaf area duration, crop growth rate and Leaf area index at 90 DAS. All these morphological and physiological traits were significantly higher in *Kharif*over*Summer.* Among the season, *Kharif* crop revealed higher observations compared to *Summer* crop with combination of 100per cent SRDF as WSF (F_3) + 0.5 per cent Zinc Sulphate. Drip fertigation and foliar spray treatments in general increased the crop growth. Similar results were found by Prabhu (2006) in chilliesfertigated and foliar sprayed with $ZnSO_4$, $FeSO_4$as compared to drip fertigation at 100 per cent RDF alone.

Growth Characters

Drip fertigation and foliar spray treatments significantly influenced the morphological characters such as plant height, number of branches; dry weight.$plant^{-1}$ and number of flower were significantly influenced by surface drip fertigation. The interaction effect of drip fertigation and foliar spray treatments in both seasonswere highly significant. The plant height at 90 DAS which was higher observed with fertigation using 100% SRDF as WSF (F_3) and foliar feeding with 0.5 % Zinc Sulphate that resulted in higher values of 157.4cm and 140.7cm at 90 DAS in *Kharif* and *summer*, respectively. Plant height was increased by 25.4 % and 28.7 % in Kharif and summer, respectively with similar treatment combinations. Whereas in plant height inKharif 2010 was higher (12.7 %) over Summer 2011at 90 DAS.The results also clearly indicated that the water soluble fertilizers played a significant role in increasing the plant height. Similarly, WSF provided based on crop stage wise nutrient requirement resulted in increased plant height compared to surface irrigation with 100% SRDF and foliar spay as also reported by Kumar and Haripriya (2010) who revealed that monthly spray ofFerrussulphate @ 0.75 % + Zinc Sulphate @ 0.50 % are significantly maximum values on all the growth attributes like plant height, number of secondary branches, no. of leaves per plant, plant spread and leaf area in Neriumas also visulalized by Sampath Kumar *et al.* (2006) in cotton.

Physiological Parameters

Leaf area index being an important tool to quantify photosynthates accumulation in sink, resulted in increased growth of pigeonpea.The same best treatment combination at 90 DAS values were higher with LAI 20.4% and 27.8 %, LAD 32.4% and 43.6 %, CGR 52.4% and 93.3 % per cent was higher compared to 50% SRDF as WSF + 100 ppm Humic Acid which was recorded during *Kharif* and *Summer*, respectively. Similar results were expressed byVeeraputhiran (2000) attributing enhanced physiological parameters such as LAI, CGR and CGR using drip fertigation over the furrow band application of cotton.The enhanced dry weight of reproductive parts by growth regulators, organics and nutrients may be due to increased translocation of assimilates from leaf and stem to the reproductive parts as also reported in pigeonpea due to application of Zinc Sulphate, Succinic Acid and Humic Acid (Singh *et al.*, 1993 and Brar *et al.*, 1992). Seed yield was maximum when $ZnSO_4$ (0.5 %) was given as a foliar spray. Zinc plays a vital role as activator of carbohydrate and protein synthesis as well as their transport to the site of seed formation as also visulalized byCharlie O Dell (2004)whilecomparing efficiency of plant use of foliar-fed nutrients versus soil-applied nutrients near roots and found foliar feeding provided about 95% use efficiency compared to about 10% efficiency use from soil applications thus providing a major benefit of foliar feeding where a specific plant nutrient deficiency may exist, be it a major or minor nutrient.

Yield and Yield Attributes

Seed yield (kg.ha^{-1}) was positively influenced by drip fertigation treatments and foliar spray treatments. Among the treatment combinations, Seed yield (kg.ha^{-1}) was higher with 100% SRDF as WSF+ 0.5 % Zinc Sulphate recorded maximum in *Kharif* (1416 kg.ha^{-1}) and in *Summer* (1251 kg.ha^{-1}) by 40.2%, 48.0 per cent higher seed yield compared to 50% SRDF as WSF + 100 ppm Humic Acid and 41.6%, 47.2 per cent higher over the control plot during *Kharif* and *Summer*, respectively. However, seed yield (kg.ha^{-1}) occurred more in *Kharif* with 13.2 % higher yield over *Summer* with same treatment combination. Higher number of pods plant^{-1} (415 in *Kharif* and 368 in Summer) with 12.8 % higher number in *Kharif* over Summer (Figure 1). This might be due to enhancement in growth and yield parameters as well as uptake of nutrients by this crop. Obviously, the cumulative effects of these parameters contributed to increased yield foliarapplication of $ZnSO_4$ (0.5 per cent) could increase the grain yield significantly over control in rice (Manoharan*et al.*, 2001). Foliar application of KCI, DAP, urea and KNO_3 increased the seed cotton yield due to more number of bolls per plant (Brar and Brar, 2002). Fertigation with 100 per cent WSF increased the fruit yield of tomato significantly over furrow irrigation and drip irrigation as reported by Hebbar *et al.* (2004). The higher seed yield correlating with higher level of water soluble fertilizers could be attributed to translocation of more carbohydrates due to high nitrogen levels. Potassium plays an important role in this translocation of metabolites for the development of seed. Moreover, higher production of seed yield under surface drip irrigation and fertigation might have paved the way for increased production of photosynthates, which ultimately resulted in increased production of seeds at harvest as also found by Somu (1995) in pigeonpea, Shashidhara (2006) in chillies and Tayo (1990) in pigeonpea.

CONCLUSIONS

Seed production is better for the *Kharif*season and thetreatment combination of 100 per cent SRDF as WSF with foliar spraying with 0.5 per cent Zinc Sulphate (F_3FS_1) and maximized the seed yield, better crop growth, higher yield attributes and substantial quantity of water saving. Thus, it clearly indicated the feasibility of introducing drip fertigation in pigeonpea seed production for higher water productivity; higher fertilizer use efficiency and sustainability in future pigeonpea seed production.

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APPENDICES

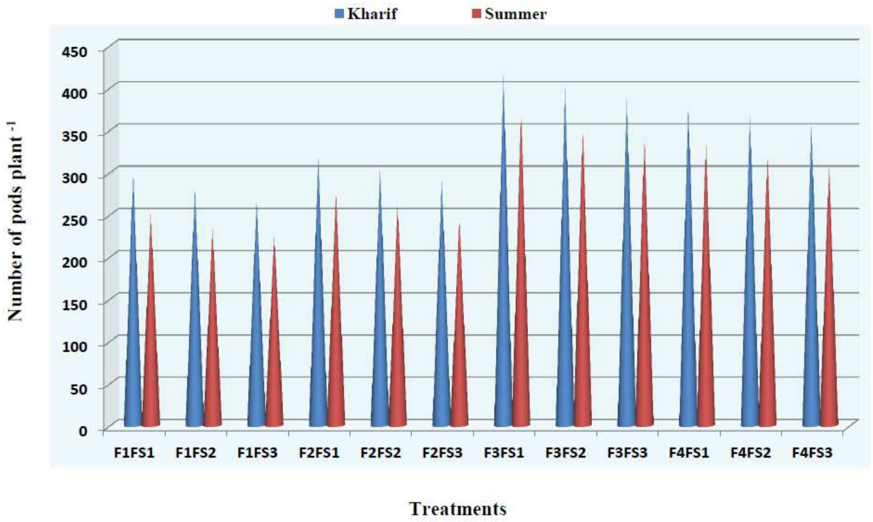

Figure 1: Influence of Fertigation and Foliat Spray on Number of Pods Plant^{-1} in Pigeonpea cv. VBN 3

Table 1: Influence of Fertigation and Foliar Spray on Plant Height (cm) at 90 DAS Inpigeonpea cv. VBN 3. (Kharif and Summer)

F- Fertigation Treatments	Plant Height (cm) at 90 Days after Sowing											
	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	140.6	129.5	125.5	131.9	119.4	115.2	109.3	114.6	130.0	122.4	117.4	123.3
F_2	143.4	136.4	131.6	137.1	128.8	121.3	116.6	122.2	136.1	128.9	124.1	129.7
F_3	157.4	153.5	146.4	152.4	140.7	136.5	132.5	136.6	149.1	145.0	139.5	144.5
F_4	151.7	145.6	141.6	146.3	135.5	129.8	125.7	130.3	143.6	137.7	133.7	138.3
Mean	148.2	141.4	136.3	141.9	131.1	125.7	121.0	125.9	139.7	133.5	128.7	133.9
	F	FS	F X FS	FS X F	F	FS	F X FS	FS X F			SEd	CD(P=0.05)
SEd	0.742	0.649	1.294	1.299	0.844	0.387	1.054	0.774	S		0.388	0.854**
CD(P=0.05)	1.815**	1.376**	2.882*	2.753*	2.065**	0.820**	2.456*	1.640*	F		0.562	1.224**
									FS		0.378	0.770**
									F X FS		0.834	1.700**
									S X F		0.973	NS
									S X FS		0.534	NS
									S X F X FS		1.069	2.177**
Absolute Control	125.5				112.3							

*DAS- Days after sowing

Table 2: Influence of Fertigation and Foliar Spray on Leaf Area Index at 90 DAS in Pigeonpea cv. VBN 3. (Kharif and Summer)

F- Fertigation Treatments	LAI at 90 DAS											
	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	5.63	5.46	5.35	5.48	4.72	4.44	4.24	4.47	5.18	4.95	4.80	4.97
F_2	5.81	5.66	5.65	5.71	4.93	4.75	4.62	4.77	5.37	5.20	5.14	5.24
F_3	6.44	6.35	6.25	6.35	5.42	5.30	5.17	5.30	5.93	5.83	5.71	5.82
F_4	6.22	5.89	5.81	5.98	5.24	5.02	4.78	5.01	5.73	5.46	5.30	5.49
Mean	6.03	5.84	5.76	5.88	5.08	4.88	4.70	4.89	5.55	5.36	5.23	5.38
	F	FS	F X FS	FS X F	F	FS	F X FS	FS X F			SEd	CD(P=0.05)
SEd	0.017	0.018	0.033	0.035	0.023	0.017	0.036	0.033	S		0.016	0.036**
CD(P=0.05)	0.042**	0.037**	0.074**	0.075**	0.057**	0.035**	0.081**	0.071**	F		0.014	0.031**
									FS		0.012	0.025**
									F X FS		0.024	0.050**
									S X F		0.025	0.054**
									S X FS		0.017	0.035**
									S X F X FS		0.034	NS
Absolute Control	5.12				4.33							

*DAS- Days after sowing

Table 3: Influence of Fertigation and Foliar Spray on Leaf Area Duration in Pigeonpea cv. VBN 3. (Kharif and Summer)

F- Fertigation Treatments	LAD – Leaf Area Duration											
	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	110.4	105.0	101.6	105.7	92.7	85.1	80.1	86.0	101.52	95.04	90.86	95.81
F_2	117.6	112.6	109.5	113.2	99.3	94.8	91.3	95.1	108.44	103.69	100.39	104.17
F_3	134.5	130.8	128.5	131.2	115.0	110.2	105.2	110.1	124.76	120.48	116.85	120.69
F_4	128.8	120.6	116.5	121.9	108.8	101.4	96.5	102.3	118.80	111.02	106.50	112.11
Mean	122.8	117.2	114.0	118.0	104.0	97.9	93.3	98.4	113.38	107.56	103.65	108.19
	F	FS	F X FS	FS X F	F	FS	F X FS	FS X F			SEd	CD(P=0.05)
SEd	0.356	0.365	0.693	0.729	0.318	0.415	0.749	0.830	S		0.333	0.734**
CD(P=0.05)	0.870**	0.773**	1.530**	1.546**	0.779**	0.880**	1.631*	1.759*	F		0.239	0.520**
Absolute Control	101.2				83.3				FS		0.276	0.563**
									F X FS		0.510	1.039**
									S X F		0.413	0.901**
									S X FS		0.391	0.796**
									S X F X FS		0.781	NS

*DAS- Days after sowing

Table 4: Influence of Fertigation and Foliar Spray on Crop Growth Rate g m^{-2} d^{-1} in Pigeonpea cv. VBN 3 (Kharif and Summer)

F- Fertigation Treatments	Crop Growth Rate - CGR g m^{-2} d^{-1}											
	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	16.5	16.3	15.3	16.0	13.2	11.5	10.4	11.7	14.83	13.91	12.88	13.87
F_2	20.2	16.8	15.9	17.6	13.6	12.3	10.6	12.2	16.90	14.54	13.28	14.91
F_3	23.6	23.0	22.6	23.1	20.1	17.4	16.6	18.0	21.84	20.20	19.61	20.55
F_4	18.6	17.6	16.5	17.6	15.5	13.9	12.1	13.8	17.05	15.77	14.27	15.70
Mean	19.7	18.4	17.6	18.6	15.6	13.8	12.4	13.9	17.65	16.11	15.01	16.26
	F	FS	F X FS	FS X F	F	FS	F X FS	FS X F			SEd	CD(P=0.05)
SEd	0.182	0.395	0.671	0.790	0.202	0.139	0.303	0.277	S		0.227	0.499**
CD(P=0.05)	0.447**	0.838**	1.438*	1.675*	0.494**	0.294**	0.687*	0.588*	F		0.136	0.297**
Absolute Control	14.5				10.2				FS		0.209	0.426**
									F X FS		0.368	NS
									S X F		0.236	0.514**
									S X FS		0.296	NS
									S X F X FS		0.592	1.206**

*DAS- Days after sowing

Table 5: Influence of Fertigation and Foliar Spray on Seed Yield (kg. ha^{1}) in Pigeonpea cv. VBN 3 (Kharif and Summer)

F-Fertigation Treatments	Seed yield Per ha (kg)											
	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	1056	1035	1010	1034	892	873	845	870	974	954	928	952
F_2	1143	1101	1075	1106	979	941	913	944	1061	1021	994	1025
F_3	1416	1367	1344	1376	1251	1213	1180	1215	1333	1290	1262	1295
F_4	1276	1244	1215	1245	1147	1113	1052	1104	1212	1179	1133	1175
Mean	1223	1187	1161	1190	1067	1035	998	1033	1145	1111	1079	1112
	F	FS	F X FS	FS X F	F	FS	F X FS	FS X F				
SEd	3.237	2.225	4.865	4.449	5.149	3.114	7.236	6.227				
CD(P=0.05)	7.920**	4.716**	11.019**	9.432**	12.599**	6.601**	16.539**	13.201**				
Absolute Control	1000				850							

	SEd	CD(P=0.05)
S	2.639	5.809**
F	3.041	6.626**
FS	1.913	3.897**
F X FS	4.360	8.881**
S X F	5.267	NS
S X FS	2.706	5.512**
S X F X FS	5.412	11.023**

*DAS- Days after sowing