Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(3): 4217-4220
Received: 01-03-2019
Accepted: 03-04-2019

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Effect of different drip fertigation levels on growth and yield of short duration pigeon pea varieties

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Abstract
Field experiment was conducted at Millet Breeding Station, Tamil Nadu Agricultural University, Coimbatore during 2015 and 2016 with the objective of Growth and yield of short duration Pigeon pea (*Cajanus cajan* L.) varieties under Drip fertigation system. The experiment was laid out in strip plot design with three replications. The main plot treatments were allotted with three varieties viz., Co (Rg) 7, APK 1 and VBN 3. The sub plot treatments comprised of three drip fertigation levels viz., 75%, 100% and 125% RDF (@ 25:50:25 kg NPK ha^{-1}) through WSF with Azophosmet and foliar spray of PPFM and drip fertigation at 100% RDF through WSF alone along with surface irrigation with conventional fertilizers. The effect of varieties and nutrient application methods (drip fertigation and soil application) the highest plant height, Leaf area index and dry matter production during *Kharif* 2015 and *Summer* 2016 DMP of (7042 and 6235 kg ha^{-1} during *Kharif* 2015 and *Summer* 2016). The grain yield 1992 and 1758 kg ha^{-1}were significantly observed under drip fertigation with125% RDF through WSF with Azophosmet and foliar spray of 1% PPFM. Among the pigeonpea varieties, Co (Rg) 7 performed well compared to APK 1 and VBN 3 varieties.

Keywords: Pigeonpea, drip fertigation, varieties, leaf area index, dry matter production

Introduction
Pulses have great potential to improve human health as an integral part of many diets across the globe and them, conserve our soils, protect the environment and contribute to global food security. Pigeonpea plays an important role in food security, balanced diet and alleviation of poverty, since it is used in diverse ways as a source of food, feed, fodder (Robertson *et al*., 2002) [8], fuel wood, rearing lac insects (Zhenghong *et al*., 2001) [12], hedges, windbreaks, soil conservation, green manuring and roofing. Pigeonpea enriches soil through symbiotic nitrogen fixation and provides farmers with valuable organic matter and micronutrients. It has a special mechanism to release soil-bound phosphorus to meet its own needs as well as those of subsequent crops. It is a major source of protein to about 20% of the world population (Thu *et al*., 2003) [11] and is an abundant source of minerals, vitamins and amino acids (Saxena *et al*., 2002) [9].

Pigeonpea (*Cajanus cajan* (L.) Millspaugh) is a grain legume belonging to the *Cajaninae* sub-tribe of the economically important leguminous tribe *Phaseoleae* (Greilhuber and Obermayer, 1988) [1]. Pigeonpea is known by different names all over the world *viz*., arhar, tur, kandulu, payaru, tuvar and tuvarai. The crop can be described as unique, because it is a legume and a woody shrub. It has an inherent ability to withstand drought (Okiror, 1986) [4] and its deep root system breaks the hard pans, hence called as "biological plough", extracts moisture from deeper layers of the soil and produces biomass including protein-rich grain, utilizing residual moisture (Nene and Sheila, 1990) [3].

Effective management of irrigation water is an important issue in crop production, since irrigation is a precondition for crop growth, development and production per mm of water and productivity per unit area. Shortage of water for irrigation is being increasingly felt due to pressures from depleting groundwater levels, rising alternative demands, water quality degradation and economics. Therefore, farmers are switching over to drip irrigation to improve irrigation efficiency and water productivity (Ravikumar *et al.*, 2011) [7].

Materials and Methods
Field experiment was conducted at Millet Breeding Station at Tamil Nadu Agricultural University, Coimbatore. Pigeonpea varieties viz. Co (Rg)7 (V1), APK1 (V2) and VBN3 (V3) were selected. As per the treatments schedule, 75 percent of recommended dose of water soluble fertilizers (V1F3, V2F3 and V3F3), 100 percent of recommended dose of water

soluble fertilizers (V1F2, V2F2 and V3F2 and V1F4, V2F4 and V3F4) and 125 percent of recommended dose of water soluble fertilizers (V1F5, V2F5 and V3F5) were applied through the drip as per the fertigation schedule. The recommended doses of inorganic fertilizers @ 25:50:25 NPK kg ha^{-1} were applied through drip as per the fertigation schedule in the form of water soluble fertilizers viz., Mono Ammonium Phosphate (12:61% N and P), Urea (46% N), Poly feed (19:19:19% NPK) and Sulphate of potash (50% K). The fertilizer solution was prepared by dissolving the required quantity of fertilizer with water in 1:5 ratio and injected into the irrigation system through venturi assembly. Fertigation interval was scheduled once in 7 days interval. The other usual common package of practices was followed time to time and periodical growth observations were recorded at an interval of 30 days interval.

Table 1: Effect of different fertigation levels on growth, yield attributes and harvest index of short duration pigeon pea varieties

Treatments	Plant height (cm)		DMP (kg/ ha)		No.of branches/plant		LAI		Yield	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Varieties										
V_1-Co (Rg) 7	145.8	143.6	5850	5130	8.88	7.75	2.25	1.88	1650	1449
V_2-APK 1	104.3	100.0	4665	4154	4.79	4.20	2.10	1.78	1301	1175
V_3-VBN 3	122.4	117.2	3876	3433	5.66	4.93	1.98	1.67	1076	968
SEd	3.2	3.1	117	158	0.16	0.15	0.02	0.04	41	30
CD (0.05)	9.0	8.8	324	438	0.45	0.43	0.06	0.12	116	83
F_1	105.8	100.2	3341	2997	5.17	4.54	1.55	1.33	942	852
F_2	128.4	126.0	5053	4478	6.55	5.74	2.18	1.83	1414	1267
F_3	118.6	115.8	4401	3915	6.00	5.25	2.03	1.71	1235	1111
F_4	131.2	127.6	5305	4728	6.87	5.99	2.28	1.92	1479	1325
F_5	137.0	131.9	5886	5079	7.62	6.64	2.49	2.09	1642	1431
SEd	4.3	1.6	117	124	0.32	0.12	0.10	0.02	31	33
CD (0.05)	10.7	3.8	270	287	0.75	0.29	0.23	0.06	71	77
Interaction										
$V_1 \times F_1$	111.4	106.5	4039	3598	7.23	6.40	1.66	1.39	1145	1022
$V_1 \times F_2$	155.3	154.5	6149	5352	9.01	7.80	2.39	1.96	1731	1512
$V_1 \times F_3$	135.7	138.6	5509	4727	8.47	7.45	2.11	1.77	1556	1348
$V_1 \times F_4$	159.2	156.3	6512	5739	9.27	8.06	2.47	2.07	1827	1606
$V_1 \times F_5$	**167.6**	162.2	7042	6235	10.41	9.06	2.60	2.18	1992	1758
$V_2 \times F_1$	96.7	91.7	3187	2910	4.00	3.48	1.58	1.41	898	821
$V_2 \times F_2$	104.6	101.5	5015	4468	4.91	4.37	2.14	1.80	1399	1268
$V_2 \times F_3$	101.8	96.3	4220	3830	4.35	3.78	2.05	1.72	1184	1085
$V_2 \times F_4$	106.8	103.4	5216	4662	5.21	4.55	2.26	1.90	1451	1308
$V_2 \times F_5$	111.8	107.0	5687	4902	5.49	4.81	2.48	2.08	1574	1392
$V_3 \times F_1$	109.2	102.4	2796	2483	4.29	3.73	1.42	1.19	783	712
$V_3 \times F_2$	125.3	121.9	3995	3615	5.73	5.04	2.01	1.72	1111	1021
$V_3 \times F_3$	118.4	112.5	3473	3187	5.18	4.51	1.94	1.63	966	901
$V_3 \times F_4$	127.5	123.0	4188	3782	6.14	5.34	2.11	1.79	1158	1060
$V_3 \times F_5$	131.7	126.4	4930	4100	6.95	6.05	2.40	2.02	1360	1144
SEd	4.3	3.0	151	141	0.43	0.15	0.12	0.05	52	34
CD (0.05)	10.7	6.4	321	299	NS	0.32	NS	NS	110	72

Results and discussion

The observation on the plant growth parameters and yield which were recorded have been tabulated, statistically computed and the same are presented here under the appropriate headings.

Plant height

Growth in terms of plant height at all the stages of development showed significant variation due to different varieties and levels of fertigation during *Kharif* 2015 and *Summer* 2016. Among the varieties, Co(Rg) 7 (V_1) significantly recorded tallest plants to a height of 42.7, 95.3, 131.9 and 145.8 cm in *Kharif* 2015 and 40.6, 90.3, 126.3 and 143.6 cm in *Summer* 2016 at 30, 60, 90 DAS and at harvest stage respectively. The other two varieties *viz*., APK 1 (V_2) (23.0, 68.0, 91.7 and 104.3 cm, and 21.0, 64.8, 87.4 and 100.0 cm) and VBN 3 (V_3) (31.0, 84.9, 115.3 and 122.4 cm, and 28.3, 81.5, 108.6 and 117.2 cm) recorded shortest plants in both the years at all the stages respectively. The interaction effect of fertigation levels and varieties significantly influenced the plant height of pigeonpea at 30, 60, 90 DAS and at harvest in both the seasons. Irrespective of different varieties, Co (Rg)7 along with drip fertigation with 125% RDF through WSF + Azophosmet and foliar spray of 1% PPFM (V_1F_5) significantly recorded highest plant height 48.4, 104.1, 148.5 and 167.6 cm, and 46.2, 99.7, 142.7 and 162.2 cm at 30, 60, 90 DAS and harvest stage during *Kharif* 2015 and *Summer* 2016 respectively. This was comparable with drip fertigation with 100 per cent RDF through WSF + Azophosmet and foliar spray of 1% PPFM (V_1F_4) with a height of 45.1, 100.3, 141.6 and 159.2 cm, and 43.5, 94.6, 135.1 and 156.3 cm at 30, 60, 90 DAS and harvest stage during *Kharif* 2015 and *Summer* 2016 respectively. The highest increase in vegetative growth under drip fertigation might be due to the availability of soil moisture at optimum level (Pattanaik *et al*., 2003) [5].

Number of branches per plant

In both the years 2015 1nd 2016, the number of primary branches per plant varied significantly due to different varieties. Among the different short duration pigeonpea varieties, Co(Rg)7 (V_1) recorded the higher number of primary branches per plant over other varieties. The variety Co(Rg)7 produced more primary branches registering 4.02,

7.60 and 8.88, and 3.71, 6.63 and 7.75 per plant at 30, 60 and 90 DAS during *Kharif* 2015 and *Summer* 2016 respectively. This was perhaps due to the higher production of number of leaves with more number of branches, which was in conformity with the findings of Kumar *et al.*, 2009 [2].

Leaf area index

The leaf area index of pigeonpea was significantly influenced by different fertigation levels. Among the fertigation levels, application of 125 per cent of recommended dose of fertilizer through WSF + Azophosmet biofertigation + 1% PPFM foliar spray (F_5) recorded significantly higher values of leaf area index registering 0.82, 1.86, 2.83 and 2.49, and 0.78, 1.63, 2.60 and 2.09 at all the stages during *Kharif* 2015 and *Summer* 2016 respectively. This was comparable with 100 per cent of RDF through WSF + Azophosmet biofertigation + 1% PPFM foliar spray (F_4) and 100 per cent of RDF through WSF alone (F_2) at 30, 60, 90 DAS and harvest stages. The lowest leaf area index of 0.58, 1.52, 1.87 and 1.55, and 0.55, 1.33, 1.70 and 1.33 was recorded at 30, 60, 90 DAS and harvest stage respectively by surface irrigated pigeonpea with the basal application of 100 per cent RDF through conventional fertilizer alone during *Kharif* 2015 and *Summer* 2016. Similar findings were recorded in banana for fertigation of 100 per cent RDF through drip as WSF by Sivalingam (2011) [10].

Dry matter production

The interaction effect of fertigation levels and varieties was significant. Irrespective of different varieties, the variety Co(Rg)7 under drip fertigation with 125% RDF through WSF + Azophosmet and foliar spray of 1% PPFM (V_1F_5) significantly recorded higher dry matter production of 801, 2907, 5692 and 7042 kg ha^{-1} and 705, 2560, 5081 and 6235 kg ha^{-1} during *Kharif* 2015 and *Summer* 2016 at different stages respectively. This was followed by the variety Co(Rg)7 under drip fertigation with 100 per cent RDF through WSF + Azophosmet and foliar spray of 1% PPFM (V_1F_4), which recorded a dry matter production of 754, 2677, 5294 and 6512 kg ha^{-1}, and 661, 2367, 4691 and 5739 kg ha^{-1} during *Kharif* 2015 and *Summer* 2016 respectively. The lowest dry matter production of 391, 1381, 2771 and 3341 kg ha^{-1}, and 365, 1266, 2464 and 2997 kg ha^{-1} was observed in conventional fertilizer application with surface irrigation in both seasons. Rajasekaran (2007) [6] reported higher dry matter production under 125 per cent RDF followed by 100 per cent in drip irrigated sugar beet.

Drip fertigation at 125 per cent RDF through WSF with Azophosmet and 1% PPFM foliar spray followed by 100 per cent RDF through WSF with Azophosmet and 1% PPFM foliar spray recorded higher dry matter production (7042 and 6235 kg ha^{-1} during *Kharif* 2015 and *Summer* 2016) as compared to surface irrigation with soil application of fertilizers. This was mainly due to optimum moisture supply and timely nutrient application which could have enhanced the assimilatory efficiency resulting in increased number of leaves per plant, better branching and LAI which contributed for higher dry matter production as well as promoted the activity of photosynthesis and simultaneous accumulation of dry matter.

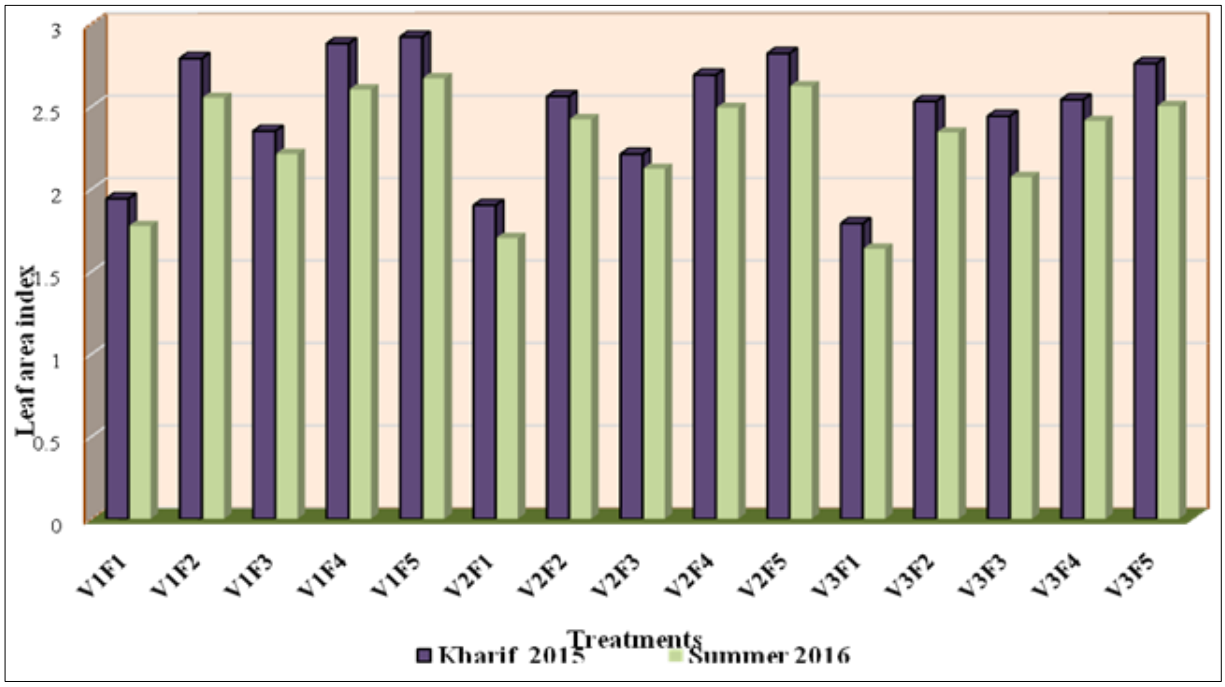

Fig 1: Effect of drip fertigation levels on leaf area index of of short duration pigeon pea varieties

Conclusion

It was concluded that the Pigeonpea cultivar Co ()Rg 7 showed statistically significant variations in all plant growth and yield characters observed in this study. The increase in pigeonpea grain yield in fertigation at 125 per cent RDF through WSF with Azophosmet and 1% PPFM foliar spray was 72 per cent in drip system over surface irrigation.

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