Research Article

Relative Performance of Fertilizer Levels on Nutrient Uptake and Yield of Pigeonpea Varieties Under Drip Fertigation

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Abstract

A field experiment was conducted at Millet Breeding Station at Tamil Nadu Agricultural University, Coimbatore, to study the relative performance of fertilizer levels on nutrient uptake and yield of pigeonpea varieties under drip fertigation. The effect of fertigation on nutrient uptake of pigeonpea was carried out in three pigeonpea varieties *viz*., Co(Rg)7, APK1 and VBN3. Drip fertigation with water soluble fertilizer at 125 %, 100 %, 75 % RDF + Azophosmet and foliar spray of 1% PPFM were tested along with surface irrigation method with application of conventional fertilizers during kharif 2015. The effect of varieties and nutrient application methods (drip fertigation and soil application) reflected on differential rate of N, P, and K uptake by the crop. The nutrient uptake was higher under increased drip fertigation dose compared to soil application of nutrients. Among the drip fertigation, the N, P and K uptake was higher with drip fertigation at 125 per cent RDF through WSF + Azophosmet and foliar spray of 1% PPFM compared to other treatments. Among the pigeonpea varieties, Co(Rg)7 performed well compared to other varieties.

Keywords: Pigeonpea, Azophosmet, Drip fertigation, Nutrient uptake, PPFM, Yield

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Introduction

Pigeonpea (*Cajanus cajan* L. Millsp.) is one of the important pulse crops in India and ranks second after chickpea in area and production. It is commonly known as "Redgram" or "Arhar". Endowed with several unique characters, pigeonpea finds an important place in the farming systems adopted by the farmers in the large number of developing countries including India. It is grown on a wide range of soil with varying physical and chemical properties. Pigeonpea being a legume, it fixes atmospheric nitrogen and the leaf fall at maturity adds organic matter to the soil. The outstanding deep root system breaks the hard pans and allows for optimum moisture and nutrients utilization, which enables it to tolerate drought, and hence it is often called as "biological plough". The cultivars recommended earlier in the region or in different agro-climatic conditions are tested with newly introduced or developed cultivars, so as to understand the production potential of different cultivars suited to that region. The demand for pulses is increasing due to increasing population; hence pigeonpea productivity has to be increased. Drip irrigation is a technique in which water is distributed through the emitters directly into the soil near the plants through a special slow-release device. Adoption of drip irrigation might help in increasing area under irrigation, productivity of crops and increase the water use efficiency [1]. Drip fertigation allows precise timing and uniform distribution of fertilizer nutrients. It is an efficient and agronomically sound method of providing soluble plant nutrients directly to the active plant root zone. The increasing acres of micro-irrigated crops provides an excellent opportunity to explore new methods of providing complete and balanced plant nutrient programs that have the potential to improve plant health and increase yields. Usually the optimizing nutrient management with drip irrigation would require that attention be paid to soil nutrient dynamics, crop nutrient requirements, as well as soil and plant monitoring techniques. Fertilizers should be applied in a form that becomes available in synchrony with crop demand for maximum utilization of nutrient from fertilizers [2]. The method of fertilizer application is very important in obtaining optimal use of fertilizer. This will increase the amount of fertilizer used by the plant and reduce the amount lost by leaching. To meet out the requirement the only way is to increase the production and productivity for that drip fertigation is the best option. The present investigation was therefore planned to study the relative performance of fertilizer levels on nutrient uptake and yield of pigeonpea varieties under drip fertigation.

Material and Methods

The field experiment was conducted at Millet Breeding Station, Tamil Nadu Agricultural University, Coimbatore. The location is geographically situated in the Western Agro-climatic Zone of Tamil Nadu at 11.0136° N latitude and 76.9378° East longitude at an altitude of 426.72 m above MSL during the growing season of kharif 2015. The experiment was laid out in strip plot design and replicated thrice. The main plot treatments were allotted with three varieties *viz.*, Co(Rg)7, APK1 and VBN3. The sub plot treatments comprised of four drip fertigation levels *viz.*, 75%, 100% and 125% RDF (@ 25:50:25 kg NPK ha^{-1}) through WSF + Azophosmet and foliar spray of PPFM, and drip fertigation at 100% RDF through WSF alone along with surface irrigation with application of conventional fertilizers. Water soluble fertilizers (WSF*) viz.,* Mono Ammonium Phosphate (12:61:0 NPK), Urea (46% N), Poly feed (19:19:19) and Sulphate of Potash (0:0:50) were applied through fertigation. Fertigation was given once in seven days. Paired row planting system was adopted under drip irrigation with spacing of 90/30×30 cm. Each plot was $40m^2$ with inline drippers were fixed at a spacing of 60 cm with a discharge rate of 4 lit hr^{-1}.

Results and Discussion

Nitrogen uptake

Different drip fertigation levels as well as varieties significantly influenced the nitrogen uptake of pigeonpea at harvest stage. During the cropping period of kharif 2015, the highest nitrogen uptake of 155.82 kg ha^{-1} was significantly observed under drip fertigation with 125 per cent RDF through WSF + Azophosmet and foliar spray of 1% PPFM. This was followed by drip fertigation with 100 per cent RDF through WSF + Azophosmet and foliar spray of 1% PPFM (139.72 kg ha^{-1}) and it was on par with fertigation of 100 per cent RDF through WSF alone through drip fertigation system (131.21 kg ha^{-1}). The surface irrigated pigeonpea with 100 per cent RDF as soil application of conventional fertilizers recorded the lowest nitrogen uptake of 87.22 kg ha^{-1}.

There was difference in N uptake due to different varieties. Among the varieties, Co(Rg)7 significantly recorded higher nitrogen uptake of 154.17 kg ha^{-1} at harvest stage. This was followed by the variety APK1 with the nitrogen uptake of 121.06 kg ha^{-1} and VBN3 recorded the lowest N uptake of 102.17 kg ha^{-1}. Higher uptake of nutrients as a result of increased dry matter production, which favored depletion of soil available plant nutrients under drip fertigation treatments. This was in conformity with the findings of Hebbar *et al*., 2004 [3]. The availability of N, P and K nutrient was higher in root zone area of drip feritgated plot which in turn increase the uptake of nutrients [4]. Similar findings of higher nutrient uptake with drip fertigation over soil application of nutrients were also reported in hybrid cotton by Veeraputhiran (2000) [5].

The interaction effect between fertigation levels and varieties on nitrogen uptake was found to be significant. At harvest stage, irrespective of different varieties, drip fertigation with 125% RDF through WSF + Azophosmet and foliar spray of 1% PPFM significantly recorded higher nitrogen uptake, which was followed by drip fertigation with 100% RDF through WSF + Azophosmet and foliar spray of 1% PPFM. Among the treatments, highest N uptake of 187.32 kg ha^{-1} was noticed by the variety Co (Rg)7 with drip fertigation of 125% RDF through WSF + Azophosmet and 1% PPFM foliar spray. The increased uptake may also be due to split application of N under drip fertigation that resulted in the reduction in loss of nutrients thereby making them available continuously to the crop. Similar findings of higher uptake with drip fertigation over soil application of nutrients were also reported in hybrid cotton by Veeraputhiran (2000) [5] and Selvakumar (2006) [6] in Chilli. Inclusion of biofertilizers in the nutrient management programme has found to increase the yield of crops by 5-10%, besides increasing the nutrient use efficiency. Supply of water at shorter intervals and N and K supply through drip irrigation created a favorable condition rendering more nutrients available in the soil. Increasing the soil nutrient availability with drip fertigation as compared with soil application was reported by Malik *et al*., 1994 [7].

Phosphorus uptake

Different drip fertigation levels as well as varieties significantly influenced the phosphorus uptake of pigeonpea at harvest stage. During the cropping period of kharif 2015, the highest phosphorus uptake of 14.22 kg ha^{-1} was significantly observed under drip fertigation with 125% RDF through WSF + Azophosmet and foliar spray of 1% PPFM. This was followed by drip fertigation with 100 per cent RDF through WSF + Azophosmet and foliar spray of 1% PPFM (12.75 kg ha^{-1}) and it was on par with fertigation of 100% RDF through WSF alone through drip fertigation system (12.01 kg ha^{-1}). The surface irrigated pigeonpea with 100% RDF as soil application of conventional fertilizers

recorded the lowest phosphorus uptake of 7.93 kg ha^{-1} by Krishnasamy *et al*. 2012 [8] reported that due to excess irrigation in surface irrigation methods, fertilizer nutrients might have been leached beyond the root zone.

Table 1 Effect of Drip fertigation levels on nutrient uptake (kg ha^{-1}) of Pigeonpea varieties during kharif 2015 at harvest stage

Treatments	N uptake	P uptake	K uptake
Varieties			
V1 – Co (Rg)7	154.17	14.23	88.99
V2 – APK 1	121.06	11.36	72.46
V3 – VBN 3	102.17	9.06	61.29
SEd	3.19	0.33	2.37
CD (0.05)	8.86	0.91	6.57
Fertilizer level			
F1-100% RDF with CF under surface irrigation	87.22	7.93	51.32
F2-100% RDF with WSF under drip fertigation	131.21	12.01	77.77
F3-75% RDF with WSF under drip fertigation + Azophosmet + 1% PPFM	115.03	10.84	68.01
F4-100% RDF with WSF under drip fertigation + Azophosmet + 1% PPFM	139.72	12.75	82.53
F5-125% RDF with WSF under drip fertigation + Azophosmet + 1% PPFM	155.82	14.22	91.62
SEd	4.02	0.35	2.19
CD (0.05)	9.27	0.80	5.06
Interaction			
SEd	3.39	0.33	2.13
CD (0.05)	7.20	0.71	4.52

There was difference in phosphorus uptake due to different varieties. Among the varieties, highest phosphorus uptake of 14.23 kg ha^{-1} was significantly recorded at harvest stage by the variety Co (Rg)7, which was followed by the variety APK 1 with the phosphorus uptake of 11.36 kg ha^{-1}. The variety VBN 3 recorded the lowest phosphorus uptake of 9.06 kg ha^{-1} among the varieties.

The interaction effect between fertigation levels and varieties on phosphorus uptake was also found to be significant. At harvest stage, irrespective of different varieties, drip fertigation with 125% RDF through WSF + Azophosmet and foliar spray of 1% PPFM significantly recorded higher phosphorus uptake, which was followed by drip fertigation with 100 per cent RDF through WSF + Azophosmet and foliar spray of 1% PPFM. Among the treatments, highest phosphorus uptake of 17.04 kg ha^{-1} was noticed with the variety Co (Rg)7 with drip fertigation of 125% RDF through WSF + Azophosmet and foliar spray of 1% PPFM. A continuous supply of water and nutrients in the active root zone might have favoured the availability and uptake of nutrients [9].

Potassium uptake

Different drip fertigation levels as well as varieties significantly influenced the potassium uptake of pigeonpea at harvest stage. The highest potassium uptake of 91.62 kg ha^{-1} was significantly observed under drip fertigation with 125% RDF through WSF + Azophosmet and foliar spray of 1% PPFM. This was followed by drip fertigation with 100 per cent RDF through WSF + Azophosmet and foliar spray of 1% PPFM (82.53 kg ha^{-1}) and was on par with fertigation of 100 per cent RDF through WSF alone through drip fertigation system (77.77 kg ha^{-1}). The surface irrigated pigeonpea with soil application of conventional fertilizers at 100 per cent RDF recorded the lowest potassium uptake of 51.32 kg ha^{-1}.

There potassium uptake due to different varieties was also significantly varied. Among the varieties, Co (Rg)7 significantly registered higher potassium uptake of 88.99 kg ha^{-1} at harvest stage. This was followed by the variety APK 1 with the potassium uptake of 72.46 kg ha^{-1} and VBN 3 recorded the lowest potassium uptake of 61.29 kg ha^{-1}.

The interaction effect due to fertigation levels and varieties on potassium uptake was found to be significantly varied. At harvest stage, irrespective of different varieties, drip fertigation with 125% RDF through WSF + Azophosmet and foliar spray of 1% PPFM significantly recorded higher potassium uptake, which was followed by drip fertigation with 100 per cent RDF through WSF + Azophosmet and foliar spray of 1% PPFM. Among the treatments, the variety Co (Rg) 7 with drip fertigation at 125% RDF through WSF + Azophosmet and foliar spray of 1% PPFM significantly recorded highest potassium uptake of 107.74 kg ha^{-1}

Application of nitrogen and potassium nutrients not only stimulated vegetative growth and capacity of the roots, but also encouraged the absorption and translocation of more nutrients which have led to increased uptake of these nutrients under higher drip fertigation levels. Comparing the methods of N application, drip fertigation increased the nutrient uptake substantially, than band application [10].

Yield characters

Application of varying levels of fertilizer as fertigation in combination with biofertigation of Azophosmet and foliar spray of PPFM positively influenced the seed yield of pigeonpea (Table 2). Drip fertigation with 125% RDF through WSF + Azophosmet and foliar spray of 1% PPFM significantly recorded the highest seed yield of 1642 kg ha^{-1}, and drip fertigation of 100 per cent RDF through WSF + Azophosmet and foliar spray of 1% PPFM produced comparable yield (1479 kg ha^{-1}) and were superior over the rest of the treatments. Soil application of recommended NPK under surface irrigation method produced lesser seed yields (942 kg ha^{-1}).

Table 2 Effect of Drip fertigation levels on Seed yield and Stalk yield of Pigeonpea varieties during *kharif* 2015

Treatments	**Grain yield (kg ha^{-1})**	**Stalk yield (kg ha^{-1})**
Varieties		
V1 – Co(Rg)7	1650	3806
V2 – APK 1	1301	3049
V3 – VBN 3	1076	2539
SEd	41	69
CD (0.05)	116	191
Fertilizer level		
F1 -100% RDF with CF under surface irrigation	942	2240
F2 -100% RDF with WSF under drip fertigation	1414	3309
F3 -75% RDF with WSF under drip fertigation + Azophosmet + 1% PPFM	1235	2916
F4 -100% RDF with WSF under drip fertigation + Azophosmet + 1% PPFM	1479	3434
F5 -125% RDF with WSF under drip fertigation + Azophosmet + 1% PPFM	1642	3758
SEd	31	59
CD (0.05)	71	136
Interaction		
SEd	52	83
CD (0.05)	110	176

Figure 1 Pigeonpea at drip fertigation field

Among the varieties and drip fertigation levels, the variety Co(Rg)7 with drip fertigation at 125 per cent RDF through WSF + Azophosmet and foliar spray of 1% PPFM registered the highest grain yield of 1650 kg ha^{-1} which

was 54 per cent increase over surface irrigation method with RDF through conventional fertilizer application (942 kg ha^{-1}).

Table 3 Effect of Drip fertigation levels on N, P and K uptake (kg ha^{-1}) of Pigeonpea varieties at harvest stage during kharif 2015

Treatments	N uptake				P uptake				K uptake			
	V1	V2	V3	Mean	V1	V2	V3	Mean	V1	V2	V3	Mean
F1	106.23	81.91	73.54	87.22	9.57	7.74	6.46	7.93	60.99	49.08	43.90	51.32
F2	159.87	129.89	103.87	131.21	14.70	12.04	9.31	12.01	92.85	77.73	62.72	77.77
F3	144.89	108.88	91.34	115.03	14.21	10.26	8.06	10.84	83.74	65.41	54.87	68.01
F4	172.57	135.62	110.98	139.72	15.63	12.78	9.84	12.75	99.63	81.37	66.59	82.53
F5	187.32	149.00	131.14	155.82	17.04	13.99	11.64	14.22	107.74	88.72	78.39	91.62
Mean	154.17	121.06	102.17	--	14.23	11.36	9.06	--	88.99	72.46	61.29	--
	V	F	F×V	V×F	V	F	F×V	V×F	V	F	F×V	V×F
SEd	3.19	4.02	3.40	4.41	0.33	0.35	0.33	0.44	2.37	2.19	2.13	3.04
CD (0.05)	8.86	9.27	7.20	10.86	0.91	0.80	0.71	1.10	6.57	5.06	4.52	7.66

Main plot	Subplot
V1 – Co (Rg)7	F1 - 100% RDF with CF under surface irrigation
V2 – APK 1	F2 - 100% RDF with WSF under drip fertigation
V3 – VBN 3	F3 - 75% RDF with WSF under drip fertigation + Azophosmet + 1% PPFM
	F4 - 100% RDF with WSF under drip fertigation + Azophosmet + 1% PPFM
	F5 - 125% RDF with WSF under drip fertigation + Azophosmet + 1% PPFM

Table 4 Effect of Drip fertigation levels on Seed and Stalk yield (kg ha^{-1}) of Pigeonpea varieties during *kharif* - 2015

Treatments	Seed yield				Stalk yield			
	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
F_1	1145	898	783	942	2702	2137	1880	2240
F_2	1731	1399	1111	1414	4016	3288	2623	3309
F_3	1556	1184	966	1235	3641	2797	2310	2916
F_4	1827	1451	1158	1479	4203	3379	2720	3434
F_5	1992	1574	1360	1642	4469	3643	3163	3758
Mean	1650	1301	1076	--	3806	3049	2539	--
	V	F	FxV	VxF	V	F	FxV	VxF
SEd	41	31	52	62	69	59	83	101
CD (0.05)	116	71	110	151	191	136	176	246

Main plot	Subplot
V1 – Co (Rg)7	F1-100% RDF with CF under surface irrigation
V2 – APK 1	F2-100% RDF with WSF under drip fertigation
V3 – VBN 3	F3-75% RDF with WSF under drip fertigation + Azophosmet + 1% PPFM
	F4-100% RDF with WSF under drip fertigation + Azophosmet + 1% PPFM
	F5-125% RDF with WSF under drip fertigation + Azophosmet + 1% PPFM

Conclusion

Drip fertigation is an efficient and effective method of applying precise amounts of irrigation water and fertilizer nutrients for higher pigeonpea production. On the basis of results obtained in present investigation, it is concluded that application of 125% RDF through WSF + Azophosmet under drip irrigation and foliar spray of 1% PPFM with variety of Co(Rg)7 can be recommended for higher yield and nutrient uptake of Pigeonpea.

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