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Effect of Drip Fertigation on Growth, Yield and Economics of Pigeonpea

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ABSTRACT

A field investigation entitled "Response of pigeonpea to different drip fertigation levels" was carried out at Department of Agronomy Farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the kharif season of 2016-17. The experiment was laid out in Randomised Block Design with four replications and eight different irrigation and fertigation treatments imposed for pigeonpea crop with an objective to study the efficacy of split application of N,P and K on growth, yield and economics of Pigeonpea. The experimental site was established with inline drip irrigation system (16 mm) lateral laid out at 90 cm with 30 cm dripper spacing. Irrigation water was applied through drip irrigation system on every alternate day at the rate of 100 per cent crop evapotranspiration level. Experiment results revealed that, in pigeonpea all the growth parameters viz. plant height, number of branches plant^{-1}, root nodules plant^{-1}, dry matter accumulation plant^{-1}, yield attributes viz. Pod plant^{-1} and seed yield were substantially enhanced by drip fertigation levels at 125:100:100 per cent recommended NPK than lower fertigation levels (75 and 100 %), drip irrigation with 100 per cent recommended NPK and over conventional soil application in furrow with 100 per cent RDNPK kg ha^{-1}. As a consequence of better growth and yield attributes, drip fertigation at 125:100:100 per cent recommended dose of NPK ha^{-1} had recorded higher pigeon-pea seed yield of 3866 kg ha^{-1}.The GMR, NMR and B:C ratio was found maximum with 125:100:100 per cent RDNPK treatment. Drip fertigation as well as soil application of fertilizer had no significant impact on seed index, protein content and all the quality parameters of pigeonpea. It could be concluded that application of 125:100:100 per cent recommended dose of N,P and K in five splits found to be best for maximizing the yield and beneficial in increasing the productivity and economic returns of pigeonpea.

Key words: *Drip, Pigeonpea, Fertigation, NPK, Economics*

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is a pulse crop belongs to the family leguminoceae (Fabaceae) and it is a multipurpose legume with a long tradition of cultivation over a three thousand years.

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It is the most widely grown cropin the country in tropic and sub tropics region and has been considered as a second most important pulse crop after chickpea. India has virtual monopoly in pigeonpea production accounting to 90% of world's total production. In India alone, pigeonpea are grown in about 3.90 million hectares, with a production of 3.17 million ton, however the average productivity is only 813kg ha^{-1}. More than 85% area of pigeon pea is under rainfed condition. The demand for pulses is increasing due toincreasing population. To meet the demand pigeonpea productivity has to be increased. Improper irrigation and nutrient management are the main reason of low productivity of pigeonpea in Maharashtra.

Increasing demand for irrigation water coupled with depleting ground water sources calls for efficient use of water. Therefore, there is need for efficient irrigation methods to these crops. The present scenario of flood irrigation should give away to controlled irrigation, such as drip irrigation which offers enormous use for economy of irrigation water and fertilizer chemicals. In conventional method, there is a heavy loss of nutrients due to leaching, denitrification, evaporation and fixation in the soil. Drip irrigation and fertigation are technologies which improve both water and fertilizer use efficiency to a great extent. Fertigation gives flexibility of fertilizer application, which enables the specific nutritional requirement of the crop to be met at different stages of its growth. Split application of fertilizers ensures required nutrients in right time and in right quantity for getting higher yield with minimum loss of nutrients. Nitrogen, phosphorus and potassium fertilizers are water soluble and play a major role in the growth and development of pigeonpea crops. Drip irrigation and fertigation are technologies which improve both water and fertilizer use efficiency to a great extent. In general, injection of fertilizers into irrigation water gives a better crop response than either band or broadcasting. Drip irrigation and fertigation will help to increase area under pigeonpea cultivation under water scarcity condition which will help to increase the branches/plant, nodule/plant, pods/plant which will ultimately increases the yield. In this respect fertigation proposed as a means to increase efficient use of water and fertilizer to increase yield, protect environment and sustained irrigated agriculture. Hence,the present study was initiated to study the influence of split application of nutrients on growth, yield and economics of pigeonpea under drip fertigation.

MATERIALS AND METHODS

The field experiment was carried out at Agronomy Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the *kharif* seasons of 2016. The topography of the field was fairly uniform and level. The soil was medium black cotton belonging to Vertisols. The experiment was laid out in randomised block design with four replications and eight different fertigation treatments imposed for pigeonpea crop i.e. 100 per cent RDNPK through soil application with furrow irrigation (T_1), drip irrigation with 100 per cent RDNPK through soil application(T_2), drip fertigation with 125:75:75 per cent RDNPK in five splits (T_3), drip fertigation with 100:75:75 per cent RDNPK in five splits (T_4), drip fertigation with 75 per cent RDNPK in five splits (T_5), drip fertigation with125:100:100 per cent RDNPK in five splits (T_6), drip fertigation with 100 per cent RDNPK in five splits (T_7), drip fertigation with 75:100:100 per cent RDNPK in five splits (T_8). The experiment site was established with inline drip irrigation system (16 mm) lateral laid out at 90 cm with 30 cm dripper spacing. Irrigation water was applied through drip irrigation system on every alternate day at the rate of 100 per cent crop evapotranspiration level.The irrigation water to be applied per plant was determined by the following formula.

$V\ (lpd) = (ETo \times Kc \times A \times Wp) - (RE \times A)$

Where,

V - Volume of water applied (litre/day/plant)

ETo - Reference evapotranspiration (mm/day)

Kc - Crop factor

A - Area under crop (m^2)

(Plant to plant spacing) × (Row to row spacing)

Wp – Wetted area fraction

RE – Effective rainfall in mm

The net depth of water to be applied in drip irrigation of alternate day was determined by the following formula.

$D= (ETo\times Kc)-RE$

Where,

D -Net depth of water to be required (mm)

ETO - Reference evapotranspiration (mm/day)

RE - Effective rainfall (mm)

The sources of nutrients were urea (46% N), single super phosphate (16% P_2O_5), phosphoric acid and murate of potash (60% K_2O) for nitrogen, phosphorus and potash, respectively. The fertilizer was applied as per the treatments. Full dose of the nitrogen, phosphorus (through SSP) and potassium were applied to the treatments T_1 and T_2 through soil application at the time of sowing by the conventional method. Remaining treatments (T_2,T_3,T_4,T_5,T_6,T_7,T_8) were applied with N,P(through phosphoric acid) and K in fertigation treatments in five unequal splits as per the growth stages of pigeonpea. The fertilizer tank of 90 litre capacity was used to apply chemical fertilizer through the irrigation water The variety of Pigeonpea PKV-TARA was sown on 11th June 2016 with recommended dose of fertilizers 25:50:30 kg NPK ha^{-1}.

RESULTS AND DISCUSSION

Growth parameters of Pigeonpea

The data presented in Table 1 revealed that plant height, number of branches, number of root nodules at 60 DAS, dry matter weight per plant was significantly influenced by different treatments. The highest value for all these characters were obtained under application of 125% N and 100% P & K through drip irrigation, closely followed by 100% NPK through drip irrigation and 75%N and 100% P & K, however lowest value for all the growth attributing characters were observed in furrow irrigation with conventional method of fertilizer application (T_1) and 100% NPK as basal with drip irrigation (T_2). The treatment drip fertigation with 125% N + 100% P+ 100% K in five splits was found at par with 100% NPK ha^{-1} in respect all the growth characters. The favourable increase in growth attributes in terms of plant height due to drip fertigation was earlier reported by Goud and Kale[3].

Increase in the levels of N, P and K through fertigation increases the plant height, number of branches, dry matter weight per plant and root nodulesper at 60 DAS which might be due to enhanced availability and uptake of nutrients leading to enhanced photosynthesis, expansion of leaves and translocation of nutrients to the reproductive parts as compared to soil application method. Higher number of branches per plant in fertigation of N, P and K splits might be due to higher uptake of nutrients and further vegetative growth of the pigeonpea plant. Singh and Yadav[16] and Manikandan *et al.*[4] have reported the beneficial effect of higher level of N, P and K fertigation on branches in pigeonpea which indicated that pigeonpea required more nutrients for enhancing the yield attributes.

Table1: Influence of different fertigation treatments on growth and ancillary characters of pigeonpea

Treatments	Plant Height (cm)	No. of branches per plant	Root nodules per plant at 60 DAS	DMW Per plant at harvest (g)
T_1 :FI with 100 % RDF Soil application	214	31.80	7.95	293.25
T_2:DI with 100 % RDF Soil application	225	37.70	9.75	331.94
T_3 :DF with 125% N + 75% P+75% K in five splits	234	42.21	12.05	368.55
T_4:DF with 100% N + 75% P+75% K in five splits	232	41.52	12.50	357.90
T_5:DF with 75% N + 75% P+75% K in five splits	229	40.02	13.68	351.58
T_6 :DF with 125% N + 100% P+ 100% K in five splits	241	48.32	17.20	585.88
T_7:DF with 100% N + 100% P+ 100% K in five splits	238	47.75	16.13	558.46
T_8:DF with 75% N + 100% P+ 100% K in five splits	235	45.42	16.00	511.38
S.E.m+	1.85	1.31	0.61	10.74
CD at 5%	5.45	3.84	1.78	31.58

FI: Furrow Irrigation DI: Drip Irrigation DF: Drip Fertigation Yield and yield attributes

The number of pod per plant and grain weight per plant was significantly influenced due to split application of RDNPK through different levels of fertigation treatments. Application of higher level of fertigation i.e. 125:100:100 per cent RDNPK in five splits recorded maximum number of pod plant (282) and grain weight per plant (107 g) and established its significance over furrow irrigation with 100 per cent recommended dose of N,P and K, drip irrigation with 100 per cent recommended dose of N,P and K through soil application, drip fertigation with 75 per cent recommended dose of N,P and K in five splits, drip fertigation with 125:100:75 per cent recommended dose of N,P and K in five splits, drip fertigation with 100:75:75 per cent recommended dose of N,P and K in five splits and drip fertigation with 75:100:100 per cent RDNPK in five splits but at par with drip fertigation with 100 per cent RDNPK in five splits.

The substantial increase in number of pod per plant and grain weight per plant due to higher levels of fertigation than lower level and conventional fertilizer application method was associated with the improvement in various growth attributes viz. plant height, number of branches, functional leaves, leaf area, dry matter accumulation per plantand its subsequent translocations to sink. The cumulative effect of these finally improved the number of pod per plant and grain weight per plant, because the ability of pigeonpea crop to produce and support more number of pods depends on dry matter accumulation and its translocation to sink. The increase in more number of pod per plant and grain weight per plant under higher level of fertigation might be due to enhanced availability and uptake of nutrients to enhance photosynthesis, expansion of leaves and translocation of nutrients to reproductive parts as compared to lower rate of N, P and K given through fertigation and over conventional soil application of fertilizers. Similar advantage of higher level of fertigation of nutrients in improving the number of pod per plant and grain weight per plant were reported earlier by Avinash Kumar and Kushwaha[1], and Manikandan & Sivasubramaniam[5].

Maximum pigeonpea grain yield (3866Kgha^{-1}) was recorded where 125% N + 100% P+ 100% K was applied in five splits through drip irrigation and was found significantly superior over all other treatments except treatment drip fertigation with 100% N + 100% P+ 100% K in five splits (3704 Kg) and drip fertigation with 75% N + 100% P+ 100% K in five splits (3506 Kg) which was found at par with each other in respect of grain yield. Differences between treatment 100 % RDF through soil application and DF with 75% N + 75% P+75% K in five splits treatments were not significant but both the treatments were significantly superior to 100 per cent dose of N,P& K given in furrow irrigation. There was 55.32% increase in yield

in treatment where higher level of fertigation (125:100:100 NPK ha^{-1}) than conventional method of irrigation with soil application of fertilizers. This indicates drip fertigation with 125% N + 100% P+ 100% K in five splits shows 25 percent saving in fertilizer when applied through irrigation water compared to conventional soil application in drip irrigation. Lowest grain and straw yield was observed in furrow irrigation with conventional application of fertilizers. Decreasing level of P and K fertigation from 100% to 75% resulted in significant decrease in grain yield.

Increased nutrient availability and absorption by the crop at the optimum moisture supply coupled with frequent and higher nutrient supply by fertigation and consequent better formation and translocation of assimilates from source to sink might have increased seed yield under fertigation. The results are in conformity with the findings of Praharaj and Kumar[6], Vimalendran and Latha[18], Chandra Sekhar[2], Praharaj *et al*.[11], Vimalendran and Latha[17].

The harvest index was significantly influenced due to fertigation over conventional method of fertilizer application. Maximum harvest index was recorded in all the fertigation treatments compared to conventional method of fertilizer application in both furrow and drip irrigation. Highest harvest index of 35.04 was obtained in treatment drip fertigation with 100% N + 75% P+75% K in five splits followed by treatment where 125% N + 100% P+ 100% K was applied in five splits through drip irrigation was given. The lowest HI was observed in treatment of furrow irrigation with conventional soil application. The results are in conformity with the results of Singh and Singh[15] and P. Chandrashekhar[2] who reported that harvest index increased with increase in the level of fertigation indicating efficient utilization of the biomass for conservation in seed yield. The non significant differences were observed in respect of test weight of pigeonpea.

Economics studies

In the pigeon pea maximum GMR of ₹ 206172/-ha^{-1} and NMR ₹ 155633/-$ha^{-1}$was obtained with the application of fertigation with 125 per cent recommended dose of N and 100 per cent of P & K in five splits followed by treatment100 percent NPK fertilizer through fertigation. Similarly highest B: C ratio (4.08 followed by 3.92) was registered in the same treatments. The values of GMR (₹ 93149/-$ha^{-1}$and NMR (₹ 62586/-ha^{-1} and B:C ratio (3.05) were lowest in furrow irrigation with conventional soil application of fertilizer.Similar results were reported by Singh *et al*.[15], Praharaj and Kumar[6]; Praharaj *et al*[7].

Table 2: Grain and Straw Yield, Test Weight and Harvest Index as influenced by different fertigation treatments

Treatments	No.of pods per plant	Grain weight per plant (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	HI (%)	Test weight (g)
T_1 :FI with 100 % RDF Soil application	145	52.0	1727	4425	28.07	9.33
T_2:DI with 100 % RDF Soil application	179	67.8	2607	5408	30.80	9.87
T_3 :DF with 125% N + 75% P+75% K in five splits	235	89.5	3214	6149	34.32	9.94
T_4:DF with 100% N + 75% P+75% K in five splits	223	85.3	3060	5674	35.04	9.74
T_5:DF with 75% N + 75% P+75% K in five splits	210	78.3	2804	5647	33.18	9.66
T_6 :DF with 125% N + 100% P+ 100% K in five splits	282	107.0	3866	7288	34.66	9.87
T_7:DF with 100% N + 100% P+ 100% K in five splits	271	102.8	3704	7231	33.87	9.73
T_8:DF with 75% N + 100% P+ 100% K in five splits	257	98.0	3506	6952	33.52	9.82
S.E.m±	5.91	3.38	147	247	--	0.91
CD at 5%	17.38	10.2	432	728	--	NS
CV %	6.25	8.26	9.67	8.20	--	3.93

Table 4: GMR, NMR and B:C ratio as influenced by different fertigation treatments

Treatments	GMR Rs/ha	COC Rs/ha	NMR Rs/ha	B:C Ratio
T_1 :FI with 100 % RDF Soil application	93851	29267	63882	3.20
T_2:DI with 100 % RDF Soil application	139928	42974	86698	3.25
T_3 :DF with 125% N + 75% P+75% K in five splits	171521	45760	124761	3.66
T_4:DF with 100% N + 75% P+75% K in five splits	163077	46376	116701	3.51
T_5:DF with 75% N + 75% P+75% K in five splits	150084	45786	104298	3.27
T_6 :DF with 125% N + 100% P+ 100% K in five splits	206172	50234	155938	4.10
T_7:DF with 100% N + 100% P+ 100% K in five splits	197877	49632	148045	3.97
T_8:DF with 75% N + 100% P+ 100% K in five splits	187470	49360	138110	3.79
S.E.m+	7658	--	7658	--
CD at 5%	22524	--	22523	--

CONCLUSIONS

It could be concluded from the study that Drip fertigation with 125% N and 100% P & K in five splitsfound to be best treatment for improving growth attributes, maximizing the yield and beneficial in increasing the productivity and economic returns of Pigeonpea.

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