

Original Research Article

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Impact of Drip Irrigation Levels on Pigeon Pea Based Intercropping Systems with Pulses in Malaprabha Command Area

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ABSTRACT

A field experiment was conducted to study the “Drip irrigation levels on pigeon pea based intercropping systems with pulses in Malaprabha command area” under a *vertisol* at the Irrigation Water Management Research Centre, Belvatagi Dharwad during *kharif*2017. The experiment was laid out under strip plot design with three replications, comprising treatments of two drip irrigations levels (70 % and 50 % PE) and three intercropping systems *viz.*, pigeon pea + green gram (1:3) and black gram (1:3) and sole pigeon pea along with rainfed sole pigeon pea (control). Drip irrigation provided at 70 per cent PE recorded higher pigeon pea seed yield (2,010 kg ha⁻¹) compared to at 50 per cent PE (1,997 kg ha⁻¹). Among the intercropping systems, sole pigeon pea under drip recorded higher seed yield (2,126 kg ha⁻¹) followed by pigeon pea intercropped with blackgram or greengram at 1:3 row ratio (1,986 and 1,898kg ha⁻¹, respectively). Interaction effect of drip irrigation at 70 per cent PE with sole pigeon pea recorded higher seed yield (2,198 kg ha⁻¹) followed by drip irrigation at 50 per cent PE with sole pigeon pea (2,053 kg ha⁻¹) and pigeonpea intercropped with blackgram at 1:3 rowratio (2,047kg ha⁻¹). Rainfed sole pigeon pea recorded lower seed yield (1,613 kg ha⁻¹). Irrespective of drip irrigation level of 50 or 70 per cent PE, pigeonpea + blackgram or greengram at 1:3 row intercropping system recorded significantly higher pigeon pea seed equivalent yield (3,412 and 3,421 kg ha⁻¹, respectively). Higher water use efficiency was recorded under drip irrigation provided at 50 percent PE in pigeonpea intercropped with greengram (1:3) (5.48kg ha⁻¹-mm) and lower was with rainfed sole pigeonpea (3.06kg ha⁻¹ -mm).

Keywords

Pigeon pea, Intercropping, Green gram, Black gram, Drip irrigation, Yield and water use efficiency

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Introduction

Land for agriculture activities is decreasing day by day as it is being put to non-agricultural purposes. It is rather inevitable to accommodate production through existing crops or cropping systems. Time and space utilization in agriculture through intercropping systems is one of the options

available for increasing production (Sankaran and Rangasamy, 1990).

Pulses are one of the basic ingredients in Indian diet and excellent feed and fodder for livestock. Pulses are endowed with the unique ability of biological nitrogen fixation, carbon sequestration, soil amelioration, low water requirement and capacity to withstand harsh

climate. Pulses have remained an integral component of sustainable crop production systems since time immemorial, especially in the dry areas. They also offer good scope for the crop diversification and intensification. Though pulses are protein rich crops, they are still being cultivated in more than 78 per cent of the energy starved rainfed condition.

Pigeonpea (*Cajanus cajan* L. Millsp.) is one of the important and protein rich seed legumes of semi-arid tropics grown throughout the tropical and subtropical regions of the world. In India, it is being grown on an area of 5.33mha with a production of 4.18mt and productivity of 913kg per ha (Anon., 2017). Only 4.5 percent of pigeonpea area is irrigated. The productivity can be improved by adopting suitable agro-techniques such as using early maturity high yielding varieties coupled with scientific irrigation management including micro irrigation.

Greengram (*Vigna radiate* L.) is also one of the important pulse crops in India. It is grown on an area of 4.32 m ha with a production of 1.95 m t and productivity of 500 kg per ha (Anon., 2017). Black gram (*Vigna mungo* L.) is another important pulse grown in India. It is cultivated on an area of 4.47 m ha with a production of 3.28 m t and productivity of 632 kg per ha (Anon., 2017). These are short duration crops with lower water requirement and soil fertility. Being short duration crops, they also fit well in various multiple and intercropping systems.

In Malaprabha command areas, maize-chickpea is the common sequence cropping system followed under delayed release of canal water during August end or first fortnight of September resulting in delayed sowing of *rabi* crops leading to lower yields. With early receipt of rains during *kharif*, the pulses *viz.*, greengram, blackgram and pigeonpea are sown. But due to long

dryspells, crops suffer from moisture stress resulting in poor yields. Hence, to overcome these problems, less water requiring pulses *viz.*, green gram and black gram can be intercropped with pigeon pea under drip irrigation to utilize the stored water from farm ponds etc., more economically which is the better option during *kharif* in this command area. Not much research work on these aspects has been carried out on pigeonpea based cropping systems under drip irrigation especially in Northern Karnataka. Keeping these points in view, the present investigation was planned.

Materials and Methods

A field experiment entitled “Drip irrigation levels on pigeon pea based intercropping systems with pulses in Malaprabha command area” was conducted during *kharif* 2017-18 at Irrigation Water Management Research Centre (IWMRC), Belvatagi, Navalagund, Karnataka. The experiment was laid out under strip plot design with three replications, comprising treatments of two drip irrigations levels (70 % and 50 % PE) and three intercropping systems *viz.*, pigeon pea + green gram (1:3) and black gram (1:3) and sole pigeon pea along with rainfed sole pigeon pea (control). The soil of the experiment plot was *vertisol* (Blacksoil). The dripperline (laterals) were spaced at 60cm distance in intercropping system and in sole pigeonpea spaced at 120cm distance and inner line drippers were spaced at the distance of 40 cm with 4 liter discharge per hour. The seed rate of pigeon pea, green gram and black gram used was 12.00, 8.25 and 9.90 kg per ha, respectively and sown as per the treatments. The sowing was carried out on 10th June, 2017 and recommended fertilizers were applied at the time of sowing 5 cm deep and 5 cm away from the seed line and covered with soil. All cultural practices were adapted as per recommendation. Irrigation was provided on the basis of Pan Evaporation (PE) at 7 days

interval. The rainfall received during the cropping period of green gram was 49.2 mm, black gram was 74.4 mm and pigeonpea was 527.6 mm at different phenological stages. The crops are harvested at physiological maturity. The experimental data were statistically analyzed using MSTAT-C programme (for pigeon pea) and the level of significance used was $P = 0.05$. Intercrop data were analyzed using 't' test with level of significance at 5 per cent.

Results and Discussion

Growth and yield of intercrops

Drip irrigation provided at 70 or 50 percent PE did not influence significantly the growth and yield in intercropped legumes (Table 1). However, numerically higher pods per plant and seed yield per plant were recorded with drip irrigation scheduled at 70 percent PE to greengram (17.3 and 11.8 g plant⁻¹, respectively) and to black gram (32.1 and 11.5 g plant⁻¹, respectively). Green gram and black gram recorded numerically higher seed yield when drip irrigation was provided at 70 percent PE (1,474 and 1,411 kg ha⁻¹, respectively) compared to drip irrigation given at 50 percent PE (1,440 and 1,374 kg ha⁻¹, respectively). It is due to fact that both the crops were of short duration and their requirement of water is less for the growth. Moisture variation was not much in rhizosphere of the crops and also it may be due to the 49.2 and 74.4 mm of rainfall received during growing period of green gram and black gram, respectively, so the effect of drip irrigation was nullified. These results were in conformity with Parmar and Thanki (2007).

Effect of drip irrigation levels on growth and yield of pigeon pea

Growth and yield parameters of pigeon pea did not differ significantly due to drip irrigation levels (Table 2). However, ranges

were viz., for plant height (233.8 to 232.2cm), total drymatter production (277.5 to 271.4 g plant⁻¹), number of pods per plant (166.7 to 165.2), seed yield (52.8 to 51.9 g plant⁻¹) and seed yield (2,010 to 1,997 kg ha⁻¹). Pigeon pea equivalent yield ranged from 2,982 to 2,933 kg ha⁻¹. Non significant differences with respect to growth and yield of pigeon pea due to the level of drip irrigation. May be due to fact that at grand growth period of pigeon pea, higher rainfall was received and higher moisture content was present in rhizosphere so that the effect of drip irrigation was not observed at 70 and 50 per cent PE. Similar results were recorded by Solanki *et al.*, (2010) and Mahalakshmi *et al.*, (2011).

Effect of intercropping on growth and yield of pigeon pea

Drip irrigation provided at 70 or 50 percent PE did not influence significantly the growth and yield of pigeon pea (Table 2). However, for intercropping, numerically higher seed yield (2,126 kg ha⁻¹) was recorded with sole pigeon pea followed by pigeon pea intercropped with black gram at 1:3 row ratio intercropping system (1,986 kg ha⁻¹). Higher seed yield was due to higher growth and yield attributes viz., plant height (237.8 and 232.7 cm, respectively), total dry matter production (286.3 and 273.2 g plant⁻¹, respectively), number of pods per plant (171.9 and 167.0, respectively) and seed yield (55.4 and 52.7gplant⁻¹, respectively), compared to pigeon pea intercropped with green gram at 1:3 row ratio, where higher competition for resources between main and intercrop resulted in lower yield attributes. These results were in conformity with Rathod *et al.*, (2004) and Rani and Raji (2010). Higher pigeon pea equivalent yield was recorded with pigeonpea + greengram (1:3) (3,394kg ha⁻¹) followed by pigeonpea + blackgram (1:3) (3,370 kg ha⁻¹) and lower was recorded with sole pigeon pea (2,109 kg ha⁻¹). The higher pigeon pea equivalent yield obtained with intercropping

systems was attributed to better performance and yields of both the component crops compared to sole pigeonpea. Similar results were reported by Malik *et al.*, (2013), Pandey *et al.*, (2013) and Singh (2013).

Interaction effect of drip irrigation levels and intercropping on growth and yield of pigeon pea

The Interaction effect between drip irrigation levels and pigeon pea intercropping systems differed significantly with respect to plant height and total dry matter production (Table 2). Significantly higher when drip irrigation was scheduled to sole pigeon pea at 70 percent PE (238.6cm and 289.6g plant⁻¹, respectively) and total dry matter production was on par with drip irrigation scheduled at 50 per cent PE to sole pigeon pea (283.0 g plant⁻¹). The plant height and total dry matter production were significantly higher compared to rainfed sole pigeon pea (191.3 cm and 222.8 g plant⁻¹, respectively).

The Interaction effect between drip irrigation levels and pigeon pea intercropping systems did not differ significantly with respect to pods per plant, seed yield per plant and seed yield per hectare. Numerically, higher pods per plant and seed yield per plant (176.7 and 57.5g plant⁻¹, respectively) was recorded with drip irrigation was scheduled at 70 percent PE compared to rainfed sole pigeonpea (133.3 and 39.3 g plant⁻¹, respectively) and higher seed yield per hectare was recorded with application of irrigation at 70 per cent PE through drip irrigation to sole pigeon pea (2,198 kg ha⁻¹) compared to rainfed sole pigeonpea (1,613kg ha⁻¹). Higher growth and yield parameters might due to the better utilization of available moisture, nutrient and lesser competition for resources leading to higher growth and yield contributing characters *viz.*, plant height, total dry matter production per plant, pods per plant and seed yield per plant. Lower values were recorded

with rainfed sole pigeon pea due to insufficient moisture availability at initial growth stages thereby reducing nutrient uptake which ultimately reflected in the lower number of plant height, total drymatter production, pods per plant and seed yield perplant.

Drip irrigation levels did not influence significantly the pigeon pea equivalent yield (PEY). Among the intercropping systems, pigeonpea intercropped with greengram or blackgram at row ratio of 1:3 recorded higher pigeon pea equivalent yield (3,394 kg ha⁻¹ and 3,370 kg ha⁻¹, respectively) compared to sole pigeon pea (2,109 kg ha⁻¹). Irrespective of drip irrigation levels, intercropping of pigeon pea with green gram or black gram at 1:3 row ratio recorded significantly higher PEY compared to sole pigeon pea and sole rainfed pigeonpea (1,613 kg ha⁻¹). The higher pigeonpea equivalent yield obtained with intercropping systems was attributed to better performance and yields of both the component crops compared to sole pigeon pea. Similar results were reported by Malik *et al.*, (2013) and Pandey *et al.*, (2013).

Water use efficiency of intercrops and intercropping system

The water use efficiency was higher with drip irrigation provided at 50 per cent PE both to green gram and black gram (Table 3) (7.22 and 5.61 kg ha⁻¹-mm, respectively) compared to drip irrigation applied at 70 per cent PE (5.69 and 4.50 kg ha⁻¹-mm, respectively). This was mainly due to the fact that at 50 percent PE, less quantity of irrigation water was provided compared to 70 percent PE, thereby increasing the WUE. Intercropped blackgram recorded lower WUE compared to greengram which was mainly due to lower seed yield and higher crop duration compared to greengram resulting in extra irrigation at the time cropping period.

Table.1 Yield and yield parameters of intercrops as influenced by drip irrigation levels

Intercrop Drip irrigation level	Green gram			Black gram		
	No. of pods plant ⁻¹	Seed yield plant ⁻¹ (g)	Seed yield (kg ha ⁻¹)	No. of pods plant ⁻¹	Seed yield plant ⁻¹ (g)	Seed yield (kg ha ⁻¹)
PE₁ – 70 % PE	17.3	11.8	1474	32.1	11.5	1411
PE₂ – 50 % PE	15.7	10.9	1440	30.0	10.8	1374
Test of significance at 5 %	NS	NS	NS	NS	NS	NS

PE : Pan evaporation

NS : Non significant

Market price (q⁻¹) Pigeon pea (5230), green gram (5375) and black gram (5200).

Table.2 Growth, yield parameters and yield of pigeon pea as influenced by drip irrigation levels and intercropping

Treatment	Plant height (cm)	TDMP at harvest (g plant ⁻¹)	Number of pods plant ⁻¹	Seed yield plant ⁻¹ (g)	Seed yield (kg ha ⁻¹)	PEY (kg ha ⁻¹)
Drip irrigation levels (PE)						
PE1 (70 % pan evaporation)	233.8 ^a	277.3 ^a	166.7 ^a	52.8 ^a	2010 ^a	2982 ^a
PE2 (50 % pan evaporation)	232.2 ^a	271.4 ^a	165.2 ^a	51.9 ^a	1997 ^a	2933 ^a
S.Em.±	1.84	1.70	3.99	1.27	58	122
Intercropping (IC)						
IC1 (Pigeon pea + green gram 1:3)	228.5 ^c	263.5 ^c	158.9 ^a	49.0 ^a	1898 ^a	3394 ^a
IC2 (Pigeon pea + black gram 1:3)	232.7 ^b	273.2 ^b	167.0 ^a	52.7 ^a	1986 ^a	3370 ^a
IC3 (Sole pigeon pea)	237.8 ^a	286.3 ^a	171.9 ^a	55.4 ^a	2126 ^a	2109 ^b
S.Em.±	0.46	2.15	4.60	2.15	72	94
Interaction (PE x IC)						
PE1 IC1	229.5 ^d	265.6 ^{de}	159.1 ^a	49.9 ^a	1906 ^a	3421 ^a
PE1 IC2	233.3 ^c	276.6 ^{bc}	164.1 ^a	51.1 ^a	1925 ^a	3328 ^a
PE1 IC3	238.7 ^a	289.6 ^a	176.7 ^a	57.5 ^a	2198 ^a	2198 ^b
PE2 IC1	227.5 ^e	261.3 ^e	158.6 ^a	48.2 ^a	1891 ^a	3368 ^a
PE2 IC2	232.1 ^c	269.8 ^{cd}	169.9 ^a	54.4 ^a	2047 ^a	3412 ^a
PE2 IC3	236.9 ^b	283.0 ^{ab}	167.1 ^a	53.2 ^a	2053 ^a	2020 ^b
S.Em.±	0.43	1.90	6.25	2.50	78	155
Control						
Rainfed sole pigeon pea	191.3	222.8	133.3	39.3	1613	1613
S.Em.±	1.54	3.32	5.93	2.45	87	150
C.D. (P = 0.05)	4.74	10.2	18.29	7.56	267	463

TDMP – Total dry matter production

Table.3 Water use efficiency of drip irrigation system

Drip irrigation level	Water applied through drip (mm)	Effective rainfall (mm)	Total water applied (mm)	Water use efficiency (kg ha ⁻¹ -mm)
Green gram				
PE ₁ – 70 % PE	210.0	49.2	259.2	5.69
PE ₂ – 50 % PE	150.2	49.2	199.4	7.22
Black gram				
PE ₁ – 70 % PE	239.2	74.4	313.6	4.50
PE ₂ – 50 % PE	170.5	74.4	244.9	5.61
Pigeon pea pulse intercropping system				
Pigeon pea + green gram (1:3) at 70 % PE	210.0	464	674.0	5.08
Pigeon pea + black gram (1:3)at 70 % PE	239.2	464	703.2	4.73
Sole pigeon pea at 70 % PE	239.2	464	703.2	3.13
Pigeon pea + green gram (1:3) at 50 % PE	150.2	464	614.2	5.48
Pigeon pea + black gram (1:3)at 50 % PE	170.5	464	634.5	5.38
Sole pigeon pea at 50 % PE	170.5	464	634.5	3.24
Rainfed sole pigeon pea (Control)	000.0	527.6	527.6	3.06

PE: Pan evaporation

Higher water use efficiency was recorded with drip irrigation provided at 50 percent PE to pigeon pea intercropped with green gram at 1:3 row ratio (5.48 kg ha⁻¹ -mm) followed by drip irrigation at 50 per cent PE to pigeon pea intercropped with black gram at 1:3 row ratio (5.38 kg ha⁻¹ -mm) and sole pigeon pea (3.24 kg ha⁻¹ -mm). Lower water use efficiency was recorded in rainfed sole pigeon pea (3.06 kg ha⁻¹ -mm). The increased WUE was mainly due to considerable saving of irrigation water, more increase in pigeon pea equivalent yield and higher nutrient use efficiency. These results corroborated with the findings of Ramulu *et al.*, (2006) and Vimalendran and Latha (2016).

It can be concluded that irrespective of drip irrigation levels at 50 or 70 per cent PE, pigeon pea + black gram or green gram at 1:3 row ratio intercropping systems recorded significantly higher pigeon pea equivalent yield (3,412 and 3,421 kg ha⁻¹, respectively).

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