

Original Research Article

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## Effect of Irrigation Levels and Cropping Systems on Quality Parameters and Economics of Pigeonpea

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### ABSTRACT

A field experiment was conducted to study “Effect of irrigation levels and cropping systems on quality parameters and economics of pigeonpea” at Zonal Agricultural Research Station, Kalaburagi, during *khari*f 2018-19. The experiment was laid out in split plot design with three main factors of irrigation levels and four sub factors of cropping systems, replicated thrice revealed that significantly higher nitrogen uptake ( $161.04 \text{ kg ha}^{-1}$ ) phosphorus uptake ( $28.26 \text{ kg ha}^{-1}$ ), potassium uptake ( $85.29 \text{ kg ha}^{-1}$ ), protein yield ( $590.73 \text{ kg ha}^{-1}$ ), grain yield ( $1575 \text{ kg ha}^{-1}$ ) and economics viz., gross returns (Rs. 2,26,245  $\text{ha}^{-1}$ ), net returns (Rs.173435  $\text{ha}^{-1}$ ) and BC ratio (4.29) with 75 % CPE ratio compared to 50 % and 100 % CPE but water use efficiency ( $5.59 \text{ Kg ha}^{-1} \text{ mm}^{-1}$ ) of pigeonpea highest in 50 % CPE compared to 75 % CPE and 100 % CPE. Among the cropping system, sole pigeonpea recorded significantly higher nitrogen uptake ( $176.72 \text{ kg ha}^{-1}$ ), phosphorus uptake ( $33.56 \text{ kg ha}^{-1}$ ), potassium uptake ( $89.70 \text{ kg ha}^{-1}$ ), protein yield ( $635.37 \text{ kg ha}^{-1}$ ), WUE ( $4.66 \text{ Kg ha}^{-1} \text{ mm}^{-1}$ ) and grain yield ( $1732 \text{ kg ha}^{-1}$ ) as compared to intercropped pigeonpea. While, pigeonpea + greengram (1:3) intercropping system recorded significantly higher gross returns (Rs. 252400  $\text{ha}^{-1}$ ), net returns (Rs. 196590  $\text{ha}^{-1}$ ) and BC ratio (4.52) as compared to sole pigeonpea.

#### Keywords

CPE, Irrigation scheduling, Cropping systems, Pigeonpea, WUE

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### Introduction

Pulses are the important sources of proteins, vitamins and minerals and are popularly known as “Poor man’s meat” and “rich man’s vegetable”, as they contribute significantly to the nutritional security of the country. The importance of pulses is much more in country like India, where majority of the people are vegetarian. Unfortunately, the pulse production in the country has not been able to

keep pace with the increasing population. The demand of pulses is increasing at a faster rate to meet the minimum protein requirements of an increasing world population. In India, pigeonpea is cultivated in an area of 4.78 million hectares with production of 4.25 million tones and productivity of 889 kg per hectare (Anon., 2018) and pigeonpea requires about 63.3 kg N, 15.8 kg  $\text{P}_2\text{O}_5$  and 49.8 kg  $\text{K}_2\text{O}$  per hectare to produce 1 tonne of pigeonpea grains (Patil and Padmani, 2007).

Nutrient uptake plays a significant role in deciding the pigeonpea yield and knowing the level of nutrient accumulation in the crop helps in the formulating the efficient fertilization schedule, as most of the applied nutrients are lost through leaching, volatilization, denitrification and chemical fixation soil (Chandrasekhar *et al.*, 2015)

Increasing demand for irrigation water coupled with depleting ground water sources calls for efficient use of water. Therefore, there is a need for efficient irrigation methods like micro irrigation. The present scenario of flood irrigation should be replaced by more efficient and controlled irrigation systems. Therefore, use of modern irrigation systems like drip irrigation provides better crop growth and greater yields, due to efficient use of water and nutrients. Among the various techniques advocated for economizing water use, scheduling of irrigation based on CPE ratio is considered to be the most effective and important. Water allocation and scheduling of irrigation based on the data of the pan evaporation are likely to result not only in better pigeonpea production but also increase water use efficiency.

## Materials and Methods

A field experiment was conducted during the *kharif* 2018-19 at Zonal Agriculture Research Station, Kalaburgi, is situated at North Eastern Dry Zone of Karnataka at a latitude of 17° 34' North, longitude of 76° 79' East and an altitude of 478 meters above mean sea level (MSL). The experiment was laid out in split plot design with three main factors of irrigation levels I<sub>1</sub>: 50 % CPE, I<sub>2</sub>: 75 % CPE and I<sub>3</sub>: 100 % CPE and four sub factors of cropping systems C<sub>1</sub>: Sole pigeon pea, C<sub>2</sub>: Pigeonpea + Greengram, C<sub>3</sub>: Pigeonpea + Blackgram and C<sub>4</sub>: Pigeonpea + Soybean, replicated thrice and Rainfed pigeonpea outside the control. Recommended dose of

fertilizer for pigeonpea (25:50:0 kg N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O) were applied at the time of sowing. Nitrogen, phosphorous and potassium were applied in the form of diammonium phosphate (DAP) and Farm yard manure (FYM) @ 6 t ha<sup>-1</sup> was incorporated into soil two weeks before sowing. Later on water soluble fertilizers were applied through drip irrigation *viz.*, 4 kg of 19:19:19 (N: P: K) and 8.5 kg of MAP (12:61:0) throughout the growing period of crop. The sowing was done on 13<sup>th</sup> June, 2018. The total rainfall received during the cropping season 549.80 mm.

The soil of the experimental site was black clay, slightly alkaline (8.20) with an electrical conductivity of 0.23 dS m<sup>-1</sup>. The soil organic carbon content was low (0.52%). The soil was low in available nitrogen (235 kg ha<sup>-1</sup>), medium in available phosphorus (32 kg ha<sup>-1</sup>) and high in available potassium (460 kg ha<sup>-1</sup>) respectively. Soil application of fertilizers at 30 DAS and foliar application of fertilizers at 50% flowering stage.

## Results and Discussion

### Nutrients uptake

The nitrogen, phosphorus and potassium uptake by pigeonpea as influenced by irrigation scheduling through drip and cropping systems are presented in Table 1.

Among the different irrigation levels, scheduling of irrigation at 75 % CPE recorded significantly higher nitrogen (161.04 kg ha<sup>-1</sup>), phosphorus (28.26 kg ha<sup>-1</sup>) and potassium (85.29 kg ha<sup>-1</sup>) uptakes in pigeonpea and significantly lower nitrogen (116.70 kg ha<sup>-1</sup>), phosphorus (20.87 kg ha<sup>-1</sup>) and potassium (49.87 kg ha<sup>-1</sup>) uptakes was recorded in 50 % CPE. Scheduling of irrigation at 75 % CPE recorded significantly higher nitrogen, phosphorus and potassium uptake, this was mainly due to higher dry matter production

and yield and also due to maintenance of optimum moisture condition which helped for better root penetration and proliferation leading to higher nutrient uptake involving diffusion, mass flow and root interception. Soil with optimum water content helps for better solubility of nutrients than limited water status as well as reduces the chances of leaching major part of nutrient due to excess water leads to higher uptake (Shiragapure and Fathima, 2018). Singh *et al.*, (2018) reported that drip irrigation at 100 % WRC registered significantly higher nitrogen, phosphorus and potassium uptake compared to other level of irrigation. These results are in conformity with Al-Kaisi and Yin (2003) in maize and Hebbbar *et al.*, (2004) in tomato.

Among the different cropping systems, sole crop of pigeonpea recorded significantly higher nitrogen uptake ( $176.72 \text{ kg ha}^{-1}$ ) phosphorus uptake ( $33.56 \text{ kg ha}^{-1}$ ) and potassium uptake ( $89.70 \text{ kg ha}^{-1}$ ) than intercropped pigeonpea. Between the intercropping system, pigeonpea + soybean in 1:3 row proportions recorded significantly higher nutrient uptake as compared to pigeonpea + greengram (1:3) and pigeonpea + blackgram (1:3) intercropping systems and significantly lower nutrient uptake was recorded in pigeonpea + greengram (1:3) intercropping system. Sole pigeonpea recorded significantly higher uptake of N, P and K mainly due to higher seed yield along with higher nutrient contents present in seed. Nutrient uptake is mainly governed by nutrient content and yield. Significantly higher grain yield, yield components and total dry matter production per plant are mainly contributed for higher total uptake of nutrient by pigeonpea.

Interaction effect between scheduling of irrigation and cropping system on nutrient uptake was found significant. Scheduling of irrigation at 75 % CPE with sole pigeonpea

recorded significantly higher nitrogen uptake ( $190.04 \text{ kg ha}^{-1}$ ), phosphorous uptake ( $34.02 \text{ kg ha}^{-1}$ ) and potassium uptake ( $92.46 \text{ kg ha}^{-1}$ ) as compared to rest of the treatment combinations. However, significantly lower nitrogen uptake ( $69.00 \text{ kg ha}^{-1}$ ), phosphorous uptake ( $16.10 \text{ kg ha}^{-1}$ ) and potassium uptake ( $34.92 \text{ kg ha}^{-1}$ ) was registered in 50 % CPE with pigeonpea + greengram (1:3) intercropping system.

The rainfed zpigeonpea recorded significantly lower nitrogen uptake ( $65.60 \text{ kg ha}^{-1}$ ), phosphorus uptake ( $14.56 \text{ kg ha}^{-1}$ ) and potassium uptake ( $31.35 \text{ kg ha}^{-1}$ ).

### **Protein yield**

Protein yield was significantly higher under scheduling of irrigation at 75 % CPE ( $590.73 \text{ kg ha}^{-1}$ ) as compared to 50 % CPE and 100 % CPE levels. But, it was on par with scheduling of irrigation at 100 % CPE ( $558.58 \text{ kg ha}^{-1}$ ) and significantly lower protein yield was recorded in 50 % CPE ( $510.16 \text{ kg ha}^{-1}$ ) (Table 2). This might be due to increase in root proliferation which facilitated the higher uptake of nitrogen from the soil resulting into higher protein content and higher protein yield. Similar results were found by Kumbhar *et al.*, (2015).

Different cropping systems significantly influenced the protein yield. Among the intercropping system, significantly higher protein yield was recorded in sole pigeonpea ( $635.37 \text{ kg ha}^{-1}$ ) as compared to the intercropped pigeonpea. Between the intercropping systems, pigeonpea intercropped with soybean in 1:3 row proportions ( $535.48 \text{ kg ha}^{-1}$ ) recorded significantly higher protein yield as compared to pigeonpea + greengram (1:3) and pigeonpea + blackgram (1:3) intercropping systems and are on par with each other (Table 2). This was probably due to comparatively

greater availability of nutrients to the sole pigeonpea as compared to intercropping where it was shared by both the crops thereby increases protein yield. The results are in close conformity with the findings of Abraham *et al.*, (2010).

The interaction effect due to scheduling of irrigation and cropping systems on protein yield of pigeonpea was found significant. Scheduling of irrigation at 75 % CPE + sole pigeonpea (685.61 kg ha<sup>-1</sup>) recorded significantly higher protein yield as compared to rest of the treatment combinations (Table 2). But it was found on par with 100 % CPE with sole pigeonpea (639.63 kg ha<sup>-1</sup>). However, significantly lower protein yield was recorded in 50 % CPE with pigeonpea + greengram (1:3) intercropping system (476.41 kg ha<sup>-1</sup>).

The rainfed pigeonpea recorded significantly lower protein yield (455.60 kg ha<sup>-1</sup>).

### **Water use efficiency**

Scheduling of irrigation at 50 % CPE recorded significantly higher water use efficiency of pigeonpea (5.59 kg ha-mm<sup>-1</sup>) when compared to 75 % CPE and 100 % CPE. Significantly lower water use efficiency was registered in 100 % CPE (3.03 kg ha-mm<sup>-1</sup>) (Table 2).

The higher water use efficiency might be due to very less amount of irrigation water applied at 50 % CPE (407.4 mm) compared to irrigation at 75 % CPE (611.3 mm) and 100 % CPE (814.3 mm). Although irrigation at 75 % CPE recorded more seed yield it could not give more irrigation water use efficiency due to more water applied and comparatively less increase in seed yield compared to irrigation at 50 % CPE. Thus higher seed yield was masked by higher amount of water applied under irrigation at 75 % CPE and 100 % CPE,

respectively, for improving water use efficiency in case of pigeonpea. The results are in arrangement with Jadhav *et al.*, (2018), Muniyappa *et al.*, (2017) and Ranjitha *et al.*, (2018).

Water use efficiency of pigeonpea differed significantly due to different cropping systems. Significantly higher water use efficiency was recorded in sole pigeonpea (4.66 kg ha-mm<sup>-1</sup>) as compared to intercropped pigeonpea.

Among the cropping systems, pigeonpea intercropped with soybean in 1:3 row proportions recorded significantly higher water use efficiency (4.15 kg ha-mm<sup>-1</sup>) as compared to pigeonpea + greengram (1:3) and pigeonpea + blackgram (1:3) intercropping systems. However, significantly lower water use efficiency was recorded in pigeonpea + greengram (1:3) intercropping system (4.04 kg ha-mm<sup>-1</sup>) (Table 2). This might be due to higher water requirement of both the component crops under intercropping system, but sole pigeonpea required less water for their growth and development compared to intercrops (greengram, blackgram and soybean) hence sole pigeonpea recorded higher water use efficiency.

The interaction effect between scheduling of irrigation and cropping systems on water use efficiency of pigeonpea was found significant. Scheduling of irrigation at 50 % CPE with sole pigeonpea recorded significantly higher water use efficiency (6.14 kg ha-mm<sup>-1</sup>) when compared to rest of the treatment combinations, but it was on par with scheduling of irrigation at 50 % CPE with pigeonpea + blackgram (5.44 kg ha-mm<sup>-1</sup>) and 50 % CPE with pigeonpea + soybean (5.44 kg ha-mm<sup>-1</sup>) intercropping system (1:3). Significantly lower water use efficiency was registered in 100 % CPE with sole pigeonpea (2.88 kg ha-mm<sup>-1</sup>) (Table 2).

## Grain yield

In the present investigation, significant difference was noticed in yield of pigeonpea as influenced by irrigation scheduling and cropping system was presented in table 3. Among the irrigation levels, scheduling of irrigation at 75 % CPE recorded significantly higher seed yield of pigeonpea (2524 kg ha<sup>-1</sup>) as compared to 50 % and 100 % CPE, but it was on par with scheduling of irrigation at 100 % CPE (2462 kg ha<sup>-1</sup>) and significantly lower seed yield was recorded in 50 % CPE (2276 kg ha<sup>-1</sup>). This may be due to continuous and controlled supply of irrigation water throughout the crop growth period. The adequate supply of sufficient moisture for prolonged period also exploits the fixed nutrients of soil in available form and regulates its supply to the crop through mineralization and prevents from leaching and other losses and thereby improve the yield (Kiran, 2014). These results are in close agreement with the findings obtained by Thanki and Solanki (2010) and Mansur *et al.*, (2010).

Among the cropping systems, sole pigeonpea recorded significantly higher seed yield (2656 kg ha<sup>-1</sup>) as compared to intercropped pigeonpea. Between the intercropping systems, pigeonpea + soybean in 1:3 row proportions recorded significantly higher seed yield (2366 kg ha<sup>-1</sup>) as compared to pigeonpea + greengram (1:3) and pigeonpea + blackgram (1:3) intercropping systems and are on par with each other.

The enhancement in yield may be due to no competition of main crop with intercrop. The results obtained from the present study contradict the findings by Ansari *et al.*, (2012) who reported higher pigeonpea yield (1.52 t ha<sup>-1</sup>) under sole than intercrop plot (0.61 t ha<sup>-1</sup>).

Interaction effect between scheduling of irrigation and cropping system was found significant. Scheduling of irrigation at 75 % CPE with sole crop of pigeonpea (2750 kg ha<sup>-1</sup>) recorded significantly higher seed yield as compared to rest of the treatment combinations. But, it was on par with the treatments 100 % CPE with sole pigeonpea (2718 kg ha<sup>-1</sup>), 50 % CPE with sole pigeonpea (2501 kg ha<sup>-1</sup>) and 75 % CPE with pigeonpea + soybean (2498 kg ha<sup>-1</sup>) intercropping system. However, significantly lower seed yield was recorded in 50 % CPE with pigeonpea + greengram (1:3) intercropping system (2171 kg ha<sup>-1</sup>). Mahalakshmi *et al.*, (2011) in pigeonpea and Muniyappa *et al.*, (2017) in chickpea also reported the similar findings.

The rainfed pigeonpea recorded significantly lower seed yield (1080 kg ha<sup>-1</sup>).

## Economics

The data pertaining to gross returns, net returns and BC ratio as influenced by irrigation scheduling through drip and cropping systems are presented in Table 3. Scheduling of irrigation at 75 % CPE recorded significantly higher gross returns (Rs. 2,26,245 ha<sup>-1</sup>), net returns (Rs. 1,73,435 ha<sup>-1</sup>) and BC ratio (4.29) as compared to 50 % CPE and 100 % CPE and significantly lower gross returns was registered in 50 % CPE (Rs. 1,96,020 ha<sup>-1</sup>), net returns (Rs. 1,43,710 ha<sup>-1</sup>) and BC ratio (3.77). Jadhav *et al.*, (2018) reported that irrigation at 75 % Epan through drip recorded significantly higher gross returns (Rs. 1,33,683 ha<sup>-1</sup>), net returns (Rs. 96,995 ha<sup>-1</sup>) and BC ratio (3.64) followed by irrigation at 100 % Epan through drip, irrigation at 50 % Epan through drip and irrigation at 50 % flowering through furrows, respectively.

**Table.1** Nutrient uptake of pigeonpea as influenced by irrigation levels and cropping systems under drip irrigation

Treatments	Nutrient uptake		
	Nitrogen (kg ha <sup>-1</sup> )	Phosphorus (kg ha <sup>-1</sup> )	Potassium (kg ha <sup>-1</sup> )
<b>Main plots: Irrigation levels (I)</b>			
50 % CPE (I <sub>1</sub> )	116.70	20.87	49.87
75 % CPE (I <sub>2</sub> )	161.04	28.26	85.29
100 % CPE (I <sub>3</sub> )	141.72	23.30	58.93
S.Em±	3.70	0.74	2.28
C.D. at 5 %	14.52	2.89	8.94
<b>Sub plot: Cropping systems (C)</b>			
Sole pigeonpea (C <sub>1</sub> )	176.72	33.56	89.70
Pigeonpea + Greengram (C <sub>2</sub> )	111.30	19.00	53.29
Pigeonpea + Blackgram (C <sub>3</sub> )	128.80	20.68	55.68
Pigeonpea + Soybean (C <sub>4</sub> )	142.30	23.32	60.12
S.Em±	6.77	0.96	3.82
C.D. at 5 %	20.12	2.86	11.34
<b>Interaction effects (I × C)</b>			
50 % CPE × Sole pigeonpea (I <sub>1</sub> × C <sub>1</sub> )	159.53	33.04	86.31
50 % CPE × Pigeonpea + Greengram (I <sub>1</sub> × C <sub>2</sub> )	69.00	16.10	34.92
50 % CPE × Pigeonpea + Blackgram (I <sub>1</sub> × C <sub>3</sub> )	110.72	16.35	36.90
50 % CPE × Pigeonpea + Soybean (I <sub>1</sub> × C <sub>4</sub> )	127.04	17.98	41.35
75 % CPE × Sole pigeonpea (I <sub>2</sub> × C <sub>1</sub> )	190.04	34.02	92.46
75 % CPE × Pigeonpea + Greengram (I <sub>2</sub> × C <sub>2</sub> )	141.03	22.35	79.68
75 % CPE × Pigeonpea + Blackgram (I <sub>2</sub> × C <sub>3</sub> )	145.60	26.35	80.45
75 % CPE × Pigeonpea + Soybean (I <sub>2</sub> × C <sub>4</sub> )	167.50	30.34	88.57
100 % CPE × Sole pigeonpea (I <sub>3</sub> × C <sub>1</sub> )	180.60	33.62	90.34
100 % CPE × Pigeonpea + Greengram (I <sub>3</sub> × C <sub>2</sub> )	123.86	18.56	45.26
100 % CPE × Pigeonpea + Blackgram (I <sub>3</sub> × C <sub>3</sub> )	130.07	19.35	49.68
100 % CPE × Pigeonpea + Soybean (I <sub>3</sub> × C <sub>4</sub> )	132.35	21.65	50.43
S.Em±	10.81	1.62	6.16
C.D. at 5 %	32.12	4.82	18.31
Rainfed pigeonpea	65.6	14.56	31.35
S.Em±	10.68	1.61	6.11
C.D. at 5 %	31.17	4.71	17.83

**Table.2** Protein content (%), protein yield (kg ha<sup>-1</sup>) and water use efficiency (Kg ha<sup>-1</sup> mm<sup>-1</sup>) of pigeonpea as influenced by irrigation levels and cropping systems under drip irrigation

Treatments	Protein content (%)	protein yield (kg ha <sup>-1</sup> )	Water use efficiency (Kg ha <sup>-1</sup> mm <sup>-1</sup> )
<b>Main plots: Irrigation levels (I)</b>			
50 % CPE (I <sub>1</sub> )	22.32	510.16	5.59
75 % CPE (I <sub>2</sub> )	23.34	590.73	4.13
100 % CPE (I <sub>3</sub> )	22.61	558.58	3.03
S.Em±	0.65	16.02	0.11
C.D. at 5 %	NS	62.89	0.43
<b>Sub plot: Cropping systems (C)</b>			
Sole pigeonpea (C <sub>1</sub> )	23.83	635.37	4.66
Pigeonpea + Greengram (C <sub>2</sub> )	22.27	514.27	4.04
Pigeonpea + Blackgram (C <sub>3</sub> )	22.37	527.50	4.14
Pigeonpea + Soybean (C <sub>4</sub> )	22.55	535.48	4.15
S.Em±	0.69	20.33	0.15
C.D. at 5 %	NS	60.40	0.45
<b>Interaction effects (I × C)</b>			
50 % CPE × Sole pigeonpea (I <sub>1</sub> × C <sub>1</sub> )	23.19	580.88	6.14
50 % CPE × Pigeonpea + Greengram (I <sub>1</sub> × C <sub>2</sub> )	21.94	476.41	5.33
50 % CPE × Pigeonpea + Blackgram (I <sub>1</sub> × C <sub>3</sub> )	22.00	487.45	5.44
50 % CPE × Pigeonpea + Soybean (I <sub>1</sub> × C <sub>4</sub> )	22.15	495.88	5.44
75 % CPE × Sole pigeonpea (I <sub>2</sub> × C <sub>1</sub> )	24.88	685.61	4.50
75 % CPE × Pigeonpea + Greengram (I <sub>2</sub> × C <sub>2</sub> )	22.63	543.89	3.92
75 % CPE × Pigeonpea + Blackgram (I <sub>2</sub> × C <sub>3</sub> )	22.81	556.76	4.01
75 % CPE × Pigeonpea + Soybean (I <sub>2</sub> × C <sub>4</sub> )	23.06	576.65	4.09
100 % CPE × Sole pigeonpea (I <sub>3</sub> × C <sub>1</sub> )	23.44	639.63	3.34
100 % CPE × Pigeonpea + Greengram (I <sub>3</sub> × C <sub>2</sub> )	22.25	522.52	2.88
100 % CPE × Pigeonpea + Blackgram (I <sub>3</sub> × C <sub>3</sub> )	22.31	538.28	2.96
100 % CPE × Pigeonpea + Soybean (I <sub>3</sub> × C <sub>4</sub> )	22.44	533.90	2.92
S.Em±	1.23	34.44	0.25
C.D. at 5 %	NS	102.33	0.75
<b>Rainfed pigeonpea</b>			
S.Em±	1.21	34.56	-
C.D. at 5 %	NS	100.89	-

**Table.3** Grain yield and economics of pigeonpea as influenced by irrigation levels and cropping systems under drip irrigation

Treatments	Grain yield (kg ha <sup>-1</sup> )	Gross returns (Rs. ha <sup>-1</sup> )	Net returns (Rs. ha <sup>-1</sup> )	BC ratio
<b>Main plots: Irrigation levels (I)</b>				
50 % CPE (I <sub>1</sub> )	2276	196020	143710	3.77
75 % CPE (I <sub>2</sub> )	2524	226245	173435	4.29
100 % CPE (I <sub>3</sub> )	2462	218010	164700	4.10
S.Em±	37	4630	4630	0.08
C.D. at 5 %	146	18210	18210	0.30
<b>Sub plot: Cropping systems (C)</b>				
Sole pigeonpea (C <sub>1</sub> )	2656	159380	120820	4.13
Pigeonpea + Greengram (C <sub>2</sub> )	2304	252400	196590	4.52
Pigeonpea + Blackgram (C <sub>3</sub> )	2358	230700	172640	3.97
Pigeonpea + Soybean (C <sub>4</sub> )	2366	211220	152410	3.59
S.Em±	58	5850	5850	0.12
C.D. at 5 %	170	17390	17390	0.40
<b>Interaction effects (I × C)</b>				
50 % CPE × Sole pigeonpea (I <sub>1</sub> × C <sub>1</sub> )	2501	150060	112000	3.94
50 % CPE × Pigeonpea + Greengram (I <sub>1</sub> × C <sub>2</sub> )	2171	230280	174970	4.16
50 % CPE × Pigeonpea + Blackgram (I <sub>1</sub> × C <sub>3</sub> )	2216	208260	150700	3.62
50 % CPE × Pigeonpea + Soybean (I <sub>1</sub> × C <sub>4</sub> )	2218	195480	137170	3.35
75 % CPE × Sole pigeonpea (I <sub>2</sub> × C <sub>1</sub> )	2750	165000	126440	4.28
75 % CPE × Pigeonpea + Greengram (I <sub>2</sub> × C <sub>2</sub> )	2399	267960	212150	4.80
75 % CPE × Pigeonpea + Blackgram (I <sub>2</sub> × C <sub>3</sub> )	2449	246720	188660	4.25
75 % CPE × Pigeonpea + Soybean (I <sub>2</sub> × C <sub>4</sub> )	2498	225300	166490	3.83
100 % CPE × Sole pigeonpea (I <sub>3</sub> × C <sub>1</sub> )	2718	163080	124020	4.18
100 % CPE × Pigeonpea + Greengram (I <sub>3</sub> × C <sub>2</sub> )	2343	258960	202650	4.60
100 % CPE × Pigeonpea + Blackgram (I <sub>3</sub> × C <sub>3</sub> )	2408	237120	178560	4.05
100 % CPE × Pigeonpea + Soybean (I <sub>3</sub> × C <sub>4</sub> )	2381	212880	153570	3.59
S.Em±	95	9930	9930	0.22
C.D. at 5 %	280	29500	29500	0.65
<b>Rainfed pigeonpea</b>				
S.Em±	95.57	7886	7844	0.16
C.D. at 5 %	278.97	23018	22896	0.47

Kumbhar *et al.*, (2015) reported that irrigation scheduling at 0.8 IW/CPE ratio recorded significantly higher net returns of Rs.37, 591 ha<sup>-1</sup> with maximum BC ratio of 2.34 in

blackgram. Similar results were reported by Pramod *et al.*, (2006) and Muniyappa *et al.*, (2017) in chickpea and Deewan *et al.*, (2017) in clusterbean.



Among all the cropping systems, pigeonpea intercropped with greengram in 1:3 row proportions recorded significantly higher gross returns (Rs. 2,52,400 ha<sup>-1</sup>), net returns (Rs. 1,96,590 ha<sup>-1</sup>) and BC ratio (4.52) as compared to other intercropping systems. However, significantly lower gross returns (Rs. 1,59,380 ha<sup>-1</sup>) and net returns (Rs. 1,20,820 ha<sup>-1</sup>) were recorded in sole pigeonpea but BC ratio (3.59) in pigeonpea + soybean (1:3). Kantwa *et al.*, (2005) reported that pigeonpea + greengram intercropping system fetched higher gross returns, net return as well as BC ratio than sole pigeonpea. This might be due to marginal difference in yield of pigeonpea and additional yield of greengram, which resulted in higher net return in pigeonpea + greengram cropping systems than in sole pigeonpea.

The interaction effect between scheduling of irrigation and cropping systems on economics was found significant. Scheduling of irrigation at 75 % CPE with pigeonpea + greengram (1:3) intercropping system recorded significantly higher gross returns (Rs. 2,67,960 ha<sup>-1</sup>), net returns (Rs. 2,12,150 ha<sup>-1</sup>) and BC ratio (4.80) as compared to all other treatment combinations. Significantly lower gross returns (Rs. 1,50,060 ha<sup>-1</sup>) and net returns (Rs. 1,12,000 ha<sup>-1</sup>) were registered in 50 % CPE with sole pigeonpea but BC ratio (3.35) was recorded in 50 % CPE with pigeonpea + soybean (1:3) intercropping system.

The rainfed pigeonpea recorded significantly lower gross returns (Rs. 66,880 ha<sup>-1</sup>), net returns (Rs. 36,518 ha<sup>-1</sup>) and BC ratio (2.20).

It is concluded that among the treatments, 75 % CPE with sole pigeonpea recorded higher nutrient uptake, protein yield and grain yield but scheduling of irrigation at 75 % CPE in pigeonpea + greengram (1:3) intercropping system was found to be more productive and

profitable system as it has recorded significantly higher net returns and benefit cost ratio when compared to other irrigation scheduling and intercropping systems.

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