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Yield, yield parameters and economics of pigeonpea (*Cajanus cajan* (L.) Millsp) as influenced by genotypes, planting geometry and protective irrigation

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ABSTRACT

A field experiment was conducted during *Kharif* 2006 to study the performance of pigeonpea genotypes to planting geometry under different protective irrigation. The two protective irrigations given at flowering and early pod filling stages recorded significantly higher maximum mean seed yield (16.51 q ha^{-1}) followed by one irrigation at flower initiation stage (14.33 q ha^{-1}) and control. Among different genotypes, BSMR-736 (14.95 q ha^{-1}) and Asha (14.13 q ha^{-1}) produced, significantly higher seed yield when compared to Maruti. And Maximum seed yield of 14.80 q per hectare was realized with 5 x 2 ft and it was 13 per cent higher than 5 x 3 ft (13.07 q per hectare). The BSMR-736 (22.88%) and Asha (21.85%) were recorded significantly higher protein content as compared to Maruti (22.03%). The protein content of pigeonpea seeds did not differ significantly due to protective irrigation and planting geometry. Among the different irrigation levels, two irrigations recorded higher net returns (Rs. 23,774 ha^{-1}) and B:C ratio (2.40). Among pigeonpea genotypes, BSMR-736 (Rs. 20,802 ha^{-1} and 2.13, respectively) and Asha (Rs. 19,136 ha^{-1} and 1.96, respectively) recorded significantly higher net returns and benefit cost ratio when compared to Maruti. The pigeonpea with planting geometry of 5 x 2 ft recorded significantly higher net returns (Rs. 20,499 ha^{-1}) and benefit cost ratio (2.09) over 5 x 3 ft.

Key words : Genotypes, Irrigation, Yield, Yield attributes, Economics, Piegonpea

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is one of the protein rich legumes of the semi-arid tropics grown throughout the tropical and sub-tropical regions of the world between 30^0 N and 35^0 S latitude. However, major area in India is lying between 14 and 28^0 N latitude, where 90 per cent of the world's pigeonpea is produced. In India, it occupies an area of about 3.52 million hectares producing 2.37 million tonnes with an average productivity of 673 kg ha^{-1} (Anonymous, 2006). Pigeonpea is grown in almost all the states of India, but the major states are Maharashtra, Uttar Pradesh, Gujarat, Madhya Pradesh and Karnataka.

Normally the crop is grown under dry land in *Kharif* under low management conditions and is fairly drought tolerant. However, the productivity of the crop is quite low. One of the possible ways of increasing its productivity is through intensive cultivation which requires the development of suitable technology. The yield potential of pigeonpea can be realized only through efficient utilization of solar radiation and mitigating terminal drought for which canopy size and shape claim a paramount importance.

MATERIALS AND METHODS

A field experiment was conducted at Agriculture College Farm, Raichur during *Kharif* 2006-07 in order to study the response of pigeonpea genotypes to planting geometry under different protective irrigations, there were 18 treatments comprising combinations of three irrigations in main plots (I_0 – No irrigation, I_1 – One irrigation at flower initiation stage and I_2 – Two irrigations at flower initiation and early pod formation), three genotypes in sub plots (Asha, Maruti and BSMR-736) and two planting geometry in sub-sub plots (5 x 2 ft and 5 x 3 ft). Treatments were replicated three times in split-split plot design. The entire quantity of recommended dose of fertilizer for pigeonpea (25:50 NP kg ha^{-1}) in the form of urea and diammonium phosphate was applied at the time of sowing. Measured quantity of irrigation water was applied to each plot as per treatments. For each irrigation, 60 mm depth of measured quantity of water was applied to individual plants. During cropping period, total rainfall received was about 428 mm considering effective rain fall, the amount of rainfall for control treatment was 360 mm and for one irrigation 420 mm and for two irrigation 480 mm including the additional irrigation water given. These data were used for calculations of water use efficiency (WUE). Five plants in each plot were randomly selected from net plot area and tagged for recording yield parameter. Observation was record on number of pods per plant, 100 seed weight (g), seed yield per plot. Seed yield per hectare was calculated based on the net plot basis. Per cent crude protein was calculated by multiplying the nitrogen per cent in seeds with a constant of 6.25. Net returns (Rs. ha^{-1}) calculated by deducting cost of cultivation (Rs. ha^{-1}) from gross returns. B:C ratio was worked out as a ratio of net returns (Rs. ha^{-1}) to cost of cultivation (Rs. ha^{-1}).

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RESULTS AND DISCUSSION

Two protective irrigations given at flowering and early pod filling stages recorded significantly higher maximum mean seed yield (16.51 q ha^{-1}) followed by one irrigation at flower initiation stage (14.33 q ha^{-1}) and control (10.96 q ha^{-1}). The seed yield increased by 3.37 q ha^{-1} with one irrigation and 5.55 q ha^{-1} with two irrigations over control. The higher seed yield in treatment receiving two irrigations may be attributed to differences in the number of pods per plant. The mean number of pods per plant was highest with two irrigations (552.14) followed by one irrigation (505.02) and control (451.81). Similar increase in seed yields were obtained with irrigations by other workers in different places (Venkateswaralu, 1967). The number of seeds per pod and 100 seed weight did not differ significantly with respect to irrigation. However, irrigation increased number of seeds per pod marginally over control.

During *Kharif* the genotype BSMR-736 (14.95 q ha^{-1}) and Asha (14.13 q ha^{-1}) produced, significantly higher seed yield when compared to Maruti (12.73 q ha^{-1}). BSMR 736 (525.00 $plant^{-1}$) and Asha (515.34 $plant^{-1}$) produced significantly higher number of pods per plant and both were 11 and 9 per cent, respectively higher when compared to Maruti (468.64 $plant^{-1}$). Further, BSMR-736 and Asha had significantly higher number of seeds per pod (3.57 and 3.56, respectively) when compared to Maruti (3.45) besides BSMR-736 and Asha recorded significantly higher 100 seed weight (9.90 g) and (9.83 g), respectively when compared to Maruti (9.40). Ravindranath Reddy *et al.* (1997)

Maximum seed yield of 14.80 q per hectare was realized with higher plant density of 11111 plants per

Table 1 : Seed yield (q ha^{-1}), stalk yield (q ha^{-1}), husk yield (q ha^{-1}), harvest index and water use efficiency of pigeonpea at various growth stages as influenced by genotypes, different irrigation levels and planting geometry

Treatments	Seed yield (q ha^{-1})	Stalk yield (q ha^{-1})	Husk yield (q ha^{-1})	Harvest index	Water use efficiency
Irrigations (I)					
I_0 – No irrigation	10.96	21.63	5.84	0.282	3.04
I_1 – One irrigation	14.33	24.71	7.74	0.313	3.41
I_2 – Two irrigation	16.51	26.64	8.72	0.320	3.44
S.E.±	0.32	0.43	0.21	0.005	0.08
C.D. (P=0.05)	1.26	1.70	0.83	0.019	0.29
Varieties (V)					
V_1 – ASHA	14.13	24.96	7.56	0.302	3.34
V_2 – Maruti	12.73	21.99	6.91	0.309	3.02
V_3 – BSMR-736	14.95	26.03	7.82	0.304	3.53
S.E.±	0.30	0.44	0.23	0.002	0.06
C.D. (P=0.05)	0.91	1.35	0.71	NS	0.20
Planting geometry (S)					
S_1 – 5' x 2'	14.80	25.97	7.87	0.301	3.50
S_2 – 5' x 3'	13.07	22.68	7.00	0.309	3.10
S.E.±	0.26	0.37	0.19	0.002	0.06
C.D. (P=0.05)	0.76	1.09	0.55	0.007	0.19
Interaction					
I x V					
S.E.±	0.512	0.76	0.40	0.004	
C.D. (P=0.05)	NS	NS	NS	NS	
I x S					
S.E.±	0.44	0.64	0.32	0.004	
C.D. (P=0.05)	1.32	NS	NS	NS	
V x S					
S.E.±	0.44	0.64	0.32	0.004	
C.D. (P=0.05)	NS	NS	NS	NS	
I x V x S					
S.E.±	0.77	1.10	0.56	0.007	
C.D. (P=0.05)	NS	NS	NS	NS	

N.S.-Non sigificant

hectare and it was 13 per cent higher than that realized at a plant density of 7407 (13.07) plants per hectare (Table 1). This increased seed yield per hectare was due to increase in plant population per unit area the results are in accordance with the results obtained by Telgote *et al.* (2004), Sharma *et al.* (2003) and Antharavalli *et al.* (2002). Increase in spacing enhanced the individual plant performance. The pigeonpea sown at wider spacing recorded significantly higher number of pods per plant as compared to closer spacing. Pods per plant recorded at wider spacing was higher by 16 per cent as compared to closer spacing. This better individual plant performance at 5 x 3 ft. spacing did not increase the seed yield per hectare as compared to the seed yield at 5 x 2 ft. spacing, as the favorable effect of wider spacing (5 x 3 ft.) on yield components was not enough to compensate the yield reduction due to lower plant population per unit area. The plant population under closer spacing (5 x 2 ft.) was 40 per cent higher than the population under wider spacing (5 x 3 ft.). These results are in agreement with the findings of Puste and Jana (1996) and Mahajan *et al.* (1997). However, the yield attributes *viz.,* 100 seed weight and number of seeds per pod did not differ significantly due to different spacing's.

The BSMR-736 (22.88%) and Asha (21.85%) were recorded significantly higher protein content as compared to Maruti (22.03%).The protein content of pigeonpea seeds did not differ significantly due to protective irrigation and planting geometry. Among the different irrigation levels, two irrigations recorded higher net returns (Rs. 23,774 ha^{-1}) and B: C ratio (2.40) due to its higher seed, stalk and husk yield. These results are in conformity with the findings of Tiwari *et al.* (1988).Among pigeonpea genotypes, BSMR-736 (Rs. 20,802 ha^{-1} and 2.13, respectively) and Asha (Rs. 19,136 ha^{-1} and 1.96, respectively) recorded significantly higher net returns and benefit cost ratio when compared to Maruti.

The pigeonpea sown at closer spacing (5 x 2 ft.) recorded significantly higher net returns (Rs. 20,499ha^{-1}) and benefit cost ratio (2.09) over (5 x 3 ft.) (Table 4). These results are in agreement with the findings of Antharavalli *et al.* (2002) and Sharma *et al.* (2003). Interaction effect of irrigation and planting geometry was significant with regard to seed yield. The application of two irrigations recorded the highest seed yield of 16.51 q ha^{-1} at plant density of 11,111 plants per hectare and it was significantly higher than the seed yield produced with other irrigation levels under all plant densities. Other interaction effects were non significant (Table 1).

Table 3 : Yield components of pigeonpea at various growth stages as influenced by genotypes, different irrigation levels and planting geometry

Treatments	No. of pods per plant	No. of seeds per pod	100 seed weight (g)
Irrigations (I)			
I_0 – No irrigation	451.81	3.48	9.67
I_1 – One irrigation	505.02	3.53	9.68
I_2 – Two irrigation	552.14	3.57	9.77
S.E.±	13.25	0.02	0.05
C.D. (P=0.05)	52.04	NS	NS
Varieties (V)			
V_1 – ASHA	515.34	3.56	9.83
V_2 – Maruti	468.63	3.45	9.40
V_3 – BSMR-736	525.00	3.57	9.90
S.E.±	8.70	0.02	0.06
C.D. (P=0.05)	26.81	0.06	0.20
Planting geometry (S)			
S_1 – 5' x 2'	463.53	3.52	9.67
S_2 – 5' x 3'	542.45	3.53	9.74
S.E.±	8.08	0.01	0.04
C.D. (P=0.05)	23.99	NS	NS
Interaction			
I x V			
S.E.±	15.06	0.03	0.11
C.D. (P=0.05)	NS	NS	NS
I x S			
S.E.±	13.99	0.01	0.07
C.D. (P=0.05)	NS	NS	NS
V x S			
S.E.±	13.99	0.01	0.07
C.D. (P=0.05)	NS	NS	NS
I x V x S			
S.E.±	24.24	0.02	0.12
C.D. (P=0.05)	NS	NS	NS

NS – Non significant

Table 2 : Interaction effect of irrigation and planting geometry on seed yield

Treatments	Seed yield (kg ha^{-1})		
	Planting geometry (5 x 2 ft)	Planting geometry (5 x 3 ft)	Mean
I_0 – No irrigation	22.58	20.69	21.63
I_1 – One irrigation	26.80	22.62	24.71
I_2 – Two irrigation	28.55	24.73	26.64
Mean	25.97	22.68	24.33
S.E..±	0.64		
C.D. (P=0.05)			

Table 4 : Cost of cultivation (Rs. ha^{-1}), gross return (Rs. ha^{-1}), net return (Rs. ha^{-1}) and benefit cost ratio (B: C) of pigeonpea as influenced by genotypes, irrigation levels and planting geometry

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{1})	BC ratio
Irrigations (I)				
I_0 – No irrigation	9,568	22,468	12,900	1.34
I_1 – One irrigation	9,768	29,317	19,549	2.00
I_2 – Two irrigations	9,968	33,743	23,774	2.40
S.E.±		471	236	0.03
C.D. (P=0.05)		1,412	876	0.13
Varieties (V)				
V_1 – Asha	9,768	28,904	19,136	1.96
V_2 – Maruti	9,768	26,055	16,287	1.67
V_3 – BSMR-736	9,768	30,570	20,802	2.13
S.E.±		460	228	0.30
C.D. (P=0.05)		1,380	685	0.09
Planting geometry (S)				
S_1 – 5' x 2'	9,780	30,279	20,499	2.09
S_2 – 5' x 3'	9,757	26,740	16,983	1.74
S.E.±		355	177	0.02
C.D. (P=0.05)		1,066	530	0.07
Interaction				
I x V				
S.E.±		1005	400	0.08
C.D. (P=0.05)		NS	NS	NS
I x S				
S.E.±		803	354	0.04
C.D. (P=0.05)		NS	NS	NS
V x S				
S.E.±		803	354	0.04
C.D. (P=0.05)		NS	NS	NS
I x V x S				
S.E.±		2,369	1,178	0.07
C.D. (P=0.05)		NS	NS	NS

NS-Non significant

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