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Green Farming Vol. **4** (3) : 262-266 (May-June, 2013) **Research Paper**

Effect of row ratio, spacing, and irrigation on seed production of a hybrid parent line ICPA 2043 (CMS) of pigeonpea

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ABSTRACT

A two year field experiment was conducted at Patancheru, AP., India during *kharif* season 2009 and 2010 in Alfisols to study the direct and interaction effects of row ratio (4:1 and 3:1), row spacing (75 cm and 150 cm), plant-to-plant spacing (30 cm and 50 cm) and irrigation (every 14 and 18 days interval during flower initiation till pod development) on the growth and yield of ICPA 2043. The total effects of irrigation and row ratios and its interactions including the interaction of row ratio, plant spacing and irrigation was found not significant on the total seed yield (kg/ha) of ICPA 2043. However, the direct effect of the different plant spacings did influenced the agronomic and yield traits of parental linedue to variations in plant population. The study further suggests that 75 cm x 30 cm is the optimum plant spacing coupled with the adoption of either of the two row ratios and irrigation frequencies will produced ample amount of seeds of parent line materials of hybrid pigeonpea.

Key words : *Cytoplasmic-nuclear male-sterility system, Hybrid parent, Irrigation, Pigeonpea, Plant spacing, Row ratio.*

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millspaugh] is one of the important protein rich (20-22%) grain legume of the semi-arid tropics. Although pigeonpea is cultivated in 4.63 M ha globally, the yields have remained stagnant for the past 4 decades due to low productivity between 650-750 kg/ha. The challenge for breeders is how to break thelow productivity in India, where pigeonpea is the second most grown pulse legume and it's production (2.89 million tons) cannot meet its required annual domestic requirement (3.4 million tons) (Price *et al*., 2003).

To improve the yield barrier, the cytoplasmic-nuclear male-sterility (CMS) system developedby ICRISAT made possible the mass production of hybrid seeds and their parent lines (Saxena *et al*., 2005). The CMS system consists of three lines: male sterile A-line; male fertile B-line or known as maintainer line; and the restorer R-line. The A-line comprises the cytoplasm of a wild relativeand the nuclear genome of a cultivated variety. The B-line contains both the cytoplasm and nuclear genome of a cultivated variety mainly used for maintaining the male sterile lines while the R-line carries the gene and genes for restoring male fertility in the presence of male sterile cytoplasm of a cultivated variety (Singh, 1990). However, the success of this system principally depends on the efficiency and effectiveness of natural mass pollen transfer process of parent B/R- to A- line through a range of bees (Saxena, 2006), including honeybee. Co-important feature is the seed production technology that will produce the optimum amount of pure and healthy seeds through appropriate agronomic management (Ali and Kumar, 2000). Agronomic management will continue to play a crucial role in enhancing resource use efficiency and realization of the genetic potential of a crop.Therefore, this study was conducted to identify the optimum plant spacing and irrigation frequency in increasing high quality seed pigeonpea of a CMS-line 'ICPA 2043'.

MATERIALS AND METHODS

The materials consisted of two parental lines (male-sterile line ICPA 2043 and male-fertile maintainer line ICPB 2043), a prerequisite of the hybrid ICPH 2671, sown in isolated Alfisols during *kharif* 2009 (Y1) and 2010 (Y2) at Patancheru, A.P., India. The parental lines were sown in two row ratios that included 4 male-sterile to 1 male-fertile (4:1) and 3 male-sterile to 1 male-fertile (3:1).There were two row spacing(75 cm and 150cm) and two plant to plant spacing (30 cmand 50 cm) of male-sterile plants while the maintainer line was sown at plant-to-plant spacing of 30 cm. During flower initiation to pod development, two irrigation frequencies (14 days and 18 days intervals) were applied at field capacity of 50 mm by flooding and ended when the pods are at physiological maturity.The row length of each treatment was ten meters. Normal agronomic practices were followed including the application of recommended fertilizer dose of 100 kg ha^{-1} of di-ammonium phosphate.In 2009 and 2010, a total 997.59 mm and 1206.29 mm annual rainfall was observed respectively. For both years, there was a minimal rainfall during the month of November (2009: 44.2 mm and 2010: 17.9 mm) where pigeonpea flowers and pods started to develop. Five plants were selected randomly in each plot and data were recorded on height at 50% flowering (cm), diameter of main stem (cm), weight of dry biomass (kg), number of branches, pods per plant, seeds per

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pod, 100 seed weight (g) and seed yield per plant (g/plant). The total seed yield (kg/ha) was computed on plot basis. Analysis of variance applying the split-split plot design with two replications was used to find out the direct and interactive effect of row ratio, planting distance, and irrigation. This study was conducted to identify the best treatment combination for the optimum seed production of medium-duration (160-170 days) parent CMS-line (ICPA 2043) pigeonpea.

RESULTS AND DISCUSSION

Row ratio : The direct effect of row ratio has not influenced (P<0.05) the agronomic and yield traits of ICPA 2043 except for the number of seeds/pod during Y2 (**Table 1**) which is not in conformity to the findings of De Bruin and Pedersen (2008). Row ratio 4:1 produced the highest mean number at three seeds per pod (**Table 2**) but did not influence the total seed yield of ICPA 2043 due to some other yield trait factors that would influence the total seed yield such as number of pods and weight of 100 seeds. However, the correlation between total seed yield (kg/ha) with the two row ratios resulted in high seed production with a two year mean of 1357 kg/ha in 4:1 row ratio, and 1279 kg/ha in 3:1.

Irrigation : Majority of the findings showed that the agronomic and yield traits of ICPA 2043 was not influenced (P<0.05) by the direct effect of any of the irrigation frequencies (every 14 and 18 days interval) except for the number branches (Y1) and yield/plant (Y2) (Table 1). Irrigation of every 14 days (four irrigations) during flower initiation to pod development produced more number of branches (50) and yield/plant (70.31 g) (Table 2). However, the correlation between total seed yield (kg/ha) with the two irrigation frequencies showed high yield potentials with a two year mean of 1291 kg/ha irrigated every 14 days and 1344 kg/ha irrigated every 18 days.

Spacing : The study revealed that plant spacing has remarkable effect (P<0.05) on the growth and yield traits of ICPA 2043 on both cropping season but was not significantly different in the total seed yield (kg/ha) in Y1 although was significantly influenced in Y2 (Table 1). This analysis refuted the findings of Siag and Verma (1994) where grain yield and yield contributing characters of pigeonpea were not influenced significantly by plant spacing but rather was influenced by genotype. However, the correlation between total seed yield with the different plant spacings in Y1 revealed high yield potential with 75 cm x 30 cm producing the highest yield of 1737 kg/ha followed by 150 cm x 30 cm (1525 kg/ha), 150 cm x 50 cm (1446 kg/ha), and 75 cm x 50 cm (1305 kg/ha). In Y2, plant spacing 75 cm x 30 cm produced the highest total seed yield (1517.30 kg/ha) as compared to the other spacings (Table 2). At wider plant spacing in both cropping season, 150 cm x 50 cm produced the highest mean diameter of stem (3.04 cm and 2.75 cm), weight of biomass (1.61 kg and 0.33 kg), number of pods/plant (841 and 365), yield/plant (150.65 g and 87.36 g) for both cropping season (Y1 and Y2) and number of seeds/pod (3.1), weight of 100 seeds (13.23 g) in Y2 (Table 2).

Table 1. Effect and interactive effect of row ratio, spacing and irrigation on the agronomic and yield traits of ICPA 2043 at 5% level of significance

Treatment effect	Agronomic traits								Yield traits									
	Height at 50% flowering (cm)		Stem diameter (cm)		Biomass (kg)		Branches (no.)		Pods/ plant (no.)		Seed/ pod (no.)		Weight of 100 seeds (g)		Yield			
															Plant (g)		Hectare (kg)	
	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2
Row ratio	0.14	0.33	0.07	0.22	0.34	0.72	0.66	0.29	0.86	0.15	0.18	0.04	0.51	0.17	0.88	0.16	0.86	0.53
Irrigation	0.22	0.45	0.39	0.25	0.18	0.44	0.03	0.40	0.45	0.14	0.76	0.30	0.11	0.77	0.25	0.02	0.22	0.06
Spacing	0.78	0.11	<.0001	0.03	<.0001	.0008	0.25	0.21	<.0001	.0001	0.77	.0009	0.13	.0008	0.01	.0007	0.58	0.01
Interactive effect of row ratio + spacing	0.32	0.84	0.01	0.02	0.45	0.06	0.29	0.24	0.75	0.02	0.61	0.02	0.04	0.17	0.81	0.09	0.82	0.32
Interactive effect of row ratio + irrigation	0.97	0.58	0.28	0.70	0.70	0.86	0.03	0.33	0.32	0.97	0.61	0.71	0.27	0.24	0.14	0.03	0.07	0.11
Interactive effect of spacing + irrigation	0.19	0.03	0.11	0.88	0.38	0.17	0.67	0.14	0.16	0.84	0.87	0.74	0.92	0.06	0.30	0.54	0.49	0.90
Interactive effect of row ratio, spacing and irrigation	0.55	0.94	0.08	0.63	0.71	0.14	0.45	0.28	0.60	0.94	0.71	0.98	0.92	0.11	0.51	0.89	0.68	0.95

Table 2. Mean attributes of ICPA 2043 as influenced by the direct and interactive effects of row ratio, spacing and irrigation.

Traits	Year 1			Year 2		
	Factor	Treatment	Mean	Factor	Treatment	Mean
Height at 50 % flowering (cm)				Interactive effect of spacing + irrigation	150 x 30 + every 18 days	194.2
					75 x 50 + every 14 days	191.2
					150 x 50 + every 18 days	190.8
					75 x 50 + every 18 days	190.4
					75 x 30 + every 14 days	189.9
					75 x 30 + every 18 days	189.8
					150 x 30 + every 14 days	180.8
					150 x 50 + every 14 days	176.0
Stem diameter (cm)	Spacing effect	150 x 50	3.04	Spacing effect	150 x 50	2.75
		150 x 30	2.59		150 x 30	2.57
		75 x 50	2.32		75 x 50	2.38
		75 x 30	2.04		75 x 30	2.16
	Interactive effect of	4:1 + 150 x 50	3.29	Interactive effect of row ratio + spacing	4:1 + 150 x 50	3.34
	row ratio + spacing	3:1 + 150 x 50	2.78		4:1 + 150 x 30	3.01
		4:1 + 150 x 30	2.69		3:1 + 75 x 50	2.39
		3:1 + 150 x 30	2.49		4:1 + 75 x 50	2.38
		4:1 + 75 x 50	2.42		4:1 + 75 x 30	2.29
		3:1 + 75 x 50	2.23		3:1 + 150 x 50	2.15
		3:1 + 75 x 30	2.05		3:1 + 150 x 30	2.13
		4:1 + 75 x 40	2.04		3:1 + 75 x 30	2.02
Biomass (kg)	Spacing effect	150 x 50	1.61	Spacing effect	150 x 50	0.33
		150 x 30	1.23		150 x 30	0.29
		75 x 50	0.83		75 x 50	0.25
		75 x 30	0.73		75 x 30	0.24
Branches (no.)	Irrigation effect	Every 14 days	50			
		Every 18 days	40			
	Interactive effect of	3:1 +every 14 days	57			
	row ratio + irrigation	4:1 + every 18 days	44			
		4:1 + every 14 days	43			
		3:1 + every 18 days	36			
Pods/plant (no.)	Spacing effect	150 x 50	841	Spacing effect	150 x 50	365
		150 x 30	586		150 x 30	342
		75 x 50	444		75 x 50	209
		75 x 30	377		75 x 30	178
				Interactive effect of row ratio + spacing	4:1 + 150 x 50	448
					4:1 + 150 x 30	413
					3:1 + 150 x 50	281
					3:1 + 150 x 30	272
					3:1 + 75 x 50	220

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Traits	Year 1			Year 2		
	Factor	Treatment	Mean	Factor	Treatment	Mean
					4: 1 + 75 x 50	198
					3:1 + 75 x 30	183
					4:1 + 75 x 30	173
Seeds/pod (no.)				Ratio effect	4:1	3.0
					3:1	2.5
				Spacing effect	150 x 50	3.10
					150 x 30	3.10
					75 x 50	2.41
					75 x 30	2.22
				Interactive effect of row ratio + spacing	4:1 + 150 x 30	3.62
					4:1 + 150 x 50	3.55
					3:1 + 150 x 50	2.66
					3:1 + 150 x 30	2.57
					3:1 + 75 x 50	2.49
					4:1 + 75 x 50	2.32
					3:1 + 75 x 30	2.25
					4:1 + 75 x 30	2.20
Weight of 100 seeds (g)	Interactive effect of	3:1 + 150 x 50	10.27	Spacing effect	150 x 50	13.23
	row ratio + spacing	3:1 + 75 x 50	10.27		150 x 30	12.81
		4:1 + 75 x 30	10.08		75 x 50	12.24
		4:1 + 75 x 50	10.05		75 x 30	12.09
		3:1 + 150 x 30	9.68			
		3:1 + 75 x 30	9.62			
		4:1 + 150 x 30	9.32			
		4:1 + 150 x 50	9.00			
Yield/plant (g)	Spacing effect	150 x 50	150.65	Spacing effect	150 x 50	87.36
		150 x 30	94.74		150 x 30	76.99
		75 x 50	69.96		75 x 50	50.48
		75 x 30	53.93		75 x 30	49.14
				Irrigation effect	Every 14 days	70.31
					Every 18 days	61.73
				Interactive effect of row ratio + irrigation	4:1 + every 14 days	77.2
					3:1 + every 14 days	63.4
					4:1 + every 18 days	62.0
					3:1 + every 18 days	61.4
Yield/ha (kg)				Spacing effect	75 x 30	1517.30
					150 x 30	1226.80
					75 x 50	947.40
					150 x 50	839.80

Note : Mean data provided are only those with significant difference ($P<0.05$) revealed in Table 1.

Nevertheless, wider spacing did not influence the total seed yield (kg/ha) of ICPA 2043 due to increase in plant density at closer spacing which conforms to the findings of Mula *et al*. (2010), Kumar *et al*. (2001), and Mohd and Yogeswara Rao (1983).

Row ratio and plant spacing : The interactive effect of row ratio and plant spacing was significantly different (P<0.05) on the diameter of stem of ICPA 2043 in both season (Y1 and Y2) while number of pods/plant and seeds/pod was significant in Y2 and weight of 100 seeds in Y1 (Table 1) but not in agreement to the findings of Mula *et al*. (2011). For both seasons, row ratio 4:1 with plant spacing of 150 cm x 50 cm gave the thickest stem at 3.29 cm (Y1) and 3.34 cm (Y2). Moreover in Y2, the same row ratio and plant spacing provided the most number of pods/plant at 448 but for mean number of seeds/pod, row ratio 4:1 with plant spacing of 150 cm x 30 cm have the highest at 3.62 (Table 2). In Y1, the weight of 100 seeds was highest in row ratio 3:1 with plant spacing of 150 cm x 50 cm and 75 cm x 50 cm at 10.27 g (Table2). Nonetheless, these yield traits did not influenced the total seed yield (kg/ha) in wider spacing due to more number of population in closer spacing which supports the findings of Mula *et al*. (2010), and Abrams and Julia (1973).

Row ratio and irrigation : The two year study showed that there was no major interaction effects(P<0.05) of row ratio and irrigation on the agronomic and yield characters of ICPA 2043 except for yield/plant in Y2 (Table 1). Row ratio 4:1 with irrigation of every 14 days during flower initiation till pod development (four irrigations) produced more number of seeds at 77.2 g/plant however this did not result in increase in total seed yield of ICPA 2043 which is in accordance to the findings of Mula *et al*. (2011).

Plant spacing and irrigation : The results indicated that no major interaction effects(P<0.05) of plant spacing and irrigation was observed on the agronomic and yield and yield traits for both years of the study except for the height at 50% flowering of ICPA 2043 in Y2 (Table 1). These major findings collaborate with the findings of Mohd and Yogeswara Rao (1983). The tallest mean plant was witnessed in plant spacing 150 cm x 30 cm (194.2 cm) which was irrigated every 18 days (three irrigations) during flower initiation till pod development (Table 2).

Row ratio, spacing and irrigation : The study showed that the interaction among row ratio, plant spacing and irrigation was not significant (P<0.05) for any of the agronomic and yield and yield traits of ICPA 2043 (Table 1) which corresponds to the findings of Mula *et al*. (2011) and Reddy *et al*. (1984).

CONCLUSIONS

In this two year study, the agronomic and yield characters of ICPA 2043 responded significantly on the direct effect of the different plant spacings.In contrast, the total effects of irrigation and row ratios and its interactions including the interaction of row ratio, plant spacing and irrigation was found not significant. It is further concluded that individual plant growth at wider spacing had more vigor growth than at closer spacing due to improved light availability. However, the agronomic and yield contributing traits did not influence the total seed yield (kg/ha) due to variation in plant population where at closer plant spacing, the density of plants are more than at wider spacing. Furthermore, either of the two row ratio, plant spacing and irrigation frequency treatments have direct correlation on the increase of seed yield. It is concluded that plant spacing 75 cm x 30 cm adopting either 4:1 or 3:1 row ratio and irrigating every 14 days or 18 days interval during flower initiation till pod development will produced sample amount of seeds of parent line (CMS) materials of hybrid pigeonpea.

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