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Influence of spacing and irrigation on seed production of medium-duration pigeonpea hybrid

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ABSTRACT . An experiment was conducted in Vertisols to evaluate agronomic variability for large-scale seed production of ICPH 2671 hybrid from a cytoplasmic male-sterile (CMS) line ICPA 2043 viz. direct and interaction effects of row ratio, planting distance and irrigation. The treatments included two planting ratios of 4:1 and 3:1 with male sterile (MS):male fertile (MF) lines; two row-to-row spacing (75 cm and 150 cm); two plant-to-plant spacing (30 cm and 50 cm); and two irrigation frequencies (14 and 21 day intervals during flower initiation until pod development). The study clearly revealed that individual plants sown at wider spacing have better growth and yield traits than at closer spacing. However, these traits did not influence the production of total seed yield of ICPH 2671. The study also showed that interactions provided by any of the row ratio, irrigation and planting distance combinations were not significantly different among the treatments on the various agronomic traits of ICPA 2043. The research further demonstrated that either of the two row ratio, two irrigation frequencies and plant spacing can be adopted to produce ample seeds of ICPH 2671.

Keywords : *Cajanus cajan, cytoplasmic male-sterility, irrigation, pigeonpea, planting distance, row ratio.*

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Mills.] is a major rainy-season crop in the rainfed areas of India. According to Sha and Agarwal (2009), pigeonpea area, production and productivity has substantially declined from 2007-2008 cropping season (3.79 million hectares, 3.08 million tons, 824 kg/ha) to 2008-2009 cropping season (2.19 million hectares, 2.31 million tons, 791 kg/ha). Because of low production and increasing consumption rate (3.4 million tons annually) of 'dal', India has to import from Myanmar and Africa around 1.5 to 2.8 million tons annually (CRNindia.com, 2008). The level of productivity of pigeonpea has been stagnant for the past 56 years, which poses a challenge to researchers to focus on breeding hybrid cultivars in search for higher yields (Saxena, 2008) together with the right agronomic management (Ali and Kumar, 2000).

The backbone of the hybrid breeding technology is in the efficient seed production system that will provide quality seeds at economically feasible cost. The discovery of the first pigeonpea hybrid was developed by Reddy *et al.* (1978) utilizing two genetic male-sterility (GMS) systems. However, this system did not materialized due to problems in producing ample quantity of the hybrid seeds. To ease this problem, the cytoplasmic male-sterility (CMS) system was developed which make possible the large-scale seed production of hybrids and their female parents (Saxena *et al.*, 2005). The success of a seed production of A-line principally depends on the efficiency and effectiveness of natural mass pollen transfer process of parent R- to A-line (Saxena, 2006). From this method, seeds harvested from A-line are labelled as hybrids. According to Williams (1977), the major insect pollinators, which are responsible for transferring pollen in pigeonpea at Patancheru, are the *Megachile* spp. and *Apis mellifera*. Another, is the sowing seeds at the right time and right method together with appropriate inter- and intra-row spacing; optimum soil moisture during crops development and efficient insect management are regarded as important agronomic management in seed production system (Sinha *et al.*, 1988).

Plant density is another important factor in increasing yield however, closer spacing brings variation in microclimatic factors such as light intensity, evapo-transpiration and temperature of soil surface (Sinha *et al.*, 1988). In addition, Ahlawat and Rana (2005) stated that the growth and development of pigeonpea also differ from location to location and even within the same location, variability in growth takes place. This study was conducted to obtain the optimum plant spacing and irrigation frequency for increasing hybrid seeds of ICPH 2671.

MATERIALS AND METHODS

The research was conducted during 2009-2010 at the ICRISAT, Patancheru. The experimental material consists of two parental lines that included male-sterile (ICPA 2043) and its male-fertile restorer line (ICPR 2671) sown in two row ratios of 4 MS - female to 1 MF - male (4:1) and 3 MS to 1 MF (3:1) in an isolated area of 1,700 m^2 Vertisols on June 18, 2010. In each row ratio, there are two row-to-row spacings (75 cm and 150 cm); two plant-to-plant spacings (30 cm and 50 cm) of male-

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sterile plants; and two irrigation frequencies (14 day and 21 day intervals during flower initiation till pod development). The irrigation treatment of every 14 days and 21 days has 3 irrigations each at field capacity of 50 mm/irrigation. The different treatment combinations were laid out in RCB design having two replications. The restorer line was sown at plant-to-plant spacing of 30 cm. The length of each treatment was 5 m. A basal dose of 100 kg/ha di-ammonium phosphate was applied and recommended agronomic practices were followed uniformly to all the treatments. Data on plant height at 50% flowering, diameter of main stem, weight of dry biomass, number of branches, pods/plant, seeds/pod, 100-seed mass, and seed yield were collected on 10 randomly selected competitive plants within each treatment.

The total seed yield was calculated on plot basis. To find out the effect and interactive effect of row ratio, planting distance and irrigation; analyses of variance using the split-split plot design was employed to determine the best treatment combination in optimizing seed yield of ICPH 2671.

RESULTS AND DISCUSSIONS

Row ratio effect

The major effect of row ratio on the growth and yield traits of ICPA 2043 was not significantly (P<0.05) different among the treatments except for the biomass (**Table 1**). The dry biomass weight was highest in row ratio 3:1 at 0.26 kg/plant as compared with row ratio 4:1 (**Table 2**) which conforms to the findings of Mula *et al.* (2010a) where 3:1 row ratio registered the highest biomass weight.

Planting distance effect

Planting distance exerted remarkable effect of ICPA 2043 on plant height, biomass, pods/plant, seeds/pod, weight of 100-seeds and yield/plant but did not significantly (P<0.05) influenced the stem diameter, number of branches, and yield/ha (Table 1). Plant spacing at 150 cm x 50 cm provided the highest mean height (226 cm), biomass (0.25 kg/plant), pods/plant (359), seeds/pod (3.32) and seed yield (98.6 g/plant) while plant spacing of 150 cm x 30 cm give the highest weight of 100-seeds at 14.55 g (Table 2). These findings strongly corroborated with Mula *et al.* (2010a) where at wider spacing, individual plant growth are more vigor than at closer spacing due to spreading branches that intercepts more sunlight. The yield obtain from wider spacing can be accounted for by the higher number of pods/plant which is in conformity to the findings of Venkataratnam *et al.* (1984). However, wider spacing did not influence the increased in total seed yield of ICPH 2671 because of fewer plant population as compared to closer spacing (Abrams and Julia, 1973; Sinha *et al.*, 1988; Mula *et al.*, 2010b).

Irrigation effect

The results showed that agronomic and yield and yield trait of ICPA 2043 was not significant (Table 1) which correspond to the findings of Reddy *et al.* (1984) that there was no interaction between irrigation levels on the agronomic and yield traits of ICPA 2043.

Interaction of row ratio and irrigation

The study revealed that there was no interactive effect of

Table 1. Direct and interactive effects of row ratio, irrigation and planting distance on the growth and yield attributes of ICPA 2043

Treatment effect	Agronomic traits (P(<0.05)				Yield traits (P(<0.05)				
	Plant height at 50% flowering (cm)	Stem diameter (cm)	Biomass (kg)	Branches (no.)	Pods/plant (no.)	Seeds/pod (no.)	Weight of 100 seeds (g)	Yield per Plant (g)	Yield per Hectare (kg)
Effect of row ratio	0.127ns	0.797ns	0.052*	0.787ns	0.344ns	0.136ns	0.340ns	0.066ns	0.096ns
Effect of planting distance	0.013*	0.528ns	0.013*	0.210ns	0.002*	0.0009**	0.023*	<.0001**	0.105ns
Effect of Irrigation	0.957ns	0.893ns	0.412ns	0.434ns	0.438ns	0.843ns	0.534ns	0.441ns	0.552ns
Interaction of row ratio with irrigation	0.866ns	0.947ns	1.000ns	0.973ns	0.441ns	0.615ns	0.474ns	0.875ns	0.704ns
Interaction of row ratio and planting distance	0.549ns	0.730ns	0.352ns	0.201ns	0.079ns	0.639ns	0.746ns	0.090ns	0.735ns
Interaction of irrigation and planting distance	0.471ns	0.693ns	0.589ns	0.427ns	0.336ns	0.947ns	0.326ns	1.000ns	0.986ns
Interaction among row ratio, irrigation and planting distance	0.422ns	0.708ns	0.111ns	0.864ns	0.256ns	0.338ns	0.438ns	0.704ns	0.475ns

Note: *, ** significant; ns not significant

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

Agronomic trait	Factor	Treatment	Mean
Plant height at 50% flowering (cm)	Effect of planting distance	150 cm x 30 cm	226.13
		150 cm x 50 cm	228.00
		75 cm x 30 cm	216.26
		75 cm x 50 cm	223.09
Biomass (kg)	Effect of row ratio	4:1	0.20
		3:1	0.26
	Effect of planting distance	150 cm x 30 cm	0.24
		150 cm x 50 cm	0.25
		75 cm x 30 cm	0.21
		75 cm x 50 cm	0.23
Pods/plant (no.)	Effect of planting distance	150 cm x 30 cm	291
		150 cm x 50 cm	359
		75 cm x 30 cm	190
		75 cm x 50 cm	251
Seeds/pod (no.)	Effect of planting distance	150 cm x 30 cm	3.25
		150 cm x 50 cm	3.32
		75 cm x 30 cm	2.75
		75 cm x 50 cm	2.83
Weight of) 100-seeds (g	Effect of planting distance	150 cm x 30 cm	14.55
		150 cm x 50 cm	14.55
		75 cm x 30 cm	14.08
		75 cm x 50 cm	13.89
Yield/plant (g)	Effect of planting distance	150 cm x 30 cm	68.72
		150 cm x 50 cm	98.61
		75 cm x 30 cm	42.09
		75 cm x 50 cm	59.23

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

row ratio and irrigation on the agronomic and yield attributes of ICPA 2043 (Table 1) which conforms to the study of Mula *et al.* (2010a) where row ratio was not affected by irrigation treatments.

Interaction of row ratio and planting distance

All the agronomic and yield trait of ICPA 2043 was not influenced by the interactive effect of row ratio and planting distance (Table 1).

Interaction of irrigation and planting distance

The interactive effect of irrigation and planting distance was not significant (Table 1) which agree with the findings of Kumar Rao *et al.* (1992) where no major interactions were observed between the two irrigation levels and plant densities on the various agronomic characters.

Interaction among row ratio, planting distance and irrigation

The study demonstrated that the interaction among row ratio, planting distance and irrigation was not significant (Table 1) which collaborate with the findings of Reddy *et al.* (1984) that there was no interaction between irrigation levels and plant density for any of the characters studied.

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