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Effect of integrated agronomic practices on hybrids and pure-line varieties under different environmental conditions in pigeonpea [*Cajanus cajan* (L.) Millspaugh]

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ABSTRACT

The field experiment was conducted at two locations during *kharif* 2011 and 2012 at Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani, Maharashtra and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh to study the effect of various integrated agronomic practices on hybrids and pure-line varieties of pigeonpea. The genotypes used were three medium maturity group hybrids (ICPH 2671, ICPH 2740 and ICPH 3762) and three pure-line varieties (BDN 711, BSMR 736 and Asha) laid out in split-plot design with three replications in Vertisols. The experimental material was planted in three treatments *viz.*, T_1 [75 x 30 cm + 100 kg DAP (basal) + no protective irrigation]; T_2 [75 x 60 cm + 50 N:100 P_2O_5 kg ha^{-1} (split application: 50% as basal and 50% at 60 days) + two protective irrigations (during mid-flowering and mid-pod development stage)]; and T_3 [150 x 30 cm + 50 N:100 P_2O_5 kg ha^{-1} (split application: 50% as basal and 50% at 60 days) + two protective irrigations (mid-flowering and mid-pod development stage)]. The results indicated that significantly higher seed yield, biomass and harvest index was recorded in T_2 at 3923.9 kg ha^{-1}, 8816.6 kg ha^{-1} and 30.8%, respectively as compared to T_3 (3262.5 kg ha^{-1}, 7670.1 kg ha^{-1} and 29.8%, respectively) and T_1 (2932.3 kg ha^{-1}, 7633.3 kg ha^{-1} and 27.8%, respectively). Genotype × environment interaction indicated that over the two locations in two years, hybrids recorded higher seed yield as compared to pure-line varieties. However, G_3T_2 [ICPH 3762 + (75 x 60 cm + 50 kg N:100 P_2O_5 kg ha^{-1} (split application at 50% as basal and 50% at 60 days after sowing) + two irrigations (during mid-flowering and mid-pod development stage)] recorded the highest seed yield (4153.6 kg ha^{-1}). Number of pods plant^{-1} and biomass weight (kg ha^{-1}) showed significant variation in the interaction of environment × genotype × treatment (EGT). $E_1G_3T_3$ recorded significantly higher number of pods plant^{-1} (1181.9) followed by $E_1G_3T_2$ (1026.1) which significantly converted into higher seed yield plant^{-1} (237.1 g & 240.1 g respectively) while $E_2G_2T_2$ exhibited significantly greater biomass (11977.9 kg ha^{-1}). Among all the genotypes tested, Hybrid ICPH 3762 recorded highest number of pods plant^{-1} in T_3 in almost all environments.

Key words : *Agronomic practices, Environment, Hybrid, Pigeonpea varieties, Yield attributes.*

INTRODUCTION

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is an important food legume crop in Indian sustainable agriculture. In India, around 4.04 million hectare of pigeonpea is cultivated with production of 2.65 million tonnes having an average yield of 656 kg ha^{-1} (IIPR, 2013). Maharashtra accounts for over 29.92% (1.21 million hectare) area of pigeonpea with production of 0.85 million tonnes and productivity of 704 kg ha^{-1} (DAC, 2012). While, in Andhra Pradesh pigeonpea covered 0.48 million hectare (11.93%) with low productivity of 307 kg ha^{-1} (DAC, 2012). However, it was observed that in India, pigeonpea area showed positive growth rate but productivity remains unchanged (Sharma *et al.*, 2013).

The World's first commercial hybrid ICPH 2671 (Saxena *et al.*, 2013) and ICPH 2740 has been released for commercial cultivation. In 30 multi-location trials on farmers field, these two promising hybrids exhibited >30-35% yield advantage over high yielding varieties. In earlier studies, it was reported that yield and yield attributes of pigeonpea were significantly increased in wider spacing (Tuppad *et al.*, 2012, Goud *et al.*, 2012) and irrigation (Mula *et al.*, 2013). Meena *et al.* (2013) reported that the low yield of pigeonpea is mainly attributed to inadequate and imbalanced nutrient application particularly with respect to nitrogen and phosphorus. Selection of proper plant spacing (optimum plant density), adequate nutrient supply and irrigation are the most important factors to increase the productivity of pigeonpea (Ali and Kumar, 2000; Sekhon *et al.*, 1996).

In this context, enhancing production to meet the

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requirement of growing populace, the need to introduce pigeonpea hybrids with appropriate agronomic practices is necessary. The experiment was conducted to understand the effect of integrated agronomic practices in response to wider spacing, fertilizer and irrigation treatments in determining the yield and yield potentials of hybrids and varieties.

MATERIALS AND METHODS

The experiment was conducted at VNMKV, Parbhani and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, A.P. during cropping season 2011-12 and 2012-13 in Vertisols by using six medium duration genotypes of pigeonpea which includes three hybrids [ICPH 2671 (G_1), ICPH 2740 (G_2), and ICPH 3762 (G_3)] and three varieties [BDN 711 (G_4), BSMR 736 (G_5) and Asha (G_6)]. Among varieties, BSMR 736 and Asha were used as standard check. The experimental materials have three treatments in combination with spacing, fertilizer and irrigation which are T_1 control [75 x 30 cm + 100 kg ha^{-1} DAP (basal) + No irrigation]; T_2 [75 x 60 cm + 50 kg N:100 P_2O_5 kg ha^{-1} (split application at 50% as basal and 50% at 60 days after sowing) + two irrigations (during mid-flowering and mid-pod development stage)]; and T_3 [150 x 30 cm + 50 kg N:100 P_2O_5 kg ha^{-1} (split application at 50% as basal and 50% at 60 days after sowing) + two irrigations (during mid-flowering and mid-pod development stage)]. The different treatments were laid out in split plot design with three replications. Recommended package of cultural management practices and plant protection measures were adopted to raise a healthy crop.

The data for yield and yield contributing characters were recorded on five competitive plants in each treatment and replication. The data were subjected to statistical analysis to understand the effect of treatment combination on yield and yield contributing characters of pigeonpea hybrids and varieties.

Details of statistical analysis : The experiment was laid out in Split Plot design with three treatments of a. treatments (T_1, T_2, and T_3) as whole plot units; b. six genotypes (G_1, G_2, G_3, G_4, G_5, G_6) as subplot units and; c. across four environments (E_1 - 2011 at Parbhani, E_2 - 2012 at Parbhani, E_3 - 2011 at Patancheru, E_4 - 2012 at Patancheru).

For each morphological trait, data were analyzed by using SAS MIXED procedure (SAS Inst. 2002-2008, SAS V 9. 3).

RESULTS AND DISCUSSION

Effect of environments and genotypes for various yield and yield attributes for two seasons : The variation due to environment was found significant. Among two environments, the pigeonpea genotypes tested in Parbhani showed superiority for almost all the characters as compared in Patancheru except plant height at maturity and harvest index. Among four seasons, the genotypes performed well in E_1 (2011 at Parbhani) for yield and yield contributing characters. The pooled mean over two years & across the environments recorded for yield and harvest index was 3372.9 kg ha^{-1} & 29.6%, respectively (**Table 2**).

Hybrids required more number of days to 50% flowering (119.1 days) and maturity (173.6 days) as compared to varieties (113.3 and 162.4 days, respectively) (**Table 3**). Likewise, hybrids

Table 1. Analysis of variance (F values) for various yield and its associated traits of pigeonpea over two years and across the environments

Source	Df	Days to 50% flowering	Days to 80% maturity	Plant height at maturity (cm)	No. of primary branches plant^{-1}	No. of secondary branches plant^{-1}	No. of pods plant^{-1}
Environment	3	1007.05**	50.49**	43.13**	59.10**	20.49**	9.64**
Genotype	5	1715.17**	2042.39*	130.42**	23.88**	36.42**	13.19**
Treatment	2	2.77	12.70**	0.03	4.50*	9.86**	64.77**
Environment × Treatment	6	1.48	11.21**	1.30	2.15	0.55	3.16*
Genotype × Treatment	10	1.77	1.98*	1.05	1.45	1.32	2.80**
Genotype × Environment	15	40.94**	15.33**	4.99**	1.96*	3.25**	2.79**
Environment × Genotype × Treatment	30	0.96	0.75	0.67	0.84	0.96	1.95**

Contd...

Source	Df	Seeds pod^{-1}	100-seed weight (g)	Seed yield plant^{-1} (g)	Seed yield ha^{-1} (g)	Biomass ha^{-1} (kg)	Harvest index (%)
Environment	3	5.32*	45.51**	10.34**	34.75*	53.53**	10.51**
Genotype	5	32.21**	148.31**	6.25**	11.75**	47.53**	9.53**
Treatment	2	0.78	0.49	56.53**	75.82**	28.96**	17.69**
Environment × Treatment	6	1.97	3.08	2.39	13.67**	8.72**	2.65
Genotype × Treatment	10	0.61	0.80	0.35	0.98	0.55	1.51
Genotype × Environment	15	1.74*	23.00**	1.48	2.11**	6.87**	3.72**
Environment × Genotype × Treatment	30	1.16	1.52	0.96	0.95	1.73*	1.33

Note : * Significant at 5% and ** Significant at 1% level.

Table 2. *Per se* performance for various yield and yield contributing characters of pigeonpea in each environment

Characters	Environments						Pooled mean
	E_1	E_2	Mean	E_3	E_4	Mean	
Days to 50% flowering	120.9a	114.7c	117.8	119.1b	110.2d	114.6	116.2
Days to 80 % maturity	170.1a	167.3b	168.7	169.4a	165.3c	167.4	168.0
Plant height at maturity (cm)	189.3b	174.1b	181.7	173.1c	213.6a	193.4	187.5
No. of primary branches plant^{-1}	15.8a	9.9b	12.8	15.0a	9.5b	12.3	12.5
No. of secondary branches plant^{-1}	56.6a	54.5a	55.5	43.8b	33.6c	38.7	47.1
No. of pods plant^{-1}	665.3a	514.9bc	590.1	522.0b	414.2c	468.1	529.1
Seeds pod^{-1}	3.5b	3.5b	3.5	3.7ab	3.6b	3.6	3.6
100-seed weight (g)	11.3a	10.7c	11.0	11.2b	10.9c	11.0	11.0
Seed yield plant^{-1} (g)	184.3a	127.9b	156.1	129.6b	128.7b	129.2	142.6
Seed yield ha^{-1} (kg)	4224.8a	3149.5b	3687.1	2752.9c	3364.5b	3058.7	3372.9
Biomass ha^{-1} (kg)	8851.9a	8975.9a	8913.9	6376.9c	7955.2b	7166.1	8040.0
Harvest index (%)	32.3a	26.0b	29.3	30.2a	29.7a	29.9	29.6

Note : Means followed by the same letter in a row do not differ significantly at P = 0.05

E_1 - 2011 at Parbhani, E_2 - 2012 at Parbhani, E_3 - 2011 at Patancheru, E_4 - 2012 at Patancheru.

showed greater plant height (197.3 cm) at maturity, number of primary branches plant^{-1} (13.8) and higher number of secondary branches plant^{-1} (54.1) which is directly correlated to increased dry matter accumulation. The higher dry matter accumulation of hybrids (18%) resulted in increase in seed yield (3513.2 kg ha^{-1}) as compared to varieties (3232.9 kg ha^{-1}). The seed yield plant^{-1} of hybrids was significantly higher (151.4 g) than varieties (133.9 g) due to more number of pods plant^{-1} and 100-seed weight (11.4 g). These results indicated that hybrids out performed varieties for seed yield and its related traits which conforms to the findings of Saxena *et al.* (2013), Meena *et al.* (2013) and Tuppad *et al.* (2012).

Treatments effect : Days to 50% flowering, plant height at maturity and seed pod^{-1} was not significantly influenced by the effect of various treatments over two years and across the environments (**Table 4**). However, significant number of primary branches plant^{-1} (13.2), higher number of pods plant^{-1} (624.8) and higher seed yield plant^{-1} (163.9) are observed in T_3 as compared to T_2 (12.5; 549.2; 151.1g, respectively) and T_1 (11.9; 413.3 and 112.8 g, respectively). Among three treatments, T_2 showed the highest in biomass weight (8816.6 kg ha^{-1}) which significantly contributed to increase in seed yield (3923.9 kg ha^{-1}) and harvest index (30.8%) as compared to T_3 (7670.1 kg ha^{-1}; 29.8%, respectively) and T_1 (7633.3 kg ha^{-1}; 27.8%, respectively). The results indicated that pigeonpea genotypes with wider spacing, higher fertilizer rate and protective irrigations produced significantly higher biomass and seed yield which corresponds to the findings of Goud *et al.* (2012).

Environment × treatment interactions effect : The environment × treatment interaction were significantly different for days to maturity, number of pods plant^{-1}, seed yield (kg ha^{-1}) and biomass weight (kg ha^{-1}) as shown in Table 1. Among all environment and treatment combinations, E_4T_1 (2012 at Patancheru with T_1) matured early (164.5 days) whereas, E_1T_1

Table 3. *Per se* performance of hybrids and varieties of pigeonpea for yield and yield contributing characters for two years and across the environments

Genotypes	Days to 50% flowering	Days to 80% maturity	Plant height at maturity (cm)	No. of primary branches plant^{-1}	No. of secondary branches plant^{-1}	No. of pods plant^{-1}	Seed pod^{-1}	100-seed weight (g)	Seed yield plant^{-1} (g)	Seed yield ha^{-1} (kg)	Biomass ha^{-1} (kg)	Harvest index (%)
Hybrids												
G_1	114.1d	168.5c	191.5b	14.0a	57.1a	547.5b	3.5c	11.2b	154.9a	3556.9ab	8568.9ab	29.3ad
G_2	120.1c	174.4b	201.0a	13.4ab	52.2ab	490.9c	3.6b	11.9a	145.8a	3425.2ab	8733.1a	28.2d
G_3	123.2a	178.0a	199.3a	14.1a	53.0ab	629.4a	3.6b	11.1c	153.5a	3557.5a	8812.9a	28.8ad
Mean	119.1	173.6	197.3	13.8	54.1	555.9	3.6	11.4	151.4	3513.2	8705	28.8
Varieties												
G_4	103.3e	155.1e	158.6d	8.9d	23.3d	431.9d	3.9a	9.8e	118.3b	2955.4c	6364.5d	31.7a
G_5	114.5d	163.8d	185.0c	12.1c	45.8bc	545.8b	3.5c	10.7d	143.3a	3336.2b	7544.7c	30.7a
G_6	122.0b	168.5c	189.8b	12.8bc	51.3bc	529.1bc	3.4c	11.4b	140.0a	3406.3ab	8215.7b	29.3bc
Mean	113.3	162.4	177.8	11.3	40.1	502.3	3.6	10.6	133.9	3232.6	7375	30.5

Note : Means followed by the same letter in a column do not differ significantly at P = 0.05

G_1 = ICPH 2671, G_2 = ICPH 2740, G_3 = ICPH 3762, G_4 = BDN711, G_5 = BSMR 736, G_6 = Asha

Table 4. Effect of treatments & environment × treatment interaction on various yield and yield attributes of pigeonpea

Treat-ments	Days to 50% flowering	Days to 80% maturity	Plant height at maturity (cm)	No. of primary branches $plant^{-1}$	No. of secondary branches $plant^{-1}$	No. of pods $plant^{-1}$	Seed pod^{-1}	100-seed weight (g)	Seed yield $plant^{-1}$ (g)	Seed yield ha^{-1} (kg)	Biomass ha^{-1} (kg)	Harvest index (%)
Treatments effect												
T_1	115.9a	167.8b	187.7a	11.9b	39.1b	413.3c	3.6a	11.0a	112.8c	2932.3c	7633.3b	27.8c
T_2	116.2a	167.8b	187.6a	12.5ab	51.9a	549.2b	3.6a	11.0a	151.1b	3923.9a	8816.6a	30.8a
T_3	116.4a	168.5a	187.3a	13.2a	50.3a	624.8a	3.6a	10.9a	163.9a	3262.5b	7670.1b	29.8b
Environment x Treatment interactions effect												
E_1T_1	120.6	170.5a	188.8	15.8	50.3	538.2cd	3.5	11.4	152.8	3138.7ed	7586.5d	29.3d
E_1T_2	120.9	169.9a	187.3	14.9	57.1	675.9b	3.6	11.4	186.5	5436.0a	10566.9a	34.0a
E_1T_3	121.3	169.8ab	191.7	16.7	62.3	782.0a	3.5	11.2	213.6	4099.6b	8402.2c	32.8b
E_2T_1	114.4	166.5d	175.8	9.8	45.7	447.4de	3.5	10.8	111.3	3164.9ed	8801.2b	26.4f
E_2T_2	114.7	167.1c	174	10.4	62.2	558.1c	3.5	10.6	139.2	3321.8d	9701.4a	25.5g
E_2T_3	114.9	168.4ab	172.5	9.5	55.6	539.1cd	3.5	10.8	133.3	2961.9f	8425.2c	26.0ef
E_3T_1	118.7	169.8ab	175.5	13.9	36.4	385.1e	3.7	11	94.3	2323.3h	6013.0e	27.9e
E_3T_2	118.8	169.2a	173.5	15.3	50.9	507.8cd	3.7	11.3	136.9	3331.4d	7114.1d	31.9b
E_3T_3	119.7	169.3a	170.3	15.6	44.2	673.3b	3.6	11.2	157.5	2604.0g	6003.8e	30.3d
E_4T_1	110.2	164.5f	210.7	8.3	24.2	282.5f	3.6	11	92.8	3102.2ed	8132.4c	27.6e
E_4T_2	110.4	165.1e	215.5	9.6	37.3	455.0de	3.7	10.8	141.8	3606.8c	7884.1dc	31.4c
E_4T_3	109.8	166.4d	214.6	10.7	39.4	504.9cd	3.6	10.7	151.6	3384.6d	7849.1dc	30.1d

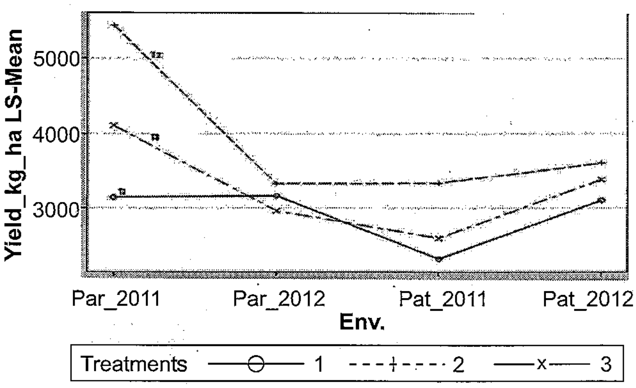

Fig. 1. The graph showing the result of environment × treatment interaction for the trait seed yield (kg ha^{-1})

(2011 at Parbhani with T_1) matured late (170.5 days) (Table 4). High seed yield (5436.0 kg ha^{-1}), biomass weight (10566.9 kg ha^{-1}) and harvest index (34%) were obtained in E_1T_2 (2011 at Parbhani with T_2) interaction. However, the highest number of pods $plant^{-1}$ (782.0), number of secondary branches $plant^{-1}$ (62.3) and primary branches $plant^{-1}$ (16.7) were recorded in E_1T_3 (2011 at Parbhani with T_3). The graphical presentation of environment × treatment interaction (**Fig. 1**) clearly indicated that E_1T_2 (2011 at Patancheru with T_2) interacted best for recording the highest seed yield (kg ha^{-1}) followed by E_1T_3 (2011 at Parbhani with T_3).

Genotype × treatment interactions effect : Genotype × treatment interaction showed significant variation for days to 80% maturity and number of pods $plant^{-1}$ (Table 1). For days to 80% maturity, G_4T_2 (BDN 711 + T_2) interaction matured early (154.9) whereas, G_3T_3 (ICPH 3762 + T_3) matured late (179.0) than rest of the interactions (Table 5). The highest number of pods $plant^{-1}$ was recorded in the G_3T_3 (804.5) however, the lowest number of pods $plant^{-1}$ was obtained in G_4T_1 (BDN 711 + T_1) (378.4). Moreover, ICPH 3762 (G_3) recorded higher pods $plant^{-1}$ in T_1 (459.6), T_2 (630.9) & T_3 (804.5) as compared to other genotypes. Among all the interactions (Table 5), G_3T_2 (ICPH 3762 + T_2) recorded highest seed yield (4153.6 kg ha^{-1}) followed by G_1T_2 (4113.7 kg ha^{-1}) & G_6T_2 (4073.2 kg ha^{-1}) while G_4T_1 (BDN 711 + T_1) exhibited lowest seed yield (2557.9 kg ha^{-1}).

The findings of present investigation revealed that hybrids with different treatments performed better than the control varieties for plant height, number of branches $plant^{-1}$, no. of pods $plant^{-1}$ & seed yield (kg ha^{-1}). The results are in confor-mity of the finding of Meena *et al.* (2013) & Goud *et al.* (2012).

Environment × genotype × treatment interactions effect : The number of pods $plant^{-1}$ and biomass weight (kg ha^{-1}) showed significant variation due to environment × genotype × treatment interaction (Table 1). The highest number of pods $plant^{-1}$ was recorded in $E_1G_3T_3$ (2011 at Parbhani by ICPH 3762) at 1181.9 (Table 6) followed by $E_1G_3T_2$ (2011 at Parbhani by ICPH 2740) at 1026.1. The higher number of pods $plant^{-1}$ recorded by $E_1G_3T_3$ and $E_1G_3T_2$ produced significantly highest seed yield $plant^{-1}$ (237.1 g and 240.1 g respectively). Among all interactions, $E_2G_2T_2$ (2012 at Parbhani with ICPH 2740) revealed the highest biomass weight (11977.9 kg ha^{-1}) followed by the interaction of $E_2G_3T_2$ (2012 at Parbhani with ICPH 3762) at 11360.7 kg ha^{-1} and $E_2G_1T_2$ (2012 at Parbhani with ICPH 2740) at 11165.0 kg ha^{-1} (**Table 6**).

Table 5. Interaction effect of genotype × treatment on various yield and its traits of pigeonpea for (two years)

Treat-ments	Days to 50% flowering	Days to 80% maturity	Plant height at maturity (cm)	No. of primary branches $plant^{-1}$	No. of secondary branches $plant^{-1}$	No. of pods $plant^{-1}$	Seed pod^{-1}	100-seed weight (g)	Seed yield $plant^{-1}$ (g)	Seed yield ha^{-1} (kg)	Biomass ha^{-1} (kg)	Harvest index (%)
G_1T_1	114	168.4f	192.2	13.4	46.4	452.6fg	3.5	11.1	126.6	3125	8070.2	29.9
G_2T_1	119.9	174.7c	202.9	12.9	43.1	386.4g	3.6	12	112.6	2913	8337.9	25.9
G_3T_1	123	177.5b	196.8	13.6	42.3	459.6f	3.6	11.1	125	3022.3	8641.9	25.9
G_4T_1	103.3	155.1i	156.7	7.7	21.1	378.4g	3.9	9.8	88.4	2557.9	5837.4	30.5
G_5T_1	114.1	163.6h	186.8	11.5	37.6	402.2fg	3.4	10.7	111.6	2983.9	7197.4	29.3
G_6T_1	121.3	167.8g	190.8	12.5	44.3	400.7fg	3.4	11.5	112.6	2991.6	7714.7	27.9
G_1T_2	114.1	168.0f	191.5	15	65.7	598.9cb	3.5	11.3	163.8	4113.7	9445.1	30.3
G_2T_2	119.6	173.8d	200	13	52.6	495.7f	3.6	11.8	151.8	3860.6	9698.3	28.5
G_3T_2	123.1	177.5b	202.7	12.8	57.4	630.9b	3.6	11.1	154.3	4153.6	9373.4	30.7
G_4T_2	103.3	154.9i	159.9	9	24.7	450.2fg	3.9	9.8	133.8	3537.6	7201.9	32.9
G_5T_2	115.1	163.7h	181	12.3	53	548.2ed	3.5	10.7	152.6	3805.1	8105.5	31.9
G_6T_2	122.2	168.9f	190.3	13.1	57.8	571.2dc	3.5	11.4	150.4	4073.2	9075.7	31.0
G_1T_3	114.2	169.1e	190.8	13.5	59.2	584.0dc	3.5	11.3	174.2	3432	8191.5	29.5
G_2T_3	120.9	174.9c	200	14.3	60.8	590.7dc	3.6	11.9	173	3502	8163.2	30.0
G_3T_3	123.6	179.0d	198.3	15.9	59.3	804.5a	3.6	11	181.3	3496.7	8423.5	29.3
G_4T_3	103.3	155.2i	159.3	10	24.2	467.2fg	3.8	9.8	132.7	2770.7	6054.2	31.4
G_5T_3	114.3	164.2h	187.1	12.4	46.9	687.1b	3.5	10.6	165.6	3219.5	7331.1	30.5
G_6T_3	122.4	168.8f	188.3	12.9	51.7	615.4b	3.5	11.3	157	3154.2	7856.8	28.6

Note : Means followed by the same letter in a column do not differ significantly at P = 0.05
G_1 = ICPH 2671, G_2 = ICPH 2740, G_3 = ICPH 3762, G_4 = BDN711, G_5 = BSMR 736, G_6 = Asha

The present investigation revealed that pigeonpea hybrids recorded significantly higher number of pods $plant^{-1}$ and biomass (kg ha^{-1}), which contributes into higher seed yield as compared to pure-line cultivars. Various treatments significantly influenced the seed yield $plant^{-1}$, seed yield (kg ha^{-1}), biomass (kg ha^{-1}), and harvest index (%). The genotype × environment interaction over four environments (**Fig. 2**) indicated that hybrids obtained greater seed yield than inbred cultivars. Likewise, the genotypes showed better performance in wider spacing, higher fertilizer rate and two protective irrigations (T_2 and T_3) due to greater availability of space, light, nutrients, and moisture as compared to closer spacing, normal fertilizer rate and no protective irrigation. Hybrid ICPH 3762 recorded higher number of pods $plant^{-1}$ in T_1 (459.6), T_2 (630.9) and T_3 (804.5) as compared to other genotypes and may have the potential to produced more in intensive cultivation (T_2 and T_3). However, in environment × genotype × treatment interaction, $E_1G_3T_3$ exhibited significantly higher number of pods $plant^{-1}$ (1181.9) followed by $E_1G_3T_2$ (1026.1) that significantly converted into higher seed yield per $plant^{-1}$ (237.1g and 240.1g respectively). While $E_2G_2T_2$ obtained significantly greater biomass (11977.9 kg ha^{-1}). However, the findings of the present study showed that among the genotypes and treatment interactions, hybrid ICPH 3762 and ICPH 2671 produced the highest seed yield (4153.6 kg ha^{-1} and 4113.7 kg ha^{-1} respectively) following wider spacing of 75 x 60 cm applied with higher fertilizer rate (50 kg N:100 P_2O_5 kg ha^{-1} (split application at 50% as basal and 50% at 60 days after sowing) and 2 protective irrigations during flowering & pod development.

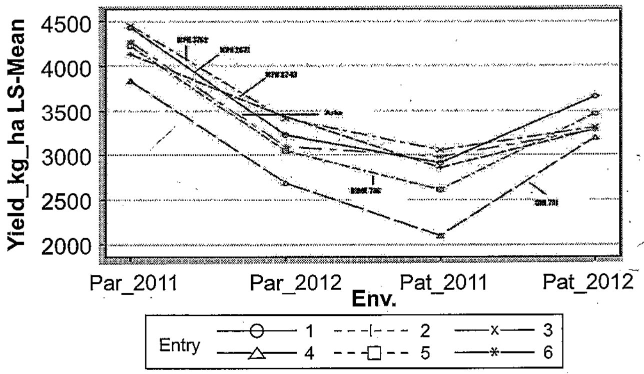

Fig. 2. The graph showing the result of genotype × environment interaction for the trait seed yield (kg ha^{-1})

This data set indicated that the cultivation of high yielding hybrids in wider spacing, higher fertilizer rate and two protective irrigations (like T_2 and T_3) could be help to increase the productivity of pigeonpea upto some extent.

REFERENCES

Ali M and Kumar S. 2000. Problems and prospects of pulses research in India. *Indian Farming*. **50** (8) : 4-13.

DAC. 2012. Directorate of Economics and Statistics, Department of Agriculture and Cooperation. pp. 6.

Goud V V, Kale, H B, Konde N M and Mohod P V. 2012. Optimization of agronomic requirement for medium duration hybrid under rainfed condition in Vertisol. *Legume Res.* **35** (3) : 261-264.

IIPR, Kanpur 2013. All India Co-ordinate Research Project on Pigeonpea, Project Co-ordinator's Report, *Indian Institute of*

Table 6. Environment × genotype × treatment interaction effect on various yield and yield attributes of pigeonpea

Genotypes	E1 T1	E1 T2	E1 T3	E2 T1	E2 T2	E2 T3	E3 T1	E3 T2	E3 T3	E4 T1	E4 T2	E4 T3
No. of pods plant^{-1}												
G_1	550.0a	614.7a	654.5a	544.4a	683.3a	575.9a	436.5a	523.7a	604.9a	307.4c	573.8ab	500.7b
G_2	495.2a	520.4a	647.5a	468.0a	577.2a	641.8a	361.1b	524.3a	585.1a	221.1c	360.9ab	488.4a
G_3	523.5c	1026.1b	1181.9ab	410.2a	634.1a	579.6a	481.9b	447.4b	866.7a	394.8cb	416.1b	589.9a
G_4	663.9a	493.0a	490.2a	372.9a	432.5a	393.9a	261.9cb	421.8ba	562.3a	214.7c	453.5ab	422.4b
G_5	491.2cb	692.7b	992.6a	386.5a	449.8a	533.1a	406.1cb	568.5ba	699.3a	324.7c	481.9b	523.3ab
G_6	505.1b	708.3ab	725.1a	502.3a	571.8a	510.3a	363.0c	560.7ba	721.3a	232.5c	444.1b	504.9ab
Contd...												
Seed yield plant^{-1}												
G_1	175.1	187.3	215.5	112.9	158.9	147.7	120.1	140.7	162.7	98.1	168.5	148.2
G_2	166.6	189.6	217.5	116.5	161.2	155.6	89.9	143.9	168.6	77.5	112.5	150.4
G_3	157.6	240.1	237.1	110.0	157.8	151.9	116.0	103.6	181.1	116.5	116.6	176.8
G_4	112.9	135.2	170.2	102.1	105.5	99.6	60.0	137.1	121.6	78.6	157.4	139.4
G_5	140.6	180.1	231.7	105.5	109.9	125.0	90.7	152.7	149.4	109.7	167.9	156.3
G_6	164.1	187.6	208.5	120.8	142.2	119.8	89.2	143.6	161.3	76.3	128.2	138.4
Contd...												
Biomass ha^{-1} (kg)												
G_1	8025.2cb	11165.0a	8687.1b	8797.0a	9351.2a	8433.6a	6681.7bc	8777.3a	6586.5c	8776.9a	8487.0a	9058.9a
G_2	8395.5cb	10504.3a	8199.3b	10263.2ab	11977.9a	9060.2b	6573.9a	6857.1a	6842.1a	8119.1cb	9453.6a	8551.4ba
G_3	8423.6cb	10991.6a	9006.5b	11140.4ab	11360.7a	10225.6b	7051.4ab	7848.7a	6726.8b	7952.4a	7292.5a	7735.0a
G_4	5778.3c	9648.0ab	8250.6b	5526.3a	6750.7a	5137.8a	4644.1ab	5722.4a	4230.6b	7401.0a	6686.4ba	6597.8cb
G_5	7610.3cb	10195.7a	7664.2b	8170.4a	8930.9a	8884.7a	5325.8a	6334.4a	5773.2a	7683.0a	6960.9a	7002.5a
G_6	7286.1c	10896.9a	8605.3b	8909.8a	9837.1a	8809.5a	5800.8cb	7144.7a	5863.4b	8862.2a	8424.0a	8149.1a

Note : Means followed by the same letter in a row in individual environment do not differ significantly at P = 0.05

Pulse Research, Kanpur 13th-15th May 2013.

Meena B K, Hulihall U K, Sumeriya H K and Padiwal N K. 2013. Physical characters, yield and nutrient concentration and its uptake by medium duration pigeonpea hybrid ICPH 2671 as influenced by fertility levels and planting geometry. *Annals of Agri-Bio Research.* **18** (3): 328-335.

Mula M G, Saxena K B, Rathore A and Kumar R V. 2013. Effect of row ratio, spacing and irrigation on seed production of a hybrid parent line ICPA 2043 (CMS) of pigeonpea. *Green Farming.* **4** (3) **:** 262-266.

Mula M G and Saxena K B. 2010. *Lifting the Level of Awareness on Pigeonpea - A global perspective.* Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. pp. 540. ISBN : 978-92-9066-535-9.

Saxena K B, Kumar R V, Tikle A N, Saxena M K, Goutam V S, Rao S K, Khare D K, Chouhan Y S, Saxena R K, Reddy B V S, Sharma D, Reddy L J, Green J M, Faris D G, Mula M, Sultana R, Srivastava R K, Gowda C L L, Sawargaonkar S L and Varsney R K. 2013. ICPH 2671 the world's first commercial food legume hybrid. *Plant breeding.* **135 :** 479-485.

Saxena K B, Kumar R V and Sultana R. 2010. Quality nutrition through pigeonpea a review. *Health.* **2** (11) **:** 1335-1344.

Sekhon H S, Singh G, Sidhu P S and Sarlach R S. 1996. Effect of varying plant densities on the growth and yield of new pigeonpea hybrid and another genotypes. *Crop Improvement.* **23 :** 93-98.

Sharma M K, Sisodia B S and Kanhaiya Lal. 2013. Growth and trends of pulse production in India. *Journal of Food Legumes.* **26** (1&2) **:** 86-92.

Tuppad G B, Koppalkar B G, Halepyati A S and Desai B K. 2012. Yield and economics of pigeonpea genotypes as influenced by planting geometry under rainfed condition. *Karnataka J. Agric. Sci.* **25** (2) **:** 179-182.