Green Farming Vol. **6** (3) : 525-528 ; May-June, 2015 **Research Paper**

Integrated cultural management on the yield and yield traits of pigeonpea hybrids and varieties

M.G. MULA[a1+], D.P. THAKARE[ab2*], S.P. MEHTRE[b3], A. RATHORE[a4] and ANILKUMAR VEMULA[a5]

[a]*International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru - 502 324 (A.P.)*

[b]*Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani - 431 402 (Maharashtra)*

Received : 01 September 2014 ; Revised accepted : 21 April 2015

ABSTRACT

Six pigeonpea genotypes of medium duration hybrids (ICPH 2671, ICPH 2740 and ICPH 3762) and varieties (BDN 711, BSMR 736 and Asha) were evaluated applying different integrated agronomic approaches for the various yield and yield traits of pigeonpea at Vansantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani, Maharashtra in k*harif* 2011 and 2012. The findings indicated that among the three treatments, T_2 recorded the highest seed yield of 4378.87 kg/ha as compared to T_3 (3530.71 kg/ha) and T_1 (3151.79 kg/ha). Of the six genotypes, ICPH 3762 produced the highest number of pod clusters (394.6), number of pods (725.91) and seed yield/plant (171.98 g) which translated to total seed yield of 3931.51 kg/ha. The effect of genotype × treatment interaction showed that ICPH 3762 with T_2 recorded higher number of pod clusters (514.07), more pods (830.13) and better yield/plant (198.47 g) which tantamount to higher seed yield of 4566.67 kg/ha. The results indicated that following spacing of 75 cm x 60 cm along with fertilizer rate of 50 kg N:100 P_2O_5 kg/ha in split application at 50% as basal and 50% at 60 days after sowing including two protective irrigations (at mid-flowering and mid-pod development stage) significantly increases total seed yield (kg/ha).

Key words : *Cultural management, Hybrids & varieties, , Morphological traits, Pigeonpea genotypes, Seed yield.*

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millspaugh] is considered as the most valuable food legume crop for sustainable agriculture because of its tolerant to drought and high protein content (22-24%). Pigeonpea is cultivated in 4.04 m ha with the use of over 100 released inbred cultivars however, annual production of 2.65 mt and productivity of 656 kg/ha remains low (IIPR, 2013).

According to Indian Institute of Pulses Research (IIPR) (2013), pigeonpea is widely cultivated in Maharashtra state (1.21 m ha) because of its suitability to fit into various cropping patterns Due to uneven distribution of rainfall, pigeonpea flowering and maturity has to face intense post-terminal drought. Even though the area under cultivation of pigeonpea is highest in Maharashtra (29%), productivity (704 kg/ha) is very low as compared to other states.

Hybrid technology based on cytoplasmic nuclear male sterility (CMS) was introduced in pigeonpea breeding through ICRISAT (Saxena *et al*., 2005). The two promising medium duration hybrids ICPH 2671 and ICPH 2740 were released by Madhya Pradesh and Andhra Pradesh, respectively for commercial cultivation which recorded at least 30% standard heterosis over the traditional varieties 'Maruti' and 'Asha' (Saxena *et al*., 2013). Based on Mula *et al*. research in 2013, hybrids were found superior over varieties in rainfed conditions but also have the potential to express more in terms of yield and yield contributing characters under wider spacing and irrigated conditions. Moreover, Meena *et al*. (2013) reported that the low yield of pigeonpea is mainly attributed to inadequate and imbalanced nutrient application particularly with nitrogen and phosphorus. Selection of a proper geometry (plant spacing), appropriate nutrient supply, irrigation, and pest and disease management are the most important factors to increase the productivity of pigeonpea (Ali and Kumar, 2000; Sekhon *et al*., 1996).

Hence, this investigation is designed to recognize the effect of intensive agronomy combination with spacing, irrigation and fertilizer application on hybrids and varieties of pigeonpea to improve the seed yield and its related traits.

MATERIALS AND METHODS

The investigation was carried out at Parbhani during *kharif* 2011 (Y_1) and 2012 (Y_2) in Vertisols at Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV). Three medium duration 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)] of pigeonpea were used. The seeds were treated with tetra methyl thiuram disulphide @2.5g/kg prior to sowing

[1]Sr. Scientist [+](m.mula@cgiar.org), [3]Assoc. Professor, [4]Scientist,
[2]Ph.D. Scholar *(dipalithakare02@gmail.com), [5]Scientific Officer

needing three treatments (a combination of spacing, fertilizer, and irrigation): T_1 – control [75 cm x 30 cm + 100 kg/ha di-ammonium phosphate (DAP) as basal + No irrigation]; T_2 – 75 cm x 60 cm + [50 N kg/ha + 100 P_2O_5 kg/ha (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 cm x 30 cm + [50 N kg/ha + 100 P_2O_5 kg/ha (split application at 50% as basal and 50% at 60 days after sowing)] + two irrigations (during mid-flowering and mid-pod development stage). Recommended package of cultural practices and plant protection measures were adopted as per need to raise a healthy crop.

Five competitive plants were selected for recording the data on various morphological characters like days to 50% flowering, plant height, number of pod clusters/plant, number of pods, seed yield/plant and total seed yield.

Statistical analysis : The experiment was laid out in Split Plot design with three treatments (T_1, T_2, and T_3) consisting three replications (as whole plot units) and six genotypes (G_1, G_2, G_3, G_4, G_5, and G_6) as sub-plot units for two seasons. For each morphological trait, data were analyzed by Multi-year split plot design using SAS MIXED procedure (SAS Inst. 2002-2008, SAS V 9. 3).

RESULTS AND DISCUSSION

Days to 50% flowering : Days to 50% flowering was significant in both seasons (**Table 1**) where early flowering was observed in the Y_2 (114.7 days) as compared to Y_1 (120.9). Genotypes flowered late in Y_1 due to extended rainy season which led to prolong vegetative & reproductive stage (**Table 2**).

Among the genotypes (Table 2), BDN 711 flowered earlier (105.4 days) whereas, ICPH 3762 flowered late (124.8 days). Amid three hybrids, ICPH 2671 recorded early flowering (115.1) than ICPH 2740 (121.5 days) and ICPH 3762 (124.8 days).

The treatment effect was found non-significant to days to 50% flowering which corresponds to the findings of Walelign and Walelign (2012). Out of three treatments, T_1 exhibited early flowering (117.5 days) while T_3 flowered late (118.1 days).

In genotype × treatment (G × T) interaction effect, G_4T_1 (105.3 days) and G_4T_3 (105.3 days) recorded significantly early flowering as compared to other G × T combinations (**Table 3**).

Plant height at maturity (cm) : A significant differences for plant height were observed between two seasons (Table 1) where Y_1 (189.28 cm) was noted higher than Y_2 (174.11 cm) as revealed in Table 2.

Table 1. Analysis of variance (ANOVA) (F values) for various morphological traits of pigeonpea

Source	Df	Days to 50% flowering (no.)	Plant height at maturity (cm)	Primary branches /plant (no.)	Pod clusters /plant (no.)	Pods per Plant (no.)	Seed yield /plant (g)	Total seed yield (kg/ha)
Year	1	1074.80**	30.25**	115.98**	22.28**	5.72	12.17*	27.09**
Genotype	5	2050.53**	31.45**	10.72**	13.02**	7.79**	5.24**	4.93**
Treatment	2	3.75	0.39	0.31	11.35**	17.72**	12.90**	42.90**
Genotype x Treatment	10	2.40**	0.60	0.79	4.69**	3.80**	0.61	0.44

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

Table 2. Mean performance of treatments & cultivars of pigeonpea for yield & its related traits for across the seasons

Year	Treat-ments	Geno-types	Days to 50% flowering (no.)	Plant height at maturity (cm)	Primary branches/ plant (no.)	Pod clusters /plant (no.)	Pods per plant (no.)	Seed yield/ plant (g)	Total seed yield (kg/ha)
Y_1			120.9^{a}	189.28^{a}	15.77^{a}	382.9^{a}	665.33	184.3^{a}	4224.76^{a}
Y_2			114.7^{b}	174.11^{b}	9.91^{b}	241.6^{b}	514.88	127.94^{b}	3149.49^{b}
	T_1		117.5	182.32	12.77	252.3^{b}	492.78^{b}	132.07^{b}	3151.79^{b}
	T_2		117.8	180.66	12.64	338.1^{ab}	617.00^{a}	162.86^{a}	4378.87^{a}
	T_3		118.1	182.11	13.12	346.5^{a}	660.54^{a}	173.43^{a}	3530.71^{b}
		ICPH 2671(G_1)	115.1^{e}	185.33^{bc}	13.03b^{c}	333.6^{ab}	603.81^{ab}	170.01^{a}	3828.32^{ab}
		ICPH 2740(G_2)	121.5^{c}	192.24^{a}	14.01^{ab}	297.6^{bc}	558.36^{bc}	167.81^{a}	3781.25^{ab}
		ICPH 3762(G_3)	124.8^{b}	188.77^{ab}	14.45^{a}	394.6^{a}	725.91^{a}	171.98^{a}	3931.51^{a}
		BDN 711(G_4)	105.4^{f}	156.54^{d}	9.46^{d}	201.0c	474.41^{c}	120.93^{a}	3263.51^{c}
		BSMR 736(G_5) (Control)	114.9^{d}	186.21^{bc}	12.49^{c}	328.7^{ab}	590.99^{bc}	148.82^{b}	3635.91^{b}
		Asha(G_6) (Control)	125.1^{a}	181.07^{c}	13.60^{bc}	318.3^{bc}	587.17^{b}	157.17^{b}	3682.24^{ab}
		CV	0.91	4.25	19.11	22.74	20.5	22.05	11.4

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

Table 3. Genotype x treatment interaction for different morphological characters of pigeonpea for across the seasons.

Interaction	Days to 50% flowering (no.)	Plant height at maturity (cm)	Primary branches/ plant (no.)	Pod clusters /plant (no.)	Pods per plant (no.)	Seed yield/ plant (g)	Total seed yield (kg/ha)
G_1T_1	115.3^{f}	185.82	13.48	284.23^{efgh}	547.20^{defg}	144.03	3331.64
G_2T_1	121.2^{e}	194.88	13.72	256.60^{fghi}	481. 60^{fg}	141.53	3206.33
G_3T_1	124.0^{c}	186.35	15.00	240.80^{fghi}	466.83^{fg}	133.77	3340.43
G_4T_1	105.3^{g}	155.10	8.52	189.87^{i}	518.43^{defg}	107.52	2667.33
G_5T_1	114.7^{f}	189.37	12.00	244.17^{fghi}	438.87^{g}	123.08	3251.40
G_6T_1	124.3^{bc}	182.42	13.90	298.20^{efg}	503.73^{efg}	142.48	3113.63
G_1T_2	114.8^{f}	185.25	13.70	394.40^{bcd}	649.00^{bcd}	173.10	4508.14
G_2T_2	121.2^{e}	192.62	13.87	280.47^{efgh}	548.80^{cdefg}	175.37	4514.61
G_3T_2	125.0^{ab}	190.72	13.02	514.07^{a}	830.13^{a}	198.47	4566.10
G_4T_2	105.5^{g}	156.00	9.87	200.23^{hi}	462.77^{g}	120.38	3911.16
G_5T_2	115.2^{f}	179.47	12.20	290.47^{efg}	571.23^{cdefg}	144.98	4219.52
G_6T_2	125.2^{ab}	179.90	13.17	348.70^{cde}	640.07^{bcde}	164.88	4553.67
G_1T_3	115.0^{f}	184.93	11.92	322.03^{def}	615.23^{cdef}	192.90	3645.18
G_2T_3	122.2^{d}	189.23	14.45	355.83^{cde}	644.67^{bcde}	186.54	3622.81
G_3T_3	125.5^{a}	189.23	15.33	428.90^{abc}	880.77^{a}	183.70	3900.44
G_4T_3	105.3^{g}	158.53	10.00	212.77^{ghi}	442.03^{g}	134.88	3212.05
G_5T_3	114.8^{f}	189.80	13.27	451.40^{ab}	762.87^{ab}	178.38	3436.80
G_6T_3	125.8^{a}	180.90	13.73	307.97^{def}	617.70^{cdef}	164.15	3367.00

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

Genotypes were significantly different in plant height in which ICPH 3762 recorded higher plants (192.24 cm) while BDN 711 exhibited shorter plants (156.54 cm). Overall, hybrids found taller than the varieties (Table 2) which is in accordance with Shoba and Balan (2010).

Significant differences were not observed due to treatments effect. Among three treatments, T_1 produced taller plants (182.32 cm) however, shorter plant height was observed in T_2 (180.66 cm). The interaction of genotype × treatment effect were found non-significant however, ICPH 2740 recorded taller plants (194.88 cm) in T_1 (G_2T_1) while BDN 711 in T_1 (G_4T_1) obtained the shortest plant (155.10 cm) (Table 3).

Number of primary branches/plant : Highly significant variation were found between two seasons for no. of primary branches (Table 1) which reflects that highest no. of primary branches is in Y_1 (15.77) as compared to Y_2 (9.91) (Table 2).

Significant differences were observed on the effect of genotypes. Among six genotypes, ICPH 3762 gave the highest number of primary branches (14.45) over BSMR 736 (12.49) and Asha (13.60) while BDN 711 exhibited the lowest number of primary branches (9.46) as revealed in Table 2 which conforms to the findings of Sameer Kumar *et al*. (2009).

The treatment effect had no significant variation as represented in Table 1 however, T_3 recorded highest number of primary branches (13.12) and T_2 gives least number of primary branches (12.64) which conforms the results of Tuppad *et al*. (2012).

Genotype × treatment (G × T) interaction effect was found non-significant for the number of primary branches. Moreover, ICPH 3762 in T_3 showed the highest (15.33) number of primary branches and BDN 711 in T_1 produced less (8.52) number of primary branches.

Number of pod clusters/plant : The number of pod clusters was significantly different amid seasons, genotypes, treatments, and genotype × treatment interaction (Table 1). Table 2 revealed that significantly more number of pod clusters were recorded in Y_1 (382.9) than Y_2 (241.6).

Out of six genotypes, ICPH 3762 had more number of pod clusters (394.6) over Asha (318.3) and BDN 711 (201.0) which corresponds to the findings of Kyu (2011) where hybrids had more number of pod clusters/plant than varieties. Among treatments, T_3 produced more number of pod clusters (346.5) than T_1 (252.3) but not significant with T_2 (338.1) as shown in Table 2. The effect of genotype × treatment interaction (Table 3) showed that ICPH 3762 with T_2 (G_3T_2) produced the highest number of pods clusters (514.07) while BDN 711 with T_1 (G_4T_1) recorded the least number of pods clusters (189.87).

Number of pods/plant : A significant difference on the number of pods/plant amongst the genotype as shown in Table 1 which indicated the existence of variability among the genotypes. As such, the performance of genotypes across the seasons (Table 2) indicated that ICPH 3762 produced the highest number of pods (725.91) over both controls (BSMR 736 - 590.99 and Asha - 587.17) while BDN 711 produced the least pods (474.41) which is in conformity to the finding of Goud *et al*. (2012).

Treatment effect showed that significantly greater number of pods was recorded in T_3 (660.54) than T_1 (492.78) but not significant over T_2 (617.00) as presented in Table 2 which corresponds to the results of Tuppad *et al*. (2012). The effect of genotype × treatment interaction revealed that more pods was noted in ICPH 3762 with T_2 (G3T2) at 830.13 while minimum number of pods was produced by BSMR 736 with T_1 (G_5T_1) at 438.87 for across the seasons (Table 3). This finding was in accordance with Meena *et al*. (2013) where hybrids produced more pods in wider spacing and fertilizer rate.

Seed yield/plant : A significant variation was observed in seed yield/plant across two seasons (Table 1) where the highest seed yield was recorded in Y_1 (184.3) than Y_2 (127.94 g) (Table 2).

The effect of genotypes showed significant differences for seed yield (Table 1). Out of six genotypes of pigeonpea (Table 2), ICPH 3762 (171.98 g) produced the highest yield followed by ICPH 2671 (170.98 g) and ICPH 2740 (167.81 g) over the controls (BSMR 736 - 148.82 g and Asha - 157.17 g) while BDN 711 yielded the lowest (120.93 g) which is in accordance to the findings of Meena *et al*. (2013).

The effect of treatment was significantly different on the seed yield as shown in Table 2 where T_3 produced more seeds (173.43 g) as compared to T_1 (132.07 g) but not significantly different in T_2 (162.86 g) which conforms to the findings of Tuppad *et al*. (2012). The genotype × treatment interaction effect was not significant for seed yield however, the highest seed yield/plant was noted by ICPH 3762 in T_2 (98.47 g) while the least seed yield/plant was BDN 711 in T_1 (107.52 g).

Total seed yield/ha (kg) : The total seed yield was different across season (Table 1) in which the highest seed yield produced was in Y_1 (4224.76 kg/ha) (Table 2) which is in line to the discoveries of Rathore and Sharma (2011) where the mean performance of yield is a complex character that is influenced by various environmental effects.

Significant variation were noted among the genotypes for total seed yield (Table 1) where ICPH 3762 yielded more seeds (3931.51 kg/ha) over the controls (BSMR 736 - 3635.91 kg/ha and Asha - 3682.24 kg/ha) whereas, BDN 711 produced the least at 3263.51 kg/ha (Table 2) which conforms to the results of Meena *et al*. (2013); and Saxena *et al*. (2013).

Among three treatments, T_2 recorded significantly higher seed yield (4378.87 kg/ha) as compared to T_3 (3530.71 kg/ha) and T_1 (3151.79 kg/ha) as shown in Table 3. Similar results were reported by Tuppad *et al*. (2012); and Goud *et al*. (2012) which indicated that under wider spacing and higher fertilizer rate pigeonpea genotypes contributed more seed yield because of more availability of area, nutrients, light and moisture.

No significant differences were observed in genotype × treatment interaction effect nevertheless, the highest total seed yield (4566.10 kg/ha) was obtained by hybrid ICPH 3762 in T_2 (G_3T_2) while the lowest total seed yield (2667.33 kg/ha) was recorded in G_4T_1 (BDN 711 in T_1) (Table 3).

REFERENCES

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

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 :** 261-264.

Indian Institute of Pulses Research (IIPR), Kanpur 2013. All India Co-ordinate Research Project on Pigeonpea, *Project Co-ordinator's Report, Indian Institute of Pulse Res.,* Kanpur 13th-15th May 2013.

Kyu K L. 2011. Studies on hybrid vigour and inbreeding depression in CMS-based pigeonpea [*Cajanus cajan* (L.) Millspaugh] hybrids. Master thesis, A.N.G.R. Agri. Univ., Hyderabad (Unpublished).

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 :** 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 :** 262-266.

Rathore H K and Sharma R N. 2011. Association studies among yield and attributes in erect and semi-spreading pigeonpea (*Cajanus cajan l*). *Elixir Agriculture*. **30 :** 1843-1847.

Sameer Kumar, C V, Ch Sreelakshmi and Kishore Varma P. 2009. Studies on combining ability and heterosis in pigeonpea (*Cajanus cajan* L.). *Legume Research.* **32** (2) **:** 92-97.

Saxena K B, Kumar R V, Srivastava N and Shiying B. 2005.A cytoplasmic nuclear male sterility system derived from a cross between *Cajanus cajanifolius* and *Cajanus cajan. Euphytica*. **145 :** 289-294.

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 Varshney R K. 2013. ICPH 2671 – the world's first commercial food legume hybrid. *Plant Breeding.* **135 :** 479-485.

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.

Shoba D and Balan A. 2010. Heterosis in CMS/GMS based pigeonpea [*Cajanus cajan* (L.) Millsp.] hybrids. *Agriculture Science Digest*. **30** (1) **:** 32-36.

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 :** 179-182.

Walelign Worku and Walelign Desimie 2012. Growth, light interception and radiation use efficiency response of pigeonpea (*Cajanus cajan*) to planting density in Southern Ethiopia. *Journal of Agronomy*. **11** (4) **:** 85-93.

□