

Agronomic management of pigeonpea (*Cajanus cajana*) based intercropping systems for improving productivity under rainfed conditions

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Abstract: A field experiment was conducted at Gulbarga during *kharif* seasons of 2003 - 2005 to evaluate the effect of two pigeonpea varieties viz., ICPL-87119 (Asha) and ICP-8863 (Maruti) and two intercrops viz., greengram cv. Chinamung and pearl millet cv. ICTP-8203 in 1:2 row proportions. The pooled results indicated that intercropping of pigeonpea genotype ICPL-87119 (Asha) with greengram (15.11 q/ha) and pearl millet (13.87 q ha⁻¹) recorded significantly higher seed yield as compared to ICP-8863 (Maruti) genotype intercropped with greengram (13.69 q ha⁻¹) and pearl millet (12.56 q ha⁻¹). The seed yield of greengram and pearl millet were more when intercropped with Asha (3.24 and 5.46 q ha⁻¹, respectively) genotype as compared to ICP-8863 (Maruti) (2.96 and 5.04 q ha⁻¹, respectively). Among the cropping systems, pigeonpea ICPL-87119 (Asha) + greengram intercropping system with RDF + 2% urea spray at 15 and 30 Days after harvest of intercrops recorded significantly higher pigeonpea equivalent (19.53 and 18.99 q ha⁻¹), gross returns (Rs. 31439 and 30576 ha⁻¹), net returns (Rs. 23984 and 22928 ha⁻¹) and B:C ratio (3.81 and 3.63) over other intercropping systems.

Key words: Intercropping, pigeonpea genotype, greengram, pearl millet, foliar spray

Introduction

Pigeonpea (*Cajanus cajana*) is an important pulse crop of dryland agriculture because of its ability to produce economic yield under limited moisture conditions. Pigeonpea is an important pulse crop of Karnataka state, having 5.80 lakh ha area, 2.60 lakh tones production and 448 kg ha⁻¹ productivity. Karnataka contribution to area and production is 16% and 12%, respectively. The productivity of pigeonpea in Karnataka is low as compared to national average productivity (689 kg ha⁻¹). Pulse production is very low, to increase pigeonpea production intercropping of pigeonpea with pulses and foliar spray of 2% urea are essential to increase the production. When pigeonpea is grown as a sole crop, it is relatively inefficient because of its slow initial growth rate and harvest index (Willey, *et al.* 1980); therefore it is grown as intercrop, which helps in efficient utilization of available resources for enhancing the productivity and profit. Intercropping is an age old practice being followed by subsistence farmers to achieve their domestic needs. The main advantage of the intercropping is that the component crops are able to use the growth resources differently and make better overall use of growth resources than grown separately (Willey, 1979). Studies showed that foliar application of urea along with recommended dose of fertilizer have given significantly higher seed yield of pigeonpea (Mathen *et al.* 1990 and Pujari *et al.* 1998). Thus an effort was made to study the effect of foliar spray of 2% urea on pigeonpea based intercropping systems in north eastern dry zone of Karnataka.

Material and methods

The field experiment was conducted on shallow black soils at Agricultural Research Station, Gulbarga, University of Agricultural Sciences; Raichur (Karnataka), during *kharif*

seasons of 2003 - 2005 to study the effect of pigeonpea based intercropping systems as influenced by genotypes and 2% urea spray. The treatment consists of two pigeonpea varieties viz., ICPL-87119 (Asha) and ICP-8863 (Maruti) and these genotypes were intercropped with greengram cv. chinamung and pearl millet cv. ICTP-8203 in 1:2 row proportions. The experiment was laid out in a randomized complete block design with three replications. The soil of the experimental field was clay loam having organic carbon 0.50 %, available nitrogen 180 kg ha⁻¹, phosphorous 25 kg ha⁻¹ and potash 350 kg ha⁻¹ and EC 0.41 dS/m with pH 8.80. Bold and healthy seeds were selected and were treated with captan 2.0 g per kg of seed. Later, the seeds were inoculated with suitable Rhizobium strains and dried in shade before sowing. The seeds were hand dibbled on 12-7-2003, 14-7-2004 and 19-7-2005 at 90 cm row spacing for pigeonpea + greengram intercropping system and 145 cm row spacing for pigeonpea + pearl millet intercropping system was followed to achieve the required plant densities. The recommended dose of fertilizers (NPK kg ha⁻¹) was given for all the component crops (Pigeonpea- 25:50:00, greengram - 25:50:00 and pearl millet - 50:25:00) in the form of urea, diammonium phosphate and muriate of potash as a basal dose. In case of intercropping treatments, the fertilizers were applied in proportionate to the sole optimum population for main crop and intercrops separately. Weeding and plant protection measures were undertaken as per need of the crops; the required plant population was maintained. Various growth parameters at 30, 60, 90, 120, 150, 180 DAS and at harvest were recorded. The crops were harvested at their physiological maturity. At the time of sowing during all the *kharif* seasons of 2003, 2004 and 2005 adequate moisture was present in the soil. During the year 2003, the rainfall of 655.30 mm was received in 37 rainy days while 726.20 mm rainfall was received in 44 rainy days during cropping period of 2004 and 695 mm rainfall was

received in 42 rainy days during 2005. The same trend of results was observed during 2003, 2004 and 2005 and hence the results of pooled analysis are used for results and discussion. Fischer's method of analysis of variance was used for analysis and interpretation of the data as outlined by Gomez and Gomez (1984).

Results and discussion

The data on plant morphogenic characters viz., plant height (cm), number of primary and secondary branches, number of pods, 100 seed weight, gross returns, net returns and B:C ratio of pigeonpea based intercropping systems were presented in Table 1, 2 and 3. The intercropping of pigeonpea genotypes with greengram and pearl millet influenced the growth and growth

parameters of pigeonpea significantly. The pigeonpea genotype Asha recorded significantly higher plant height (161.70 to 183.22 cm), number of primary (7.93 to 10.44) and secondary (4.88 to 6.43) branches, number of pods (79.64 to 90.84), 100 seed weight (10.11 to 10.18) as compared to Maruti genotype (148.27 to 168.43 cm, 7.06 to 8.40, 4.29 to 5.12, 67.88 to 78.16 and 9.14 to 9.23, respectively) under different intercropping systems with RDF + 2% urea spray. Among different intercropping treatments, intercropping of pigeonpea genotype Asha with greengram and foliar spray of 2% urea within 15 DAH recorded significantly higher plant height (183.22 cm), number of primary (10.44), secondary branches (6.43), number of pods (90.84) and 100 seed weight (10.16) as compared to rest of the intercropping treatments. Foliar spraying of urea retards the loss of chlorophyll

Table 1. Growth and growth parameters of pigeonpea in pigeonpea based intercropping systems as influenced by genotypes and 2% urea spray

Sl. No.	Treatments		Plant height (cm)				No. of primary branches				No. of secondary branches			
							Plant ⁻¹				Plant ⁻¹			
			2003	2004	2005	Pooled	2003	2004	2005	Pooled	2003	2004	2005	Pooled
1	T ₁	ICPL-87119+Greengram+RDF	170.54	168.39	155.38	164.77	9.15	9.03	8.34	8.84	5.63	5.56	5.13	5.44
2	T ₂	Treat 1+2% urea spray at 15 DAH of intercrop	189.63	187.25	172.78	183.22	10.81	10.67	9.84	10.44	6.66	6.57	6.06	6.43
3	T ₃	Treat 2+2% urea spray at 30 days of first spray	187.26	184.91	170.62	180.93	10.27	10.14	9.35	9.92	6.32	6.24	5.76	6.11
4	T ₄	ICPL-87119+Bajra+RDF	167.36	165.26	152.48	161.70	8.21	8.10	7.48	7.93	5.05	4.99	4.60	4.88
5	T ₅	Treat 4+2% urea spray at 15 DAH of intercrop	175.26	173.06	159.68	169.33	9.42	9.30	8.58	9.10	5.80	5.72	5.28	5.60
6	T ₆	Treat 5+2% urea spray at 30 days of first spray	176.44	174.22	160.75	170.47	9.64	9.51	8.78	9.31	5.93	5.86	5.40	5.73
7	T ₇	ICP- 8863+Greengram+RDF	155.54	153.59	141.71	150.28	8.61	8.50	7.85	8.32	5.30	5.23	4.83	5.12
8	T ₈	Treat 7+2% urea spray at 15 DAH of intercrop	162.91	160.86	148.43	157.40	8.56	8.45	7.80	8.27	5.27	5.20	4.80	5.09
9	T ₉	Treat 8+2% urea spray at 30 days of first spray	176.16	173.94	160.50	170.20	8.69	8.58	7.92	8.40	5.35	5.28	4.88	5.17
10	T ₁₀	ICP-8863+Bajra+RDF	153.46	151.53	139.82	148.27	7.27	7.17	6.62	7.02	4.47	4.42	4.07	4.32
11	T ₁₁	Treat 10+2% urea spray at 15 DAH of intercrop	174.33	172.14	158.83	168.43	7.21	7.12	6.57	6.97	4.44	4.38	4.05	4.29
12	T ₁₂	Treat 11+2% urea spray at 30 days of first spray.	172.15	169.99	156.85	166.33	7.31	7.22	6.66	7.06	4.49	4.44	4.09	4.34
		S.Em+	5.75	4.92	4.68	4.58	0.29	0.31	0.26	0.28	0.18	0.21	0.20	0.17
		C D at 5%	16.86	14.43	13.97	13.52	0.86	0.92	0.77	0.84	0.55	0.62	0.59	0.52

RDF=Recommended Dose of Fertilizer, DAH= Days after harvest

Table 2. Yield of intercrops and pigeonpea in pigeonpea based intercropping systems as influenced by genotypes and 2% urea spray

Sl. No.	Treatments	No. of pods plant ⁻¹			100 seed weight (g)			Yield of intercrops (q ha ⁻¹)			Yield of pigeonpea (q ha ⁻¹)		
		2003	2004	2005	Pooled	2003	2004	2005	Pooled	2003	2004	2005	Pooled
1	T ₁ ICPL-87119+Greengram+ RDF	85.45	84.38	77.85	82.56	10.46	10.33	9.53	10.11	3.29	2.62	3.42	3.11
2	T ₂ Treat 1+2% urea spray at 15 DAH of intercrop	94.02	92.84	85.66	90.84	10.52	10.38	9.58	10.16	3.34	2.84	3.57	3.25
3	T ₃ Treat 2+2% urea spray at 30 days of first spray	91.45	90.30	83.32	88.36	10.49	10.36	9.56	10.14	3.45	2.94	3.69	3.36
4	T ₄ ICPL-87119+Bajra+RDF	82.43	81.39	75.10	79.64	10.48	10.35	9.55	10.13	5.18	4.11	6.21	5.16
5	T ₅ Treat 4+2% urea spray at 15 DAH of intercrop	86.15	85.07	78.50	83.24	10.52	10.38	9.58	10.16	5.38	4.72	6.35	5.48
6	T ₆ Treat 5+2% urea spray at 30 days of first spray	87.31	86.22	79.55	84.36	10.54	10.40	9.60	10.18	5.47	5.34	6.40	5.73
7	T ₇ ICP-8863+Greengram+RDF	72.12	71.21	65.71	69.68	9.46v	9.34	8.62	9.14	2.98	2.12	3.25	2.78
8	T ₈ Treat 7+2% urea spray at 15 DAH of intercrop	77.91	76.94	70.99	75.28	9.48	9.36	8.64	9.16	2.84	2.61	3.41	2.95
9	T ₉ Treat 8+2% urea spray at 30 days of first spray	80.90	79.88	73.70	78.16	9.53	9.41	8.69	9.21	3.08	2.81	3.58	3.15
10	T ₁₀ ICP-8863+Bajra+RDF	70.26	69.37	64.01	67.88	9.48	9.36	8.64	9.16	4.86	3.91	5.51	4.64
11	T ₁₁ Treat 10+2% urea spray at 15 DAH of intercrop	76.42	75.46	69.63	73.84	9.48	9.36	8.64	9.16	5.01	4.63	5.45	5.03
12	T ₁₂ Treat 11+2% urea spray at 30 days of first spray.	78.37	77.39	71.40	75.72	9.55	9.43	8.70	9.23	5.54	5.28	5.58	5.46
SEm+		2.42	2.89	2.63	2.36	0.07	0.09	0.08	0.04	0.37	0.41	0.35	0.15
C D at 5%		7.10	8.69	7.88	7.08	0.20	0.26	0.23	0.13	1.11	1.20	1.04	0.45

RDF=Recommended Dose of Fertilizer, DAH= Days after harvest

and leaf nitrogen with increase in photosynthetic ability resulting in higher growth attributing characters. These findings are in conformity with results obtained by Malla Reddy *et al* (2005) and Manjula Devi and Pillai (1987) who have reported significantly higher growth and yield parameters of black gram with 2% urea spray at 30, and 60 DAS over control.

Among the two pigeonpea varieties, Asha recorded significantly higher seed yield over Maruti in pigeonpea + greengram and pigeonpea + Pearl millet intercropping systems. The average seed yield of Asha was 15.11 q ha⁻¹ in pigeonpea + greengram and 13.87 q ha⁻¹ in pigeonpea + pearl millet intercropping systems. Whereas, the seed yield of Maruti genotype was 13.69 q ha⁻¹ and 12.56 q ha⁻¹ in pigeonpea + greengram and pigeonpea + pearl millet intercropping systems respectively. Padmalatha and Gurunath Rao (1993) studied yield potentiality of pigeonpea varieties viz., ICPL-1, ICPL-4 and ICPL-312 and concluded that ICPL-1 produced 10 and 54 per cent higher yield when compared to ICPL-312 and ICPL-4, respectively. Nagamani *et al.* (1995) reported significantly higher seed yield in ICPL-8863 over ICPL-332 at Bapatla. The reason for higher yield was attributed to better utilization of resources like light, nutrients and moisture by pigeonpea + greengram intercropping system. Arjun Sharma *et al.*, 2004, reported highest yield of pigeonpea+ greengram intercropping system compared to pigeonpea + little millet and pigeonpea + foxtail millet

intercropping system. Rathod *et al.*, 2004 observed that intercropping of groundnut and French bean with pigeonpea in 1:2 or 1:3 row ratios resulted in maximum pigeonpea yield over pigeonpea intercropped with cowpea and sesame.

The yield of intercrops viz., greengram and pearl millet were more when intercropped with pigeonpea genotype Asha as compared to Maruti. The yield of greengram ranged from 3.11 to 3.36 q ha⁻¹ and 2.78 to 3.15 q ha⁻¹ respectively, in Asha and Maruti intercropping systems. Similarly the yield of pearl millet ranged from 6.21 to 6.40 q ha⁻¹ and 4.64 to 5.46 q ha⁻¹ respectively, in Asha and Maruti intercropping systems.

Effect of 2% foliar spray of urea on seed yield of Asha and Maruti varieties of pigeonpea, Asha recorded higher seed yields of 15.99 q ha⁻¹ (T2) and 14.10 q ha⁻¹ (T5) when urea was sprayed at 15 days after harvest of the intercrops greengram and pearl millet respectively, compared to urea spray at 30 days after harvest of the intercrops. But Maruti recorded higher seed yields of 14.21 q ha⁻¹ (T9) and 12.86 q ha⁻¹ (T12) when urea was sprayed at 15 days after harvest of the intercrops greengram and pearl millet respectively, compared to urea spray at 30 days after harvest of the intercrops. These results are in conformity with the findings of Mathan *et al.* (1994) who reported the higher yield of pigeonpea when 2% DAP was sprayed at 70 days after sowing.

Table 3. Pigeonpea equivalent yield and economic analysis of pigeonpea based intercropping systems as influenced by genotypes and 2% urea spray (Pooled over 3 years)

Treatments	PEY				Gross returns				Net returns				B:C ratio			
	(q ha ⁻¹)				(Rs ha ⁻¹)				(Rs ha ⁻¹)							
T1 ICPL-87119+Greengram+RDF	19.48	15.61	17.08	17.39	31170	26572	26252	27998	23125	18527	18207	20653	3.87	3.30	3.26	3.48
T2 Treat 1+2% urea spray at 15 DAH of intercrop	23.56	18.10	16.95	19.54	34492	30552	29274	31439	26242	22302	21024	23984	4.18	3.70	3.55	3.81
T3 Treat 2+2% urea spray at 30 days of first spray	22.45	18.87	15.66	18.99	32722	30188	28818	30576	24307	21773	20403	22928	3.89	3.59	3.42	3.63
T4 ICPL-87119+Bajra+RDF	17.57	13.64	13.16	14.79	26510	22951	21057	23506	18385	14826	12932	16279	3.26	2.82	2.59	2.89
T5 Treat 4+2% urea spray at 15 DAH of intercrop	19.17	15.71	12.89	15.92	27474	25128	23303	25301	19199	16853	15028	18004	3.32	3.04	2.82	3.06
T6 Treat 5+2% urea spray at 30 days of first spray	18.44	16.58	14.02	16.35	27903	26526	23504	25977	19478	18101	15079	18553	3.31	3.15	2.79	3.08
T7 ICP-8863+Greengram+RDF	17.70	15.65	15.06	16.14	28324	25032	24602	25986	20279	16987	16557	18591	3.52	3.11	3.06	3.23
T8 Treat 7+2% urea spray at 15 DAH of intercrop	19.12	16.97	14.88	16.99	28984	27146	25930	27353	20734	18896	17680	21678	3.51	3.29	3.14	3.32
T9 Treat 8+2% urea spray at 30 days of first spray	18.63	19.85	14.44	17.64	29816	33378	26860	30018	21401	24963	18445	20702	3.54	3.97	3.19	3.57
T10 ICP-8863+Bajra+RDF	17.37	12.50	10.95	13.61	24590	21363	19123	21692	16465	13238	10998	14343	3.03	2.63	2.35	2.6
T11 Treat 10+2% urea spray at 15 DAH of intercrop	10.93	13.98	14.08	12.99	25513	22363	20933	22936	17238	14088	12658	15546	3.08	2.70	2.53	2.77
T12 Treat 11+2% urea spray at 30 days of first spray.	18.28	14.45	10.99	14.57	26050	23120	20790	23320	17625	14695	12365	15797	3.09	2.74	2.47	2.7
S.E.m±	0.55	0.61	0.51	0.41	936	942	902	894	710	693	721	642	0.13	0.15	0.18	0.6
C D at 5%	1.61	1.82	1.55	1.08	2745	2820	2701	2681	2083	2080	2165	1928	0.38	0.45	0.52	0.46

Price of produce: Pigeonpea: Rs. 1600, 1600, 1750. Greengram: 1800, 1800, 1800 and Bajra: 500,500,500, respectively during 2003, 2004 and 2005.

PEY= Pigeonpea Equivalent Yield, RDF=Recommended Dose of Fertilizer, DAH= Days after harvest.

Among the intercropping systems the yield levels of pigeonpea was more when intercropped with greengram compared to pearl millet irrespective of the pigeonpea varieties (Table 2). Among the two varieties of pigeonpea, Asha recorded higher seed yield compared to Maruti irrespective of the intercrops used and 2% urea foliar sprayed at 15 or 30 days after harvest of the inter crops.

Significantly higher average pigeonpea equivalent yield of 17.78 q ha⁻¹ was noticed in pigeonpea+ greengram intercropping systems irrespective of the pigeonpea variety compared to pigeonpea + pearl millet (14.71 q ha⁻¹) intercropping system. This was attributed to better performance and yield of component crops coupled with higher market price of pigeonpea and greengram. Similarly Pujari (1996) reported significantly higher pigeonpea equivalent yield when it was intercropped with medium duration pigeonpea as compared to short duration genotype. But among the two pigeonpea varieties Asha + greengram intercropping system recorded higher pigeonpea equivalent yield compared to Maruti + greengram intercropping system irrespective of the treatments. Similar results were obtained by Arjun Sharma *et al.*, 2004.

The intercropping system of pigeonpea genotypes with greengram and bajra with RDF + 2% urea spray at 15 DAH and 30 DAH recorded higher gross returns, net returns and B: C ratio under different intercropping treatments. The higher gross returns, net returns and B: C ratio was due to the maximum yield of component crops coupled with higher market price. Among cropping systems studied, significantly higher gross returns (Rs. 31439 ha⁻¹), net returns (Rs. 23984 ha⁻¹) and B: C ratio (3.81) was obtained with pigeonpea genotype Asha + greengram intercropping system with RDF + 2% urea spray at 15 days after harvest of intercrops as compared to the rest of the intercropping systems. Satishkumar *et al* (2003) also reported that pigeonpea + greengram in 1:2 row ratios gave the highest net returns (Rs. 12,278 ha⁻¹) and benefit cost ratio (2.09).

Among the two varieties of pigeonpea, Asha recorded higher growth parameters, yield and economics as compared to Maruti irrespective of the intercrops used and 2% foliar spray of urea at 15 or 30 days after harvest of the intercrops.

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