

Original Research Article

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Productivity Potential and Economic Feasibility of Pigeonpea + Blackgram Intercropping and Integrated Nutrient Management

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ABSTRACT

Field experiment was conducted in Indira Gandhi Agriculture University, Raipur (C.G.) during *Kharif* 2015 to *Rabi* 2017. The experiment field was clayey with neutral pH. The experiment were laid out in split plot design with three replications consisted of pigeonpea and blackgram intercropping under cropping systems and integrated nutrient management viz., C₁-Pigeonpea sole (60 x 20cm), C₂-Black gram sole (30 x 10 cm), C₃-Normal planting of Pigeonpea (60 x 20 cm) + Blackgram (1 row), C₄-Paired planting of Pigeonpea (45/75 cm x 20 cm) + Blackgram (2 rows); F₀-Absolute control, F₁-100 % RDF, F₂-50 % RDF, F₃-FYM @ 5 t ha⁻¹, F₄-100 % RDF + FYM @ 5 t ha⁻¹, F₅-100 % RDF+ *Rhizobium* + PSB + *Trichoderma*, F₆-50 % RDF+ FYM @ 5 t ha⁻¹ and F₇-50% RDF+ FYM @ 5 t ha⁻¹+ *Rhizobium* + PSB + *Trichoderma*. The result revealed that significantly highest value of yield attributes and yield were recorded under sole pigeonpea (C₁) and sole blackgram (C₂). Whereas, highest equivalent yield, gross return, net return and B: C were recorded under pigeonpea + blackgram 1:1 (C₃). Among the integrated nutrient management, application of 50% RDF+ FYM @ 5 t ha⁻¹+ *Rhizobium* + PSB + *Trichoderma* (F₇) gave significantly higher yield attributes, yield, gross return, net return and B:C ratio of both crop followed by 100 % RDF + FYM @ 5 t ha⁻¹ (F₄), 100 % RDF+ *Rhizobium* + PSB + *Trichoderma* (F₅).

Keywords

Productivity potential,
Economic feasibility,
Pigeonpea,
Blackgram.

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Introduction

The greatest challenge of the 21st century in many developing countries are to produce more and more basic necessities namely food, fodder, fuel and fibre for ever increasing human and animal population from the limited available land. The availability of land for agriculture is shrinking every day as it is increasingly utilized for non-agricultural purposes. Under this situation, one of the important strategies to increase agricultural productivity and intensive land use is development of high intensity cropping systems including intercropping system. This has lead to the crisis of shortage of pulses in

India, which has aggravated the problem of malnutrition. The capita⁻¹ availability of pulses in India has declined from 64 g day⁻¹ (1951-56) to 36 g day⁻¹ (2002-03), as against FAO/WHO's recommendation of 80 g day⁻¹ (Asthana and Chaturvedi, 1999). Thus, there is an urgent need to increase the production of pulses to meet the requirement by manipulating the production technologies appropriately. Pigeonpea, a deep rooted crop with slow initial growth rate between 60 and 70 days after sowing is well suited for intercropping. Intercropping is an intensive land use system with an objective to utilize

the space between the rows of main or base crop and to produce more produce per unit area (Nagar *et al.*, 2015). Blackgram being an efficient cover crop fits well in this system.

The greatest limitation of increasing productivity of these crops is inadequate supply of nutrients since the soils of arid region are poor in native fertility and continuous application of inorganic fertilizers even in balanced form may not sustain soil fertility and productivity (Kumawat *et al.*, 2013). Integrated nutrient management includes the intelligent use of organic, inorganic, and on-line biological resources so as to sustain optimum yields, improve or maintain the soil physical and chemical properties, and provide crop nutrition packages which are technically sound, economically attractive, practically feasible and environmentally safe.

Materials and Methods

The experiment was conducted during four consecutive *kharif- Rabi* season from 2015 and 2017 at Indira Gandhi Agriculture University, Raipur, CG (India). The experiment was laid out in split plot design with three replications consisted of pigeonpea and blackgram intercropping under cropping systems and integrated nutrient management *viz.*, C₁-Pigeonpea sole (60 x 20cm), C₂-Black gram sole (30 x 10 cm), C₃-Normal planting of Pigeonpea (60 x 20 cm) + Blackgram (1 row), C₄-Paired planting of Pigeonpea (45/75 cm x 20 cm) + Blackgram (2 rows); F₀-Absolute control, F₁-100 % RDF, F₂-50 % RDF, F₃-FYM @ 5 t ha⁻¹, F₄-100 % RDF + FYM @ 5 t ha⁻¹, F₅-100 % RDF+ *Rhizobium* + PSB + *Trichoderma*, F₆-50 % RDF+ FYM @ 5 t ha⁻¹ and F₇-50% RDF+ FYM @ 5 t ha⁻¹+ *Rhizobium* + PSB + *Trichoderma*. The soil of experiment field was 'Vertisols' which is locally known as 'Kanhar'. The soil was neutral in reaction and medium in fertility

having low N, medium P and K. The climate having sub humid climatic condition with an average of 1170 mm annual rainfall. The seed rate was 20 kg ha⁻¹ for pigeonpea and 15 kg ha⁻¹ for blackgram. The seed rate was regulated according to the proportion of area under each crop component in intercropping situations.

Pigeonpea equivalent yield was calculated by converting the seed yield of soybean in to pigeonpea yield, considering the market price of both the grains (Rs kg⁻¹). This was done with the help of following formula for each plot.

CEY (kg ha⁻¹) = Seed yield of blackgram (kg ha⁻¹) / Seed yield of pigeonpea (kg ha⁻¹) X Market price of blackgram (Rs kg⁻¹)

Net return (Rs ha⁻¹ and Rs⁻¹ invested) based on the current market price of fertilizers, prevailing wages of labours and market price of the produce.

Net return (Rs ha⁻¹) = Gross realization (Rs ha⁻¹) – Cost of cultivation (Rs ha⁻¹)

The benefit: cost ratio was calculated with the help of the following formula:

Benefit: cost ratio =
$$\frac{\text{Net return}}{\text{Total cost of cultivation}}$$

Results and Discussion

Effect on yield attributes

On the basis of mean data of 2 years data revealed that significantly higher yield attributes were recorded under sole crop, however, No of seeds pod⁻¹ of blackgram was at par with pigeonpea + blackgram 1:1 (C₃) and 100 seed weight of both crop significantly differ.

This is might due to maximum dry matter accumulation in sole crop and plant population is high in sole blackgram and low under intercropping system.

Among the integrated nutrient management, highest value of yield attributes *i.e.*, No of pod plant⁻¹, Weight of pods plant⁻¹ and No of seeds pod⁻¹ were recorded under application of F₇-50% RDF+ FYM @ 5 t ha⁻¹+ *Rhizobium* + PSB + *Trichoderma*, which was significantly superior over other. However it was at par with F₄-100 % RDF + 5 t FYM ha⁻¹, F₅-100 % RDF+ *Rhizobium* + PSB + *Trichoderma* and F₆-50 % RDF+ 5 t FYM ha⁻¹. Whereas, F₁-100 % RDF, F₂-50 % RDF, F₃-FYM @ 5 t ha⁻¹, F₄-100 % RDF + 5 t FYM ha⁻¹ was also at par for No of seeds pod⁻¹ of blackgram. The enhancement in yield attributing character may be due to improved nutrient supply and microbial activity in the rhizosphere with the application chemical fertilizer, organic manure and biofertilizer. *Rhizobium* might help in fast root nodulation and fixed more nitrogen in the roots of the plant and phosphate solubilising bacteria protect conversion of applied and native available phosphorus into unavailable forms and solubilise organic phosphorus to available forms which resulted in increasing availability of phosphorus for vital functions, resulting in improvement in growth, yield attributes and yield of pigeonpea. This result accordance with the Jat and Ahlawat (2003), Malik *et al.*, (2013) and Sikka *et al.*, (2016).

Effect on yield

Significantly maximum yield of pigeonpea, blackgram and pigeonpea equivalent yield of blackgram was recorded under sole crop. Among the integrated nutrient management practices, maximum yield of both crop was recorded under the application of F₇-50% RDF+ FYM @ 5 t ha⁻¹+ *Rhizobium* + PSB + *Trichoderma*, which was significantly

superior over others, which was at par with F₅-100 % RDF+ *Rhizobium* + PSB + *Trichoderma*. However, pigeonpea yield was also at par with F₄-100 % RDF + FYM @ 5 t ha⁻¹. Total yield was maximum under pigeonpea + blackgram 1:1 and it was at par with pigeonpea + blackgram 2:2. As regards to integrated nutrient management, maximum yield was recorded under application of F₇-50% RDF+ FYM @ 5 t ha⁻¹+ *Rhizobium* + PSB + *Trichoderma* which is significantly superior over others. While minimum yield was recorded under no fertilization application.

Pigeonpea being long duration crop with slow initial growth and deep root system did not pose any severe competition for natural resources with blackgram under different cropping system and also it adds organic matter through leaf litter production and biologically fixed nitrogen for the benefit of the intercropping systems. On the other hand blackgram being fast growing shallow rooted crop, utilized the resources from top layer (0-30 cm) of the soil and serving as cover crop conserved soil moisture reduced soil temperature and added organic matter to the soil. This is in accordance with the findings of Bhatti *et al.*, (2006), Pramod *et al.*, (2006) and Padhi *et al.*, (2010). Combine application of inorganic fertilizer, organic manure (FYM) with biofertilizers also helps in conversion of unavailable nutrients to available form through increased microbial activity and enabled the crop to absorb nutrients resulting in statistically identical dry matter accumulation. Besides, nutrients management through combine application of organic manure improves the physical, chemical and biological properties of the soil, which provided better conditions to the pigeonpea as well as blackgram. These results are accordance with the findings of Ali *et al.*, (2003), Tiwari *et al.*, (2011) and Nagar *et al.*, (2015) (Tables 1 and 2).

Table.1 Yield attributes of pigeonpea as influenced by intercropping and integrated nutrient management

Treatment	Pigeonpea				Blackgram			
	No of pod plant ⁻¹	Weight of pods plant ⁻¹	No of seeds pod ⁻¹	100 seed weight (g)	No of pod plant ⁻¹	Weight of pods plant ⁻¹	No of seeds pod ⁻¹	100 seed weight (g)
Cropping systems								
C ₁	194.00	85.05	4.06	9.74	-	-	-	-
C ₂	-	-	-	-	28.36	6.4	4.87	4.06
C ₃	174.64	74.91	3.82	9.69	26.60	5.83	4.55	3.96
C ₄	164.94	70.80	3.72	9.63	25.55	5.48	4.49	3.96
SEm±	2.05	0.9	0.08	0.06	0.11	0.1	0.04	0.07
CD at 5%	8.04	3.53	NS	NS	0.42	0.33	0.17	NS
Integrated nutrient management								
F ₀	107.21	45.71	3.45	9.39	19.27	2.91	4.07	3.73
F ₁	160.58	70.08	3.78	9.69	25.78	5.37	5.17	3.92
F ₂	135.64	57.57	3.6	9.62	21.43	3.87	4.78	3.77
F ₃	141.04	60.31	3.73	9.67	23.38	4.81	5.05	3.83
F ₄	209.19	92.39	4.02	9.75	30.97	7.48	5.56	3.98
F ₅	236.84	100.9	4.19	9.78	31.67	7.85	6.01	4.03
F ₆	182.9	82.24	3.83	9.7	29.16	6.36	5.29	3.95
F ₇	249.49	106.18	4.32	9.86	33.04	8.58	6.09	4.07
SEm±	12.22	5.12	0.12	0.13	0.69	0.42	0.25	0.11
CD at 5%	34.89	14.62	0.36	NS	1.97	1.19	0.72	NS

Table.2 Seed yield and total yield of pigeonpea and blackgram and pigeonpea equivalent yield of blackgram as influenced by intercropping and integrated nutrient management

	(kg ha ⁻¹)				(Rs ha ⁻¹)			
	Pigeonpea Seed Yield	Blackgram Seed Yield	Pigeonpea equivalent Yield of blackgram	Total Yield	Cost of cultivation	Gross return	Net return	B:C ratio
Cropping System								
C ₁	1677.96	-	-	1669.63	20752	86277	65525	3.16
C ₂	-	1074.54	1069.1	1069.10	20389	53447	33058	1.62
C ₃	1558.75	500.73	498.20	2056.95	21371	106343	84972	3.98
C ₄	1448.37	459.99	457.59	1905.95	21371	99138	77767	3.64
SEm±	10.37	10.15	10.09	16.94	-	718	718	0.03
CD at 5%	40.72	39.87	39.62	58.63	-	2483	2483	0.12
Integrated Nutrient Management								
F ₀	1109	512.74	510.24	1214.43	18785	63572	44787	2.38
F ₁	1587.98	637.22	633.97	1666.46	21435	85559	64124	2.99
F ₂	1350.32	562.07	559.24	1432.18	20109	74025	53916	2.68
F ₃	1504.35	597	594	1573.76	20160	81047	60887	3.02
F ₄	1732.77	782.85	778.75	1883.64	22810	96399	74021	3.25
F ₅	1751.47	803.23	799.07	1912.90	21467	97967	74961	3.49
F ₆	1637.68	693.21	689.68	1745.52	21484	89976	68492	3.19
F ₇	1797.74	839.04	834.75	1974.36	21516	101866	81456	3.79
SEm±	25.04	14.50	14.46	21.29	-	992	992	0.05
CD at 5%	71.47	41.39	41.27	60.33	-	2810	2810	0.14

Crop equivalent yield is an important index in assessing the performance of different crops under a given circumstance. Based on the price structure, economic yield of component crops is converted into base crop yield *i.e.*, pigeonpea equivalent yield. The pigeonpea equivalent yield obtained in pigeonpea + blackgram 1:1 rows under intercropping system was attributed to better performance and yields of both the component crops under intercropping system. Similar results were reported by Subbian and Selvaraju (2000), Kantawa *et al.*, (2006) and Dhandayuthapani *et al.*, (2015).

Effect on economics

Highest cost of cultivation was recorded under intercropping because of additional seed is required. Among the integrated nutrient management practices, highest cost of cultivation was recorded under the application of F₄-100 % RDF + FYM @ 5 t ha⁻¹ because of higher prices of inputs. Highest value of gross return, net return and B: C ratio was recorded under pigeonpea + blackgram 1:1, which was significantly superior over others. However, integrated supply of F₇-50% RDF+ FYM @ 5 t ha⁻¹+ *Rhizobium* + PSB + *Trichoderma* gave maximum return as compare to other integrated management practices.

In case of cropping system the highest value of cost of cultivation was found in sole intercropping because combine rate of both crop seed have more price. Highest gross return, net return and B: C ratio might be due to higher grain yield of pigeonpea coupled with higher market price of component crops under the intercropping system.

These findings are in accordance with the result of Solaiappan *et al.*, (1994), Prasad *et al.*, (2007) Kasbe and Karanjikar (2009) and Chaudhari *et al.*, (2017).

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