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Potential of Pigeonpea (Cajanus Cajan) Intercropping on Mid Hills of North Eastern Region of India

Subrata Ray, Biman De, Sujoy Hazari and Bhargabi Chakraborty
AICRP on Pigeonpea, College of Agriculture, Tripura-799210, India.

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ABSTRACT
The field experiment was conducted during two consecutive *kharif* seasons of 2012-13 and 2013-14 at the research farm of College of Agriculture, Lembucherra, Tripura to find out the potentiality of pigeonpea intercropping for mid hills of northeastern region. The treatment comprised 9 intercropping systems apart from sole of intercrops. Intercropping system of single row main crop (pigeonpea) with two rows for cowpea, blackgram, greengram and sesame, where 1:1 system have blackgram, greengram, sesame and groundnut at 30cm apart respectively. The investigational results exhibited that pigeonpea + black gram (1:1) intercropping performed better than other combinations followed by pigeonpea + green gram (1:1) with reference to PEY (pigeonpea equivalent yield) and net return. Growing of pigeonpea under intercropping system with blackgram found to be highly remunerative with proper utilization of land under rainfed mid hills of northeastern region.

Introduction

Among the pulses pigeonpea [*Cajanus cajan* (L.) Millsp.] is a promising rainy-season crop for rainfed uplands. Intercropping, under rainfed ecosystem, ensures stability in yield and minimizes risk of crop loss due to weather aberrations. Short duration pigeonpea are performing well in foot and mid-hills of northeast. Pulses and oilseed cultivation in some districts is also very popular among the farmers. Crops are grown as a sole or mixed in haphazard manner under rainfed conditions in less fertile soil during rainy season resulting in its low yield (Prakash *et al*., 2005). Intercropping can play a significant role to enhance the productivity and profitability per unit area and time through more efficient use of land, water and solar energy besides assuring insurance against crop failure due to failure of one or the other crop due to vagaries of weather or disease/pest epidemics in rainfed agriculture. Intercropping of pigeonpea with pulses & oilseed has been reported as one of the best combination (Shanna and Rajput 1996, Dwivedi and Bajpai 1997) because of their more suitability for better growth and development as pigeonpea grown at a wider row distance. Entire northeast, having very small holding size, acreage and productivity of the crop can be greatly enhanced by replacing upland rice *(Oryza sativa* L.) with either pigeonpea alone or in combination with other compatible crops. Rao and Willey (1980) observed that under rainfed conditions where the chances of crop failure are more, intercropping is more stable and dependable than sole crops. The deep root-system of this crop has made it more suitable for its cultivation under rainfed condition. Again, initial slow growth habit of pigeonpea offers a good scope for a wide spectrum of intercrops. Selection of an appropriate component crop enhances the total productivity of the system by virtue of best use of available resources and inputs. The present study was therefore undertaken to evaluate the performance of various intercropping systems with the variety 'UPAS 120' of pigeonpea.

Materials and Methods

The field experiment was conducted during two consecutive *kharif* seasons of 2012-13 and 2013-14 at the research farm of College of Agriculture, Lembucherra, Tripura. The soil of the experimental site was sandy loam having *p*H of 5.5, organic carbon (0.47%), available phosphorus 8.30 kg/ha, available potash 176.0 kg/ ha and available sulphur 12.0 kg/ha. The experiment was carried out during the *kharif* seasons where the climate of hilly zone is sub-tropical in nature with distinctive characteristics of high rainfall, high humidity and a prolonged winter. The bulk density of soil was 1.36 mg/m^3 and pore space was 34.9%. The treatment comprised 9 intercropping system apart from sole crop of cowpea 'Local', sesame 'B-67', blackgram 'Azad Urd-2', greengram 'PDM-5' and groundnut 'TAG-24'. Intercropping system of single row main crop (Pigeonpea) with two rows for cowpea, blackgram, greengram and sesame, where 1:1 system have blackgram, greengram, sesame and groundnut at 30cm apart respectively. Recommended doses of fertilizers were applied to each crop in sole stand whereas in intercropping systems no supplementary fertilizers were given to intercrops. Crops were sown at first week of July as per treatment and for comparison between the systems, their yields were converted into pigeonpea-equivalent on price basis (Yadav and Newaj, 1990). The data collected from the field and laboratory experiments were subjected to statistical analysis appropriate to the design and the treatment variations were tested for significance by F test (Gomez and Gomez, 1983). The standard errors of mean and critical differences are indicated in tables. For determination of critical differences at 5% level of significance, Fisher and Yates (1963) tables were consulted.

Results and discussion

Different cropping system significantly affected plant characters at 50% flowering where highest main crop height was achieved with sesame and primary branch with sole (Table-1). The competition was more from sesame which might me owing to the dense canopy of the tall growing intercrops, whereas wider spacing with minimal competition increased branch number (Chaudhury and Thakur , 2005).

Tele:
E-mail addresses: bhargabi07@gmail.com

Table 1. Plant stand and flowering characters as affected by various inter-cropping system (mean of two years)

Inter-cropping system	Plant Stand (%)	Flowering (DAS)			Plant character at 50% flowering	
		1st	50%		Plant Height (cm)	Primary Branch (Number)
Pigeonpea+Cowpea(1:2)	92.06	74.00	87.00		222.83	28.00
Pigeonpea sole	91.15	79.50	95.00		232.50	32.17
Pigeonpea + Sesame (1:1)	90.39	74.50	84.50		243.00	24.33
Pigeonpea +Blackgram(1:1)	91.24	75.00	91.00		205.83	24.67
Pigeonpea +Blackgram (1:2)	90.06	79.00	92.00		222.83	31.00
Pigeonpea + Sesame (1:2)	89.07	69.00	85.50		230.17	23.33
Pigeonpea +Greengram (1:1)	89.40	72.00	87.50		223.67	27.33
Pigeonpea +Greengram (1:2)	91.72	70.50	84.50		228.17	28.83
Pigeonpea + Groundnut (1:1)	90.62	68.50	84.00		200.67	23.33
SEm ±		0.83	1.28		8.72	2.05
CD (P=0.05)		2.51	3.84		26.16	6.14

Table 2. Yield and yield attributing characters as affected by various inter-cropping system (mean of two years)

Inter-cropping system	Main crop					Intercrop
	Pod/ Plant (Number)	Pod yield (Kg/ha)	Test weight (g)	Grain yield (Kg/ha)		Yield (Kg/ha)
Pigeonpea+Cowpea(1:2)	228.25	2186.58	8.64	1671.45		474.74
Pigeonpea sole	123.37	2845.84	7.74	1683.95		
Pigeonpea + Sesame (1:1)	142.60	2566.03	8.24	1506.19		405.19
Pigeonpea + Blackgram(1:1)	261.50	3602.88	9.20	2089.91		413.85
Pigeonpea + Blackgram (1:2)	224.00	2666.26	8.60	1558.23		450.92
Pigeonpea + Sesame (1:2)	227.45	3213.97	8.35	1831.91		428.02
Pigeonpea + Greengram (1:1)	236.50	3847.22	8.69	2032.40		436.52
Pigeonpea +Greengram (1:2)	212.08	2475.76	8.88	1557.24		472.75
Pigeonpea + Groundnut (1:1)	135.06	1517.59	9.27	1281.2		253.69
SEm ±	3.49	196.27	0.19	95.35		4.30
CD (P=0.05)	10.47	588.43	0.58	285.88		12.89

Table 3. Crop productivity, yield equivalent and economics as affected by various inter-cropping system (mean of two years)

Treatments	Grain yield of main crop (Kg/ha)	Grain yield of sole crop (Kg/ha)	PEY(Pigeonpea equivalent yield) (Kg/Ha)	Net return (Rs/Ha)	Benefit :Cost Ratio	LER (Land Equivalent Ratio)	Per day return (Rs./ha/day)
Pigeonpea+Cowpea(1:2)	1671.45		2108.00	66454.46	2.63	1.56	427.55
Pigeonpea sole	1683.95		1683.95	48527.15	1.96	1.00	300.11
Pigeonpea + Sesame (1:1)	1506.19		1934.67	58149.12	2.24	1.59	384.00
Pigeonpea +Blackgram(1:1)	2089.91		2503.76	84114.93	3.39	1.79	527.73
Pigeonpea +Blackgram (1:2)	1558.23		2009.15	62129.93	2.46	1.53	387.39
Pigeonpea + Sesame (1:2)	1831.91		2284.53	74627.67	3.02	1.82	489.65
Pigeonpea +Greengram (1:1)	2032.4		2494.01	82554.28	3.18	1.85	534.78
Pigeonpea +Greengram (1:2)	1557.24		2057.16	64712.41	2.61	1.63	423.07
Pigeonpea + Groundnut (1:1)	1281.2		1747.75	49845.15	1.90	1.17	326.94
SEm ±	95.35			3981.78			
CD (P=0.05)	285.88			11937.16			
Cowpea sole		833.45	766.39	19316.87	1.38	1.00	175.61
Sesame sole		580.69	614.07	15261.89	1.33	1.00	129.34
Blackgram sole		750.62	741.99	17062.52	1.12	1.00	196.12
Greengram sole		674.24	712.99	18979.04	1.58	1.00	201.90
Groundnut sole		619.13	1138.63	32168.40	1.85	1.00	265.85
SEm ±		4.46		230.24			
CD (P=0.05)		14.54		750.86			

The MSP/market price of pigeonpea, cowpea, sesame, blackgram, greengram and groundnut during 2012-13 and 2013-14 were 43.50, 40.00, 46.00, 43.50, 46.00 and 80.00 per kg respectively.

From the pooled data of two years, intercropping combinations of one row of pigeonpea + one row of blackgram proved superior thereby giving significantly higher pigeonpea yield (2089.91Kg/ha) compared to pigeonpea + blackgram paired rows (1558.23 Kg/ha) and pigeonpea sole respectively throughout the experimental years. It might be due to less crop competition for nutrient owing to 50% less plant population of blackgram in former and indirectly to higher no. of pods per plant and 100 seed weight (Prakash *et al.,* 2005). Poor performance been showed by pigeonpea + paired planting of greengram (Table-2). But among the different intercrops, pooled value of cowpea yield (474 Kg/ha) showed significantly higher than other crops which might be due to higher number of plant stand (92.06%) in the system.

Pooled yield data showed that all the intercropping combination of pigeonpea and blackgram/greengram (urdbean/mungbean) being at par recorded significantly higher pigeonpea equivalent yield (table-3) compared with the sole pigeonpea. This might be due to fairly good yield of pigeonpea in intercropping system and an extra yield of urdbean/mungbean as bonus in intercropping system (Sharma and Rajput, 1996 & Jat and Ahlawat, 2003). Intercropping of one row of pigeonpea + one row of groundnut registered highest pigeonpea equivalent yield (2503.76 Kg/ha) closely followed by pigeonpea + greengram in 1:1 row proportion (2494.01 Kg/ha) which were 48.68% and 48.10% higher respectively than the sole pigeonpea (1683.95 kg/ha).

All the intercropping treatments exhibited higher LER values (1.17-1.85). Higher land equivalent ratio due to intercropping of pigeonpea was also similarly reported by Jat and Ahlawat (2004). Among the pigeonpea intercropping system, pigeonpea + greengram (1:1) registered highest values of land equivalent ratio (1.85) followed by pigeonpea + sesame in 1:2 row proportions.

The pigeonpea yield showed that a significant variation in different cropping system (Table 3). There was significant reduction in pigeonpea sole cropping compared with the intercropping of pigeonpea. The pooled maximum grain yield was found in pigeonpea +blackgram (1:1) and the minimum grain yield was recorded in intercropping of pigeonpea with groundnut with return per rupee 3.39 and 1.90 respectively. Yield of pigeonpea +blackgram(1:1) and pigeonpea + greengram (1:1) was higher compare to the pigeonpea + blackgram(1:2) and pigeonpea + greengram (1:2) which might be due to half plant population of blackgram in former with average land equivalent ratio which is also confirmed with the findings of Jat and Ahlawat (2003).

Various intercropping systems registered significant pigeonpea equivalent yield (Table 3). The pooled results revealed that pigeonpea + blackgram (1:1) intercropping performed better than other combinations followed by pigeonpea + greengram (1:1) with reference to PEY (pigeonpea equivalent yield) and net return. Again, among the pigeonpea based inter-cropping systems, pigeonpea + blackgram (1:1) proved more productive with significantly higher pigeonpea-equivalent yield (2503.76 kg/ha) which may be due to higher main crop yield with fair production of intercrop w.r.t. minimum support price and remained at par with pigeonpea + greengram (1:1) PEY i.e. 2494.01 kg/ha (Prakash *et al.,* 2005).

The pooled value of net returns revealed significant variation in different intercropping system (Table 3). The significant reduction in net returns to sole cropping compared with the intercropping of pigeonpea. The maximum net return was found in pigeonpea + blackgram (1:1) i.e. 84114.93 Rs/ha and the minimum net return was recorded in sole cropping of pigeonpea (48527.15 Rs/ha). In respect to per day return, pigeonpea+ greengram (1:1) i.e. 534.78 Rs/ha/day was followed by pigeonpea+ blackgram (1:1) i.e. 527.73 Rs/ha/day, which might be due to lower maturity days of pigeonpea + greengram intercropping though higher productivity was registered under pigeonpea + blackgram intercropping (Chaudhury and Thakur, 2005).

Conclusion

The pooled data exposed that pigeonpea + blackgram (1:1) intercropping accomplished superior than other combinations shadowed by pigeonpea + greengram (1:1) with reference to PEY (pigeonpea equivalent yield) and net return. The maximum grain yield was found in pigeonpea + blackgram (1:1). Thus it is suggested that growing of pigeonpea under intercropping system either with blackgram for higher productivity with good monetary return or with greengram for proper utilization of land under rainfed mid hills of northeastern region.

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