Exploring yield potential of Pigeonpea and Soybean intercropping systems in NEHZ

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Abstract

A field study was conducted on yield potential of Pigeonpea and Soybean intercropping systems at the experimental farm of School of Agricultural Sciences and Rural Development (SASRD) on AICRP on Pigeonpea Nagaland University Medziphema Campus under rainfed conditions during 2016 and 2017. The treatment comprised of different row ratios of Pigeonpea and Soybean i.e 1:1, 1:2, 2:1 and 2:2 respectively with sole Pigeonpea and Soybean. The variety used for Pigeonpea was UPAS 120 and for Soybean was JS-9752 respectively. The experiment was laid in RBD with 3 Replications and 6 Treatments. Sole Pigeonpea performed better with respect to growth and yield. Among the different intercropping systems paired rows (2:2) ratios of Pigeonpea and Soybean performed significantly better in terms of yield (1025.64 Kg/ha) which was at par with (2:1) row ratios. As for economics paired row (2:2) ratios of Pigeonpea and Soybean proved superior to all other treatments in LER (1.89), Net return (Rs 86877/ha), Gross return (Rs 133177.8/ha) and Pigeonpea Equivalent yield (876.9 Kg/ha) which was at par with (1:2) row ratios of Pigeonpea and Soybean.

Keywords: Economics, Growth, Intercropping, LER, Pigeonpea, Soybean, Yield, Pigeonpea equivalent yield

1. Introduction

It is well known that the crop production is unstable and at times uneconomic due to vagaries of monsoon in dry land areas of scarcity zone. Appropriate intercropping systems besides meeting the varied requirements of farmer, provide stability in rainfed agriculture and improve the total productivity through better utilization of natural resource. Pigeonpea being a long duration crop and slow growing at initial stages provide opportunity for intercropping of short duration pulses and oilseed in between the rows. Such crop intensification systems help in better use of available natural resources such as soil, space, moisture and it is the promising way to boost total productivity of pulses.

Pigeonpea (*Cajanus cajan* L.) is one of the major grain legume crops of tropical and subtropical regions and it is grown predominantly under rainfed conditions. India accounts for 90 per cent of world's pigeonpea growing area and 85 per cent of world's production of pigeonpea. As a soil ameliorant, pigeonpea is known to provide several benefits to the soil in which it is cultivated. When pigeonpea is grown as a sole crop, it is relatively inefficient because of its slow initial growth rate and low harvest index (Willey et al., 1980) and the initial slow growth rate and deep root system of pigeonpea offers good scope for intercropping with fast growing early maturing and shallow rooted crops (Ramamoorthy et al., 2004). Therefore a short duration intercrop can be grown in between pigeonpea, which helps in efficient utilization of available resources for enhancing the productivity and profitability. Pigeonpea is an important pulse crop of the country. The area and production of pigeonpea for the year 2015-2016 under Nagaland was 3050 ha and 2750 metric tonnes (*Kharif*) (Anonymous, 2017).

Soybean (Glycine max L.) is the only major crop that has witnessed an impressive expansion in acreage and production at the global level. Soybean is considered as a wonder crop due to its dual qualities viz. high protein and oil content. This crop has gained considerable importance in the agricultural economy of the country. When pigeonpea is grown as a sole crop, it is relatively inefficient because of its slow initial growth rate and low harvest index (Willey, 1979); therefore it is grown as intercrop, which helps in efficient utilization of available resources for enhancing the productivity and profitability. In Nagaland, The area and production of soybean for the year 2015-2016 under Nagaland was 24860 ha and 31170 metric tonnes (*Kharif*) (Anonymous, 2017). It is one of the most popular food items of majority of the people of Nagaland and is utilized as a pulse crop and as fermented products locally called as 'Akhuni'.

Intercropping of pigeonpea with soybean, greengram and blackgram reduce growth and yield of pigeonpea because of higher competitive ability over pigeonpea as they have a faster vegetative growth during early stage (Billore et al. 2009).For successful and profitable intercropping system, there must be proper row ratio of component crop in order to avoid limitation of reduced plant population of base crop under traditional inter-cropping system (Pandey *et al*., 1999).

2. Materials and Methods

An experiment was conducted at the experimental farm of School of Agricultural Sciences and Rural Development Medziphema, Nagaland, under rainfed condition to study the performance of pigeonpea + soybean intercropping over sole crops of pigeonpea and soybean. The experimental site is located at $25^0$45'43'' North latitude and $93^0$53'04'' East longitude at an altitude of 310 metres above mean sea level. The prevailing climate represents sub-humid tropical climatic zone with high relative humidity, moderate temperature and medium to high rainfall. The mean temperature ranges from 21 ºC to 30 ºC during summer and rarely goes below 8 ºC in winter due to high atmospheric humidity. The average rainfall varies between 2,000 and 2,500 mm starting from April and ends with the month of September while the period from October to March remains completely dry. The soil of the experiment plot was categorized as sandy loam and well drained.

The experiment was conducted in randomized block design with 3 replications. The six treatments in the experiment were comprised of sole pigeonpea, sole soybean, and pigeonpea + soybean in the row ratios of 1:1, 1:2, 2:1 and 2:2 respectively.

3. Results and Discussions

Significantly taller plants of pigeonpea were observed in sole pigeonpea than the intercropping treatments at 25 DAS, 50 DAS and 75 DAS. At harvest also, pigeonpea plants were taller in sole pigeonpea than the intercropping treatments though those were statistically similar. This might be due to the absence of intercrop competition in sole pigeonpea. Among the intercropping treatments paired rows of Pigeonpea + Soybean recorded the tallest plant height. This might be due to better spatial complementarity of the component crops that led to better utilization of growth resources.

Maximum number of pods/plant was recorded in sole Pigeonpea. Sole crop performed better than intercrops. While among the intercropping 2:2 row ratio performed better than all the other intercrop treatments.

Maximum number of nodules per plant was recorded in Sole Soybean and among the intercropping maximum number of nodules per plant was recorded in 2:1 ratios of Pigeonpea and Soybean. This might be due to poor utilization of growth resources in 2:1 ratios of Pigeonpea and Soybean.

The maximum grain yield was recorded in sole crop as there was no competition for space, moisture, nutrients etc. as compared to intercropping treatments. Similar results were reported by Holkar *et al.*, (1991), Joshi *et al.*, (1997) and Halvankar *et al.,* (2000).

Among the intercropping treatments, 2:2 rows of Pigeonpea + Soybean was found to be superior in respect of Pigeonpea and Soybean yield. This might be due to appropriate mutual co-operation for atmospheric nitrogen by leguminous plant in 2:2 rows.

The maximum straw yield for both Pigeonpea and Soybean was recorded in sole cropping due to various yield attributing characters like maximum plant height leading to higher straw yield of Pigeonpea and Soybean.

But among the intercropping treatments 2:2 row ratio performed reasonably better than others, which might be due to efficient utilization of solar radiation in 2:2 row arrangement.

Land Equivalent Ratio (LER) gives the accurate assessment of biological efficiency of intercropping over pure cropping. LER for all the treatments were calculated in all the intercropping treatments and it was found to be greater than 1.

The highest LER value was obtained from 2:2 ratios which indicates % yield advantage over sole crops and it was statistically significant. Similar observations were made by Tomar *et al.*, (1987), Singh and Singh (1994) and Halvankar *et al.*, (2000).

Among the intercropping treatments, Pigeonpea + Soybean in paired ratios recorded higher gross return which attributed to the fact that price of Soybean is higher than other pulses. A higher gross return in sole Pigeonpea and sole Soybean crop was due to the higher grain yield of both the crops.

The highest net return was recorded in paired rows of Pigeonpea + Soybean. Higher yields of both the component crops without incurring any extra cost of cultivation resulted in higher net return in this treatment.

Benefit: Cost ratio and Pigeonpea equivalent yield (Kg/ha) was maximum in 2:2 ratios of Pigeonpea + Soybean which might be due to highest net return, though cost of cultivation was almost same as other intercropping treatments.

Summary

Intercropping is one of the important cropping systems, which provides intensification of cropping both in time and space dimensions. Intercropping generally refers to the growing of two or more crops simultaneously on the same piece of land, in a distinct row arrangement. Increased productivity is one of the added advantages of intercropping system. Intercropping of widely adoptive crop like Pigeonpea with pulses and oilseeds may be a feasible system for increasing productivity and for getting a profitable intercropping system.

The salient findings are summarised below:

1) Different row arrangement in intercropping influence the plant height at different stages and at harvest. In all the treatments sole Pigeonpea produced the maximum plant height, whereas among intercropping T_4 (2:2 row ratio) produced the maximum plant height.
2) In all the yield attributing factors like number of pods/plant were found to maximum in sole Pigeonpea treatment and among the intercropping treatments 2:2 row ratio was found to have the maximum values in all these yield attributing characters.
3) Different row arrangement in intercropping influenced the plant height at different stages and at harvest. In all the treatments, sole Pigeonpea produced the maximum plant height, whereas among the intercropping T_4 (2:2 row ratio) produced the maximum plant height.
4) The number of nodules per plant was found to be highest in sole Soybean treatment, whereas among the intercropping treatments, T_4 (2:2 row ratio) was found to be the maximum.

5) In all the yield attributing factors like number of pods per plant and number of seeds per pods were found to maximum in sole Soybean treatment and among the intercropping treatments, T_4 (2:2 row ratio) was found to have the maximum values in all these yield attributing characters.

6) Different row arrangement had significant influence on grain and straw yield. The highest grain yield and straw yield of both the crops were obtained in sole treatments, whereas among the intercropping treatments, T_4 (2:2 row ratio) obtained the maximum grain and straw yield of both the crops.

7) From the result it was found that different row arrangement had significant influence on the land equivalent ratio, the maximum land equivalent ratio was found in T_4 (2:2 row arrangement).

8) In all economic indices like Gross return, Net return and Benefit-Cost ratio and Pigeonpea equivalent yield (Kg/ha) it was found to be highest in T_4 (2:2 row ratio). Hence, it emerged as the most profitable system.

Table 1. Exploring yield potential of Pigeonpea and Soybean intercropping on growth parameters of Pigeonpea

Treatments	Plant height (cm)		No. of nodules at 100 DAS		No. of primary branches		Days to first flowering		Days to 50% flowering	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
T_1- Pigeonpea + Soybean (1:1)	252.60	245.33	24.33	23.67	42.07	40.00	74.33	73.67	101.67	101.00
T_2 - Pigeonpea + Soybean (1:2)	259.13	252.00	24.83	24.17	38.67	36.67	75.33	74.67	99.33	98.67
T_3- Pigeonpea + Soybean (2:1)	252.80	245.67	26.67	26.00	36.27	34.33	74.33	73.67	99.00	98.33
T_4 - Pigeonpea + Soybean (2:2)	269.67	262.67	25.10	24.50	39.60	37.33	75.67	75.00	102.67	102.00
T_5 –Sole Pigeonpea	271.20	264.00	24.67	24.00	37.33	35.33	74.67	74.00	98.33	97.67
SEm±	9.75	9.88	1.00	0.76	2.25	2.31	0.88	0.37	1.85	1.58
SE (d)	13.78	13.97	1.41	1.07	3.19	3.26	1.24	0.52	2.61	2.23
CD (0.05%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Exploring yield potential of Pigeonpea and Soybean Intercropping on yield parameters of Pigeonpea

Treatments	No. of pods/plant		No. of seeds/pod		Grain yield (kg/ha)		Stover yield (Kg/ha)	
	2016	2017	2016	2017	2016	2017	2016	2017
T_1- Pigeonpea + Soybean (1:1)	108.40	98.67	4.20	4.00	1319.44	979.02	5128.21	4514.37
T_2 - Pigeonpea + Soybean (1:2)	73.73	67.07	3.87	3.87	1481.48	992.61	5749.81	4485.24
T_3- Pigeonpea + Soybean (2:1)	89.53	82.87	4.13	4.13	1342.59	1004.27	4467.75	4496.89
T_4 - Pigeonpea + Soybean (2:2)	97.13	90.33	4.27	4.27	1553.24	1025.64	6682.21	4526.03
T_5 –Sole Pigeonpea	71.80	92.33	4.20	4.20	1689.82	1072.26	4778.55	4953.38
SEm±	23.18	23.22	0.19	0.14	75.18	21.73	496.02	105.89
SE (d)	32.78	32.84	0.27	0.19	106.32	30.73	701.48	149.75
CD (0.05%)	NS	NS	NS	NS	245.17	NS	NS	NS
CV (%)	NS	NS	NS	NS	8.81	NS	NS	NS

Table 3. Exploring yield potential of Pigeonpea and Soybean Intercropping on growth parameters of Soybean

Treatments	Plant height at harvest (cm)		No. of nodules at 100 DAS		No. of primary branches		Days to first flowering		Days to 50% flowering	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
T_1- Pigeonpea + Soybean (1:1)	59.00	53.67	7.86	6.80	9.13	8.33	51.00	50.33	75.33	74.67
T_2 - Pigeonpea + Soybean(1:2)	63.20	58.67	7.47	6.47	12.47	11.40	52.33	51.67	76.67	76.00
T_3- Pigeonpea + Soybean (2:1)	60.47	56.00	6.33	5.40	9.67	9.00	54.00	53.33	79.00	78.33
T_4 - Pigeonpea + Soybean(2:2)	57.13	52.00	5.13	4.47	13.33	12.60	51.33	50.67	76.33	75.67
T_6 - Sole Soybean	60.80	55.67	6.13	5.13	13.40	12.73	51.00	50.33	76.33	75.67
SEm±	5.03	5.00	0.65	0.40	0.40	0.29	1.06	0.48	1.27	0.92
SE (d)	7.11	7.08	0.92	0.57	0.57	0.41	1.51	0.68	1.79	1.30
CD (0.05%)	NS	NS	NS	1.31	1.32	0.94	NS	1.58	NS	NS
CV (%)	NS	NS	NS	12.35	6.03	4.62	NS	1.63	NS	NS

Table 4. . Exploring yield potential of Pigeonpea and Soybean Intercropping on yield parameters of Soybean

Treatments	No. of pods/plant		No. of seeds/pod		Grain yield (kg/ha)		Stover yield (Kg/ha)	
	2016	2017	2016	2017	2016	2017	2016	2017
T_1- Pigeonpea + Soybean	39.87	35.00	3.00	3.00	1004.63	1085.86	1884.23	1656.95

(1:1)								
T_2 - Pigeonpea + Soybean(1:2)	50.47	45.67	2.53	2.53	1129.63	1173.27	1961.93	1730.77
T_3- Pigeonpea + Soybean (2:1)	36.67	31.67	2.80	2.80	988.43	1126.65	1767.67	1703.57
T_4 - Pigeonpea + Soybean(2:2)	52.67	47.67	2.67	2.67	1168.98	1227.66	1903.65	1790.99
T_6–Sole Soybean	54.40	49.33	2.87	2.87	1245.37	1320.90	2078.48	1882.28
SEm±	1.04	1.10	0.14	0.16	122.34	16.59	48.76	25.52
SE (d)	1.47	1.55	0.20	0.23	173.02	23.46	68.95	36.10
CD (0.05%)	3.40	3.58	NS	NS	282.16	54.09	159.01	83.24
CV (%)	3.86	4.54	NS	NS	15.02	2.42	4.40	2.52

Table 5. . Exploring yield potential of Pigeonpea and Soybean intercropping systems on Economics

Treatments	Total cost of cultivation (`/ha)		Gross return (`/ha)		Net return (`/ha)		B:C ratio		Pigeonpea Equivalent Yield (Kg/ha)		LER	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
T_1- Pigeonpea + Soybean (1:1)	44700.00	45000	119859.95	122824.4	75159.95	77824.4	1.68	1.73	931.37	775.61	1.59	1.73
T_2 - Pigeonpea + Soybean(1:2)	46950.00	47250	137957.35	128146.2	91007.35	80896.2	1.94	1.71	1045.75	838.05	1.79	1.81
T_3- Pigeonpea + Soybean (2:1)	42500.00	42800	122071.95	126631.4	79571.95	83831.4	1.87	1.96	947.71	804.75	1.58	1.79
T_4 - Pigeonpea + Soybean(2:2)	46000.00	46300	146557.70	133177.8	100557.70	86877.8	2.19	1.88	1096.40	876.9	1.86	1.89
T_5–Sole Pigeonpea	19550.00	19850	86306.45	75058.2	66756.45	55208.2	3.41	2.78			1.00	1.00
T_6- Sole Soybean	23500.00	23800	77889.20	66045	54389.20	42245	2.31	1.77			1.00	1.00

4. Conclusion

On the basis of the findings from two year of experimentation, it can be concluded that paired rows of Pigeonpea + Soybean is the best combination for getting advantage in intercropping when compared with other row arrangements as judged by the Pigeonpea equivalent yield and favourable economic indices like net return, B:C ratio and monetary advantage. Also, between the two methods of planting, paired rows of planting is more advantageous than alternate rows of planting for obtaining increased yield of the crop. This system of intercropping proved to be very idea particularly for Nagaland farmers due to the very fact that both the crops plays an important and major role in the diet of the whole community, thereby opening a bigger and greater scope for marketing of this particular crops. This system of farming is also quiet easily adopted by farmers taking into account of the soil health benefits and also with the concept of intercropping.

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