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Original Research Article

Productivity, Profitability and Soil Fertility in Pigeonpea + Fingermillet Intercropping System as Influenced by their Row Ratio and Cultivars

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Keywords

Intercropping, Pigeon pea, Finger millet, Productivity, Profitability, Competitional indices, Nutrient uptake and soil available nutrients

A B S T R A C T

A field experiment was conducted at Birsa Agricultural University Farm, Ranchi under upland conditions during two consecutive years during kharif 2005 and 2006 to study the biological potential and economic feasibility of pigeon pea in association with finger millet cultivars in 1:1, 1:2, 1:3 and 1:4 row combinations with sole crops. Sole pigeon pea and finger millet recorded significantly higher seed yield than its intercropped stand. The maximum pigeon pea equivalent yield 13.13 q ha^{-1} were recorded under pigeon pea + finger millet (SD)1:1 which was closely followed by 12.92 q ha^{-1} from pigeon pea + finger millet (MD) 1:1 system and found superior than rest of the intercropping system under investigation. The highest net return (Rs. 15090.5 ha^{-1}), benefit cost ratio (3.31) and monetary advantages (Rs. 6203.8 ha^{-1}) were obtained with pigeon pea + finger millet (SD) in 1:1 row ratio which was superior than other row ratios and sole crops. The highest land equivalent ratio (LER) of 1.46 was obtained under pigeon pea with short duration (SD) finger millet (1:1) which was closely followed by pigeon pea + finger millet (SD) 1:2 row ratio (1.42) .Total uptake of nitrogen was higher in pigeon pea + finger millet (MD) 1:1 row ratio and phosphorus and potassium uptake was higher in sole finger millet (LD). Soil available nitrogen, phosphorus and potassium were higher in sole pigeon pea as compared to sole crop of finger millet and intercropping system.

Introduction

The main concept of intercropping is to increasing total productivity per unit area and time, as well as equitable and judicious utilization of land resources and inputs. One of the main reasons for getting higher yields from intercropping systems are mainly due to the component crops are able to use face natural resources than grown separately (Willey, 1979). A careful selection of crops having different growth habits can reduce the mutual competition to a considerable extent. In the present investigation both pigeonpea and fingermillet provides an opportunity to grow together as they have different growth habits and maturity period . The pigeonpea being deep rooted and slow growing in its early growth stage, so association of more rapidly growing crop like fingermillet can be conveniently intercropped to utilize the available natural resources more efficiently.

Soil is our national heritage. Therefore, the proper and rational use of the resource is must to supply nutrients for the plant growth which ultimately provide food, fuel, fibre and fodder to animals and men. In spite of the different ways to protect the soil, losses

due to erosion, displacement of soil and nutrient consuming continue. Efficient cropping system such as intercropping is one of the important and identified remunerative systems to overcome yield reduction and maintaining the soil health . Intercropping of pigeonpea + fingermillet in being practiced to minimize the risks and to increase the stability in drylands of Jharkhand region.

Materials and Methods

The field experiment was conducted during the rainy seasons of 2005 and 2006 at Birsa Agricultural University Farm, Ranchi in a randomized block design with three replication Short (Birsa Marwa-1), medium (HR-374) and long duration (PR-202) cultivar of finger millet were grown in row ratio of 1:1, 1:2, 1:3 and 1:4 as inter crop with pigeon pea (BR-65). There were 16 treatments which comprising of T_1-Pigeon pea sole, T_2-Finger millet (LD) sole, T_3-Finger millet (MD) sole, T_4-Finger millet (SD) sole, T_5-Pigeon pea + finger millet (LD) 1:1, T_6-Pigeon pea + finger millet (LD) 1:2, T_7-Pigeon pea + finger millet (LD)1:3, T_8-Pigeon pea + finger millet (LD)1:4, T_9-Pigeon pea + finger millet (MD) 1:1, T_{10}-Pigeon pea + finger millet (MD)1:2, T_{11}-Pigeon pea + finger millet (MD)1:3, T_{12}-Pigeon pea + finger millet (MD)1:4, T_{13}-Pigeon pea + finger millet (SD)1:1, T_{14}-Pigeon pea + finger millet (SD)1:2, T_{15}-Pigeon pea + finger millet (SD)1:3 and T_{16}-Pigeon pea + finger millet (SD)1:4.The seed rate used for pigeon pea was 20 kg ha^{-1} and that of finger millet 10 kg ha^{-1}. Row spacing of pigeon pea was 75 cm and that of finger millet at 30 cm. The soil of the experimental site was sandy loam in texture with pH 5.55, and low available N, P as well as medium in available K, The crop was sown on 8 July and 6 July during 2005 and 2006, respectively. Sole crop of pigeon pea received fertilizer levels of N_{25}, P_{50}, K_{25} kg ha^{-1}. However, finger millet used in sole as well as in intercropping received N_{50}, P_{50}, K_{25} kg ha^{-1}. A rainfall of 830.5 mm and 1292.9 mm rainfall were received from July to December during the respective year of experimentation during 2005 and 2006.

Results and Discussion

Productivity

Sole crops resulted is higher seed yields incomparison to their intercropping systems. It may be due to less interspaced competition and increased habitat population. Significantly higher grain yield of pigeonpea (10.90 q ha^{-1}) and fingermillet (LD) (25.99 q ha^{-1}) were found under sole cropping, respectively in comparison to intercropping systems. In intercropping system pigeonpea + fingermillet (SD) 1:1 row ratio recorded maximum grain yield (8.30 q ha^{-1}) which was on a par with pigeonpea + fingermillet (MD) 1:1 (7.60 q ha^{-1}) and found to be significantly superior to rest of the systems. Higher grains yield of fingermillet was recorded in pigeonpea + fingermillet (LD) 1:4 row ratio which was on a par with pigeonpea + fingermillet (LD) 1:2 row ratio and significantly higher to other combinations. The increase in yield components of pigeonpea when decreased plant density of fingermillet in intercropping system might be due to higher competitive ability of pigonpea in Sharing growth resources with fingermillet . The maximum pigeonpea equivalent yield (13.13 q ha^{-1}) was recorded in pigeonpea + fingermillet (SD) 1:1 row ratio due to high value of pigeonpea which was on a par with pigeonpea + fingermillet (MD) 1:1 (12.92 q ha^{-1}), pigeonpea + fingermillet (LD) 1:1 (12.84 q ha^{-1}), pigeonpea + fingermillet (LD) & (SD) 1:2 (12.34 q ha^{-1}) and found to be significantly superior to rest of the combinations. This observation was in

conformity with the findings of Singh and Rahman (1999). Results revealed that intercropping of pigeonpa in association with short duration cultivars in 1:1 row proportion is more advantageous than medium and long duration cultivars. Pigeonpea equivalent yield drastically decreased as the row proportion of fingermillet increased in intercropping system. This is in conformity with the findings of Mahto *et al.* (2007)

Profitability

The maximum net return (Rs. 15090.5 ha^{-1}) and benefit: cost ratio (3.31) was recorded under pegionpea + fingermillet 1:1 row ratio which was on a par with pigeonpea + fingermillet (MD) 1:1, pigeonpea + fingermillet (LD) 1:1 and pigeonpea + fingermillet (SD) 1:2 row ratios. Similar finding also observed by kumar et.al (2010). Monetary advantages was also recorded maximum under pigeonpea + fingermillet (SD) 1:1 row ratio (Rs. 6203.8 ha^{-1}) which was followed by pigeonpea + fingermillet (SD) 1:2 and pigeonpea + fingermillet (MD) 1:1 row ratio (table -1). It may be due to more number of plant density of fingermillet.

Competitional Indices

Land equivalent ratio (LER)

It is the relative land area under sole crop that is required to produce the yields to be achieved in intercropping systems. A perusal of data (table 1) indicated that the LER was recorded more than one in all the system but maximum (1.46) was obtained under pigeonpea + fingermillet (SD) 1:1 row ratio. Higher biological efficiency probably due to temporal and spatial complementarily effect resulting corresponding yield advantages (Maitra et al., 2000). This may be attributed due to low competition and better utilization of available resources (moisture, light and nutrients) by short duration cultivar of fingermillet.

Relative crowding coefficient (RCC)

Each crop in intercropping system has its own coefficient (K) which gives a measure whether that crop has produced more or less yield than expected. On the present investigation the relative crowding coefficient (K) of pigeonpea was more than one in all the intercropping system indicating more of non-competitive interference than the competitive one. The degree of non-competitive interference was more in pigeonpea + fingermillet (SD) 1:2 row ratio. However, the other spatial arrangement produced less values of RCC which showed lower degree of non-competitive interference resulting in low yield advantages. It seemed that the crop species are partially competed for the different resources. The results are in conformity with the findings of Vyas et al. (1995).

Competitive Ratio (CR)

The least competition was evaluated under pigeonpea + fingermillet (LD) 1:1 (CR = 1.01) which was followed by pigeonpea + fingermillet (MD) 1:1 (CR = 1.03) , pigeonpea + fingermillet (SD) 1:1 (CR = 1.09) . Lopwer valuebnof completion ratio indicated less competition between the two species in this ratio which partially compete for different resoures that was reported by Ali and Mishra 2001).

Nutrient uptake by crop

Highest total nitrogen uptake (80.55 kg ha^{-1}) was recorded under pigeonpea + fingermillet (MD) 1:1 row ratio followed by fingermillet

(LD) sole (80.05 kg ha^{-1}) (Table -2). This might be due to taking leguminous crop with fingermillet, which enrich soil available nitrogen. Atmosspheric nitrogen fixation also resulting higher nitrogen uptake by crop. This may be attributed to indirect benefit since legumes do not compete with cereals for soil nitrogen owing to variation in rooting pattern. Phosphorus and potassium uptake was recorded maximum (14.74 and 108.05 kg ha^{-1}, respectively) under fingermillet (LD) sole. It may be due to higher yield in sole condition which was followed by pigeonpea + fingermillet (MD) 1:1 row ratio (14.21 and 106.46 kg ha^{-1}, respectively). Deduction is nutrient uptake by a component crop in intercropping may be attributed to lower biological yield, because of crop competition. Intercropping of lower plant densities of fingermillet associaned with pigeonpea gave shigher amount of uptake of nutrients (N, P and K). This finding confirms the views of Subba Reddy and Havanagi, 1987.

Table.1 Pigeon pea grain yield, pigeonpea equivalent yield and competitional indices as influenced by pigeonpea and fingermillet intercropping systems. (Pooled Mean of 2 years)

Treatments	Grain yield (q ha^{-1})		Pigeonpea equivalent yield(qha^{-1})	Competitional indices		
	Pigeon pea	Finger millet		LER	RCC	CR
T_1-Pigeon pea sole	10.90	-	10.90	-	-	-
T_2-Finger millet (LD) sole	-	25.99	8.67	-	-	-
T_3-Finger millet (MD) sole	-	23.65	7.89	-	-	-
T_4-Finger millet (SD) sole	-	20.95	6.99	-	-	-
T_5-Pigeon pea + finger millet (LD) 1:1	7.15	17.10	12.85	1.32	1.93	1.01
T_6-Pigeon pea + finger millet (LD) 1:2	6.02	18.98	12.34	1.28	2.46	1.51
T_7-Pigeon pea + finger millet (LD) 1:3	3.50	22.67	11.06	1.20	1.43	1.11
T_8-Pigeon pea + finger millet (LD) 1:4	2.45	23.32	10.23	1.13	1.17	1.01
T_9-Pigeon pea + finger millet (MD) 1:1	7.60	15.95	12.92	1.37	2.32	1.03
T_{10}-Pigeon pea + finger millet (MD) 1:2	5.83	18.32	11.93	1.31	2.30	1.35
T_{11}-Pigeon pea + finger millet (MD) 1:3	3.75	19.63	10.29	1.17	1.57	1.23
T_{12}-Pigeon pea + finger millet (MD) 1:4	2.65	20.20	9.39	1.11	1.43	1.14
T_{13}-Pigeon pea + finger millet (SD) 1:1	8.30	14.48	13.13	1.46	3.27	1.09
T_{14}-Pigeon pea + finger millet (SD) 1:2	6.95	16.15	12.34	1.42	3.57	1.69
T_{15}-Pigeon pea + finger millet (SD) 1:3	4.60	17.68	10.50	1.27	2.20	1.51
T_{16}-Pigeon pea + finger millet (SD) 1:4	3.25	18.25	9.33	1.17	1.70	1.38
SEm ±	0.28	1.04	0.40	0.06		
CD (P= 0.05)	0.83	3.03	1.15	0.19		
CV %	8.72	9.22	6.45			

LD – Long duration, MD – Medium duration, SD – Short duration

Table.1 Economic feasibility as influenced by pigeon pea and finger millet intercropping systems. (Pooled mean of 2 years)

Treatments	Cost of cultivation (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
T_1-Pigeon pea sole	5827.0	11891.5	2.05
T_2-Finger millet (LD) sole	58805.0	10495.0	1.82
T_3-Finger millet (MD) sole	5613.5	8979.0	1.61
T_4-Finger millet (SD) sole	5544.5	7540.5	1.37
T_5-Pigeon pea + finger millet (LD) 1:1	6884.0	14345.5	2.09
T_6-Pigeon pea + finger millet (LD) 1:2	7090.5	13610.0	1.93
T_7-Pigeon pea + finger millet (LD) 1:3	7297.0	12041.0	1.66
T_8-Pigeon pea + finger millet (LD) 1:4	7439.0	10821.0	1.47
T_9-Pigeon pea + finger millet (MD) 1:1	6572.5	14995.5	2.29
T_{10}-Pigeon pea + finger millet (MD) 1:2	6779.0	13314.5	1.97
T_{11}-Pigeon pea + finger millet (MD) 1:3	6985.5	11019.0	1.58
T_{12}-Pigeon pea + finger millet (MD) 1:4	7228.0	9535.5	1.33
T_{13}-Pigeon pea + finger millet (SD) 1:1	6532.0	15090.5	2.31
T_{14}-Pigeon pea + finger millet (SD) 1:2	6742.5	14023.0	2.09
T_{15}-Pigeon pea + finger millet (SD) 1:3	6843.5	11492.5	1.69
T_{16}-Pigeon pea + finger millet (SD) 1:4	7054.0	9743.5	1.39
SEm ±	-	434.39	0.13
CD (P= 0.05)	-	1260.68	0.36
CV %	-	6.37	7.79

LD – Long duration, MD – Medium duration, SD – Short duration

Table.2 Available nutrient (Kg ha^{-1}) and total nutrient uptake (Kg ha^{-1}) influenced by Pigeon pea and finger millet intercropping system (pooled mean of 2 years)

Treatments	Available nutrient (Kg ha^{-1})			Total nutrient uptake (Kg ha^{-1})		
	N	P_2O5	K	N	P_2O5	K
T_1-Pigeon pea sole	195.13	12.68	146.78	59.96	9.06	98.84
T_2-Finger millet (LD) sole	190.44	10.89	144.73	80.05	14.74	108.05
T_3-Finger millet (MD) sole	191.33	10.81	144.38	69.70	12.34	90.48
T_4-Finger millet (SD) sole	191.30	10.74	142.88	63.67	10.14	79.00
T_5-Pigeon pea + finger millet (LD) 1:1	194.71	11.93	146.15	78.99	14.70	105.15
T_6-Pigeon pea + finger millet (LD) 1:2	194.08	11.56	144.88	78.03	14.21	104.04
T_7-Pigeon pea + finger millet (LD) 1:3	193.88	10.95	144.25	76.50	13.15	98.27
T_8-Pigeon pea + finger millet (LD) 1:4	193.28	10.83	142.83	72.54	12.14	89.85
T_9-Pigeon pea + finger millet (MD) 1:1	192.93	12.01	145.78	80.55	14.21	106.46
T_{10}-Pigeon pea + finger millet (MD) 1:2	192.55	11.54	144.60	76.72	13.77	97.70
T_{11}-Pigeon pea + finger millet (MD) 1:3	192.25	10.98	144.06	74.30	12.16	93.88
T_{12}-Pigeon pea + finger millet (MD) 1:4	191.98	10.89	143.48	71.14	10.55	85.29
T_{13}-Pigeon pea + finger millet (SD) 1:1	194.67	12.16	146.18	78.37	12.75	102.53
T_{14}-Pigeon pea + finger millet (SD) 1:2	194.05	11.63	144.76	78.28	11.98	102.20
T_{15}-Pigeon pea + finger millet (SD) 1:3	193.50	10.85	143.83	74.12	10.70	97.80
T_{16}-Pigeon pea + finger millet (SD) 1:4	193.17	10.73	143.15	74.09	9.31	89.07
SEm+	6.05	0.57	5.95			
CD (P=0.05)	NS	NS	NS			
CV%	5.43	9.98	7.13			

LD – Long duration, MD – Medium duration, SD – Short duration

Soil available nutrients

The higher soil available nitrogen (195.13 kg ha^{-1}) were observed under sole pigeonpea as compared to fingermillet sole and rest of the intercropping systems. Pigeonpea is a good nitrogen fixer which increased soil nitrogen content due to substantial nodulation and decomposition of fallen leaves.

In the present investigation also number of nodules is more in sole crop of pigeonpea as compared to intercropped pigeonpea. However, no significant difference in soil available N, P and K was observed in rest of the systems. In intercropping system, pigeonpea + fingermillet in 1:1 row ration recorded maximum soil available nutrients than other row ratios. when row ratio of fingermillet increased in pigeonpea + fingermillet intercropping system available nutrients (N, P and K) were decreased in soil. It may be due to competition for nutrients in between higher plant densities of fingermillet.

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