

Sustainable intercrop association of little millet (*Panicum miliare*) with groundnut (*Arachis hypogaea*) and pigeonpea (*Cajanus cajan*)

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ABSTRACT

An experiment was conducted during the rainy season (*kharif*) 1989, 1990 and 1991 to evaluate the economically and biologically sustainable intercrop association of 'Birsa Gondli' little millet (*Panicum miliare* L.) with 'AK 12-24' groundnut (*Arachis hypogaea* L.) and little millet with 'BR 65' pigeonpea [*Cajanus cajan* (L.) Millsp.]. Intercropping of either groundnut or pigeonpea with little millet was found beneficial to sole-stand yield of little millet, but it was uneconomical to sole-stand yield of both the intercrops. Among the intercrops, association of little millet with groundnut in 2 : 1, 2 : 2 and 4 : 1 row ratios were found more remunerative, which gave higher monetary advantage of Rs 320/ha and Rs 489/ha respectively than sole little millet. These treatments also accounted for higher net return (212%–232%), net return to Rs/Re investments (Rs 1.27–1.49), net return/day (Rs 16.72–18.31) and finally relative net return (Rs 1.59–1.70) over sole little millet. Row ratio of 4:1 also accounted for maximum land-equivalent ratio (1.26) and product of crowding coefficient (K 25.43).

Little millet (*Panicum miliare* L.) is one of the important food crops for the tribal folk. It becomes available for consumption at the time when there is an acute shortage of foodgrains in their households due to early harvest in comparison to other rainy-season (*kharif*) crops. It would be a advantage, if some extra yield could be harvested from the same unit of land in addition to sole component. Thus intercropping of some of the other crops with little millet may be a sustainable cropping pattern under low management conditions. Rafey and Prasad (1992) evaluated the feasibility of growing maize with pigeonpea under the same agroclimatic conditions but information on growing of little millet in association with other crops is not adequate. Hence an experiment was conducted to evaluate the com-

parative performance of little millet with groundnut (*Arachis hypogaea* L.) and pigeonpea [*Cajanus cajan* (L.) Millsp.] at different row ratios under dryland condition of plateau region.

MATERIALS AND METHODS

An experiment was conducted at Ranchi (625 m altitude 20° 17' N and 85° 19' E) during the monsoon season of 1989–1991. The soil was sandy loam with 22% clay, low in water-holding capacity (at 1/3 bar 18% and at 15 bar 8%). It was low in available N (156.0 kg/ha) and available P (9.5 kg/ha) and medium in exchangeable K (145.0 kg/ha) and pH 6.1. The total rainfall during the crop period of June to December in 1989, 1990 and 1991 was 933.1 mm, 1,287.8 mm and 1,079.3 mm respectively.

The treatments consisted of 3 sole stands of each 'Birsa Gondli 1' little millet, 'AK 12-24' groundnut and 'BR 65' pigeonpea and intercrop associations of little millet with each groundnut and pigeonpea in row ratios of 2 : 1, 4 : 1, 6 : 1, 2 : 2, 4 : 2 and 6 : 2. Thus 15 treatments were replicated thrice in randomized block design. The nutrients in the sole stands of little millet, groundnut and pigeonpea were applied as 20 : 20 : 0, 20 : 50 : 30 and 20 : 50 : 30 N : P : K (kg/ha) respectively and in intercrops as per their row ratios. The row spacing each for little millet and groundnut was 25 cm and for pigeonpea 75 cm.

The pooled grain yield of 3 years were statistically analysed. It was further computed for different competition functions, partial and total land-equivalent ratios, competitive ratio, relative crowding coefficient and their products, aggressivity of little millet on intercrops groundnut and pigeonpea and that of intercrops on little millet as described by Willey (1979). It was further, calculated for area-time equivalent ratio as proposed by Hiebsch (1978). It was also evaluated on the basis of different economical parameters, viz. monetary advantages (value of combined intercrops yields) $\times$ LER-1/ LER, net return, net return/Re investment, differences in net return over sole stand of little millet and relative net return as suggested by Jain and Rao (1980).

RESULTS AND DISCUSSION

Grain yield

Significant variations in grain yields of all the species were recorded (Table 1). Although sole groundnut gave maximum yields over rest of the treatments but it was statistically equal to 4 : 1 and 2 : 2 stands of little millet with groundnut. However, all the intercrop associations of little millet

with groundnut were superior to sole stand yield of little millet, whereas 2 : 1, 4 : 2 and 6 : 2 associations of little millet gave fairly a little less yield than pure culture of little millet. Introduction of groundnut in little millet under 4 : 1 and 6 : 1 row ratios also benefited the little millet by giving more yield which was even higher than sole stand yield of little millet. This might be due to beneficial effect of legume on cereal.

Biological feasibility

The partial land-equivalent ratio of little millet was recorded even > 1.0 when it was associated with groundnut in 4 : 1 and 6 : 1 which have also accounted for overall higher values for the land-equivalent ratios 1.26 and 1.16, respectively. The same row ratios of little millet with pigeonpea also gave higher land-equivalent ratios 1.18 and 1.12. The companion crop either groundnut or pigeonpea appeared more competitive than little millet by giving higher value for competitive ratio except under equal row ratio (2 : 2), which is further evident from aggressivity factor where little millet was only aggressive under the later situation with both groundnut and pigeonpea.

The crowding coefficient indicated that it was advantageous to grow little millet with groundnut under 4 : 1 and 6 : 1 row ratios which gave higher values for this coefficient (K_1 , 18.84 and 12.56), which was further established from the products of crowding coefficients (K , 25.43 and 13.19). The same row ratios of little millet with pigeonpea also gave higher values for the product of crowding coefficients (K , 3.00 and 3.76), although these were much lower than that obtained under intercropping of groundnut. It indicated that intercropping of groundnut or pigeonpea with little millet can be biologically sustainable over sole

Table 1. Biological parameters of little millet, groundnut or pigeonpea intercropping systems

Treatment	Yield (kg/ha)	LER ₁	LER ₂	LER	CR	ALI	ALI	K ₁	K ₂	K
Little millet (sole)	595									
Groundnut (sole)	850									
Pigeonpea (sole)	556									
<i>Little millet : groundnut</i>										
2 : 1	770 (397 + 373)	0.67	0.44	1.11	0.38 : 1	-0.55	0.55	1.00	1.56	1.56
4 : 1	817 (603 + 214)	1.01	0.25	1.26	0.25 : 1	-0.50	0.50	18.84	1.35	25.43
6 : 1	730 (603 + 127)	1.01	0.15	1.16	0.19 : 1	-0.73	0.73	12.56	1.05	13.19
2 : 2	818 (389 + 429)	0.65	0.51	1.16	1.30 : 1	0.15	0.15	1.89	1.02	1.93
4 : 2	683 (421 + 262)	0.71	0.31	1.02	0.57 : 1	-0.26	0.26	1.20	0.89	1.07
6 : 2	652 (453 + 199)	0.76	0.23	0.99	0.36 : 1	-0.45	0.45	1.06	0.91	0.96
<i>Little millet : pigeonpea</i>										
2 : 1	587 (365 + 222)	0.61	0.40	1.01	0.38 : 1	-0.49	0.49	0.79	1.33	1.05
4 : 1	691 (516 + 175)	0.87	0.31	1.18	0.17 : 1	-1.04	1.04	1.63	1.84	3.00
6 : 1	659 (564 + 195)	0.95	0.17	1.12	0.16 : 1	-0.87	0.87	3.03	1.24	3.76
2 : 2	556 (294 + 264)	0.49	0.47	0.96	1.04 : 1	-0.02	0.02	0.98	0.89	0.87
4 : 2	612 (437 + 175)	0.73	0.31	1.04	0.59 : 1	-0.26	0.26	1.38	0.92	1.27
6 : 2	540 (397 + 143)	0.67	0.26	0.93	0.35 : 1	0.44	-0.44	0.66	1.01	0.67
CD = (P = 0.05)										
	125									

LER₁ and LER₂, Partial land-equivalent ratio of little millet and intercrop respectively; LER, land-equivalent ratio; CR, competitive ratio; ALI and ALI, aggressivity of little millet on intercrops and of intercrops on little millet; K₁ and K₂, crowding coefficient of little millet on intercrop and of intercrop on little millet; K, product of crowding coefficient

Figures in parentheses indicate individual crop yield

Table 2. Economic parameters of little millet, groundnut or pigeonpea intercropping systems

Treatments	Monetary advantage (Rs/ha)	Net return (Rs/ha)	Increase in net return over millet (%)	Net return (Rs/ha)	Net return/ day	ATER	Relative net return (Rs/ha)	
							Intercrop- ping vs millet	Intercrop- ping vs intercrop
Little millet (sole)		788	100	1.13	14.33			
Groundnut (sole)		2,300	292	0.82	23.00			
Pigeonpea (sole)		1,236	157	0.59	6.87			
<i>Little millet : groundnut</i>								
2 : 1	320	1,831	232	1.31	18.31	0.81	1.7	0.91
4 : 1	576	1,672	212	1.49	16.72	0.81	1.59	0.88
6 : 1	313	1,270	161	1.27	12.70	0.70	1.32	0.80
2 : 2	489	1,797	228	1.03	17.97	0.87	1.68	0.90
4 : 2	51	1,225	155	0.88	12.25	0.70	1.29	0.79
6 : 2	-24	1,102	140	0.90	11.02	0.65	1.21	0.77
<i>Little millet : pigeonpea</i>								
2 : 1	22	1,078	137	0.92	5.99	0.59	1.19	0.95
4 : 1	355	1,350	171	1.38	7.50	0.58	1.38	1.03
6 : 1	212	1,080	137	1.20	6.00	0.46	1.20	0.95
2 : 2	-96	907	115	0.65	5.04	0.62	1.08	0.90
4 : 2	82	976	124	0.84	5.42	0.53	1.13	0.92
6 : 2	-139	801	12	0.76	4.45	0.43	1.01	0.87
CD (P = 0.05)		450		0.35				

* ATER, Area-time equivalent ratio; cost of little millet @ Rs 2/kg, and of groundnut and pigeonpea @ Rs 5/kg each

seeding of little millet.

Economic feasibility

The monetary advantage evaluated over sole little millet indicated a positive gain from intercropping under almost all the situations (Table 2). The intercropping of little millet with groundnut in 4 : 1 ratio gave maximum monetary advantage, but row ratio of 2 : 1 accounted for maximum net return, followed by row ratio of 2 : 2. However, growing of groundnut as sole crop gave maximum net return. Hence, it appeared that groundnut is not benefited under

intercrop association with little millet and this was also true for pigeonpea except 4 : 1 row ratio. There was increase in net return over sole little millet under all the intercropping situations. The row ratio of little millet and groundnut in 4 : 1 also gave maximum net return/Re investment (Rs 1.49), followed by little millet with pigeonpea under the same ratio (Rs 1.38). In none of the combinations, the area-time equivalent ratio was recorded to unity, but it was nearer to 1 (ATER 0.87 to 0.81) under 2 : 2, 4 : 1 and 2 : 1 row ratios of little millet with groundnut. All these associations also

recorded higher relative net return than sole stand of little millet, whereas no monetary benefit was derived due to intercropping in comparison to sole seeding of groundnut or pigeonpea except a very little from 4 : 1 ratio of little millet with pigeonpea.

Thus association of little millet with groundnut is more beneficial than pigeonpea. Association of little millet with groundnut under 2 : 1, 4 : 1 or 2 : 2 ratios is more sustainable, as these are accounted for better values in respect of biological parameters and are economically more remunerative.

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