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Performance of intercropping legumes in fingermillet (*Eleusine coracana*) at varying fertility levels

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ABSTRACT

A field experiment conducted during the monsoon season of 1994 and 1995 showed that sole groundnut (*Arachis hypogaea* L.) higher dry-matter yield, leaf-area index and crop-growth rate at early growth stages; but sole groundnut, fingermillet [*Eleusine coracana* (L.) Gaertn.] + pigeonpea [*Cajanus cajan* (L.) Millsp.] and fingermillet + groundnut intercropping recorded higher values of the above growth attributes at later stages. Sole fingermillet produced more ears/m^2 but fingermillet + pigeonpea intercropping recorded more fingers/ear than other cropping systems. Among the legumes, pigeonpea recorded greater number of pods/plant, whereas greengram (*Phaseolus radiatus* L.) produced higher number of seeds/pod and groundnut had the highest test weight. Sole groundnut produced the highest pod and chaff yields. Fingermillet + groundnut, fingermillet + pigeonpea and sole fingermillet also gave higher yield than other cropping systems. Application 60 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha recorded more dry-matter yield, leaf-area index and crop-growth rate. It helped in increasing fingers/ear, pods/plant and seeds or kernels/pod over the low fertility levels and resulted in higher yield of all the crops under sole and intercropping systems. Sole groundnut at high fertility level gave the highest yield.

Key words : Fingermillet, Pigeonpea, Greengram, Groundnut, Soybean, Intercropping, Fertility level, Growth, Production

Intercropping is a potential system for maximizing crop production on drylands over space and time in subsistence farming situations. The major objectives of intercropping are to produce an additional crop, to optimize the use of natural resources and to stabilize the yield of crops (Willey, 1979). Fingermillet is an important coarse cereal of tropical climate grown mostly under rainfed and risky conditions in fertility depleted and water-deficit soils during monsoon in arid and semi-arid regions of India. To avoid different risk factors as well as to obtain high

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productivity form unit area, intercropping other crops with fingermillet under rainfed situation is a rule rather than an exception (Hegde and Lingegowda, 1989). Fingermillet responds well to added fertilizers even under rainfed situation (Singh and Arya, 1988). Moreover, Ikramullah *et al.* (1994) noted significant interaction effects of cropping system and fertility level on productivity of cereal and legumes. Hence the present investigation was conducted to study the effect of intercropping legumes in fingermillet at different fertility levels on growth and productivity of the crops under rainfed upland in lateritic belt of West Bengal.

MATERIALS AND METHODS

A field experiment was conducted during monsoon season of 1994 and 1995 at Regional Research Sub-station of Bidhan Chandra Krishi Viswavidyalaya, Sekhampur, West Bengal, on typical upland soil (Ultisols) in the lateritic belt under rainfed condition. The soil was sandy clay loam in texture, acidic in reaction (pH 5.8) and low in fertility status (0.45% organic carbon, 248 kg/ha available N, 17.4 kg/ha available P and 193 kg/ha available K). The experiment was laid out in factorial randomized block design and replicated twice. The plot size was 5 m × 3 m. The treatments comprised 9 cropping systems, viz. sole cropping of fingermillet cv. 'A 404', redgram or pigeonpea cv. 'UPAS 120', greengram cv. 'B 105', groundnut cv. 'ICGS 44' and soybean [*Glycine max* (L.) Merr.] cv. 'Pusa 20' and intercropping these legumes in fingermillet at 4 : 1 ratio under 3 fertility levels (0, 0 and 0; 30, 15 and 15; and 60, 30 and 30 kg N, P_2O_5 and K_2O/ha). Sole fingermillet was sown at row spacing of 20 cm, and sole greengram, groundnut and soybean were sown at 30 cm × 10 cm, whereas sole redgram was sown at 75 cm × 30 cm spacing. In case of intercropping, 4 rows of fingermillet at 20 cm apart were alternated with single row of legume. The sources of N, P_2O_5 and K_2O were urea, single superphosphate and muriate of potash respectively. Half of N was applied at sowing along with whole quantity of P_2O_5 and K_2O and the remaining N was top-dressed at 25 days after sowing. The crops were sown during the last week of June and first week of July in 1994 and 1995 respectively. Maximum and minimum air temperature during the growing period ranged from 27.1 to 36.7° C and 16.4 to 27.7° C respectively and the crop received 1,113 mm and 1,433 mm rainfall in 1994 and 1995. Observations were recorded on growth attributes at different stages, yield and yield components at maturity of the crop.

RESULTS AND DISCUSSION

Growth attributes

Sole groundnut produced the maximum dry matter and leaf-area index at early stages of crop growth; and sole groundnut, fingermillet + pigeonpea and fingermillet + groundnut were very close in producing dry matter at 100 to 120 days sowing (DAS). Sole groundnut and sole soybean remained statistically at par for leaf-area index which were higher than other cropping systems at 100 days (Table 1). Intercropping of fingermillet with legumes showed higher leaf-area index. Sole groundnut recorded

Table 1. Effect of cropping systems and fertility levels on growth attributes (average data of 2 years)

Treatment	Dry-matter accumulation (g/m^2) at days*					Leaf-area index at days*					Crop-growth rate (g/m^2/day) at days*			
	40	60	80	100	120	40	60	80	100	120	40–60	60–80	80–100	100–120
Cropping system														
Sole fingermillet (FM)	54	186	278	379	451	0.38	0.80	1.47	0.82	0.19	6.63	4.60	5.05	3.60
Sole pigeonpea (PP)	18	40	72	120	183	0.18	0.51	0.82	1.32	0.72	1.10	1.60	2.40	3.15
Sole greengram (GG)	53	167	242			0.61	3.10	1.28			5.70	3.75		
Sole groundnut (GN)	105	251	391	445	538	1.28	2.18	3.50	3.29	1.05	7.30	7.00	2.70	4.65
Sole soybean (SB)	44	92	176	242	264	0.45	1.62	2.69	3.53	1.24	2.40	4.20	3.30	1.10
FM + PP (4:1)	65	167	299	433	561	0.51	1.13	2.05	1.75	0.91	5.10	6.60	6.70	6.40
FM + GG (4:1)	63	157	249	278	363	0.51	1.52	1.57	0.61	0.16	4.70	4.60	1.45	4.25
FM + GN (4:1)	75	186	344	450	618	0.73	1.39	2.53	1.76	0.51	5.55	7.90	5.30	8.40
FM + SB (4:1)	56	128	277	350	496	0.44	2.13	2.35	1.92	0.63	3.60	7.45	3.65	7.30
CD (P = 0.05)	11.7	27.7	52.2	76.2	96.8	0.08	0.24	0.40	0.34	0.08	0.91	1.57	0.81	1.27
Fertility (N P_2O_5 K_2O kg/ha)														
0, 0, 0	42	116	189	261	335	0.37	1.07	1.50	1.39	0.46	3.70	3.65	3.60	3.70
30, 15, 15	62	157	268	348	448	0.59	1.52	2.06	1.91	0.71	4.75	5.55	4.00	5.00
60, 30, 30	74	184	321	413	543	0.73	1.85	2.53	2.32	0.85	5.50	6.85	4.85	6.25
CD (P = 0.05)	6.8	16.0	33.1	46.7	59.3	0.05	0.18	0.23	0.21	0.05	0.52	0.91	0.49	0.77
CV (%)	14.2	15.2	18.4	18.6	18.4	12.6	18.2	16.8	15.5	10.6	16.4	20.2	14.1	20.8

*Days after sowing

the maximum crop-growth rate during 40–60 days and was followed by sole fingermillet. However, fingermillet + groundnut recorded the maximum crop-growth rate during the period from 60–80 days and 100–120 days after sowing and fingermillet + pigeonpea during 80–100 days. The differential growth behaviour of different legumes under study was mainly responsible for wide variations in different growth attributes.

Application of 60, 30 and 30 kg N, P_2O_5 and K_2O/ha recorded the highest dry-matter accumulation, leaf-area index and crop-growth rate, being significantly superior to those obtained with 30, 15 and 15 kg N, P_2O_5 and K_2O/ha and the control (Table 1). Application of 30, 15 and 15 kg N, P_2O_5 and K_2O/ha also caused greater dry-matter accumulation, leaf-area index and crop-growth rate than those at the control treatment. Hedge and Lingegowda (1989) and Ikramullah *et al.* (1994) also observed beneficial effects of fertilizer application on growth of fingermillet and legumes under sole and intercropping systems.

Yield components

Sole fingermillet owing to more plant stand gave significantly more ears than intercropped one (Table 2). The lowest number of fingers/ear was noted in

Table 2. Effect of cropping systems and fertility levels on yield components (average data of 2 years)

Treatment	Yield components of fingermillet				Yield components of legumes		
	Ears/ m^2	Fingers/ ear	Grain weight/ ear (g)	Test * weight (g)	Pods/ plant	Seed or kernel/ pod	Test weight (g)
Cropping system							
Sole fingermillet (FM)	104	4.5	1.26	3.10			
Sole pigeonpea (PP)					70.0	3.8	52.62
Sole greengram (GG)					11.4	5.7	23.03
Sole groundnut (GN)					11.2	1.7	42.21
Sole soybean (SB)					18.5	3.1	52.76
FM + PP (4:1)	78	4.6	1.27	3.06	67.0	3.7	51.42
FM + GG (4:1)	73	3.9	1.24	3.05	11.3	5.8	23.19
FM + GN (4:1)	82	4.3	1.25	3.09	11.7	1.7	41.26
FM + SB (4:1)	84	4.3	1.25	3.10	20.0	3.0	51.56
CD (P = 0.05)	17.0	0.36	NS	NS	3.07	0.35	4.33
Fertility (N, P_2O_5, K_2O, kg/ha)							
0, 0, 0	71	4.0	1.20	3.02	2.15	3.0	40.96
30, 15, 15	89	4.3	1.27	3.08	2.88	3.6	42.14
60, 30, 30	95	4.7	1.30	3.12	3.22	4.0	42.91
CD (P = 0.05)	13.2	0.29	NS	NS	1.89	0.23	NS
CV (%)	16.2	7.0	12.0	5.4	9.2	8.6	8.6

*The weight of groundnut, 100-kernel weight; test weight of other crops, 1,000-grain weight

Table 3. Effect of cropping systems and fertility levels on crop productivity (average data of 2 years)

	Fertility level (N, P_2O_5, K_2O kg/ha)				Fertility level (N, P_2O_5, K_2O kg/ha)			
	0, 0, 0	30, 15, 15	60, 30, 30	Mean	0,0,0	30,15,15	60,30,30	Mean
	Grain/seed/pod yield (kg/ha)				Straw/stick/chaff yield (kg/ha)			
Cropping system								
Sole fingermillet (FM)	1,181	1,471	1,702	1,451	2,569	3,257	3,697	3,174
Sole pigeonpea (PP)	349	565	734	549	694	1,128	1,505	1,109
Sole greengram (GG)	424	592	724	580	1,009	1,399	1,727	1,378
Sole groundnut (GN)	1,780	2,342	2,740	2,287	2,779	3,633	2,352	3,588
Sole soybean (SB)	514	684	831	676	1,035	1,373	1,663	1,357
FM + PP (4:1)	1,196 (944+252)	1,540 (1,115=385)	1,802 1,308+494)	1,513	2,624 (2,092+532)	3,358 (2,579+779)	3,998 (2,997+1,001)	3,327
FM + GG (4:1)	9,48 (845+103)	1,220 (1,052+168)	1,422 (1,217+205)	1,197	2,142 (1,903+239)	2,754 (2,330+424)	3,264 (2,701+563)	2,720
FM + GN (4:1)	1398 (866+532)	1,832 (1,133+699)	2,198 (1,370+828)	1,809	2,737 (1,921+816)	3,604 (2,518+1086)	4,411 (3,040+1,371)	3,566
FM + SB (4:1)	1,028 (880+148)	1,256 (1,055+201)	1,413 (1,178+235)	1,232	2,236 (1,928+308)	2,817 (2,316+501)	3,291 (2,626+665)	2,781
Mean	980	1278	1507		1981	2591	3095	
	*C**	*F*	*X × F*	*CV(%)*	*C**	*F*	*C×F*	*CV(%)*
CD (P = 0.05)	147	85	254	9.8	311	179	538	10.3

*C, Cropping system; F, fertility level

Figures in the parentheses indicate yields of individual crops in intercropping system fingermillet + greengram intercropping system and was significantly inferior to all other cropping systems. Intercropping system did not influence grain weight/ear and 1,000-grain weight of fingermillet. The results also revealed that pigeonpea under both sole and intercropping situations gave significantly higher number of pods/plant than other legumes. The highest number of seeds/pod was recorded by greengram and the highest test weight was recorded by groundnut. The results corroborate the findings of Singh and Arya (1988) and Barik *et al.* (1998).

Application of 30, 15 and 15 or 60, 30 and 30 kg N, P_2O_5 and K_2O/ha increased ears/m^2 over the control (Table 2). Application of 60, 30 and 30 kg N, P_2O_5 and K_2O/ha increased the fingers/ear over the application of 30, 15 and 15 kg N, P_2O_5 and K_2O/ha and the control. High fertility level (60, 30 and 30 kg N, P_2O_5 and K_2O/ha) showed its superiority to lower level and the control in increasing pods/plant and seeds or kernels/pod. Application of 30, 15 and 15 kg N, P_2O_5 and K_2O/ha enhanced the above yield components of legumes over the control.

Crop productivity

Grain and straw yields of fingermillet were reduced considerably when intercropped with legumes compared with the pure stand of fingermillet during both the years (Table 3). Such reduction was due to decrease in plant stand compared with that of sole cropping of fingermillet. Siddeswaran *et al.* (1987) and Singh and Arya (1999) also noticed reduction in fingermillet yield under intercropping situation. However, the combined grain or seed or pod yield of fingermillet and legumes was much higher in all intercropping systems except intercropping greengram with fingermillet when compared with sole cropping of fingermillet. Besides, sole groundnut recorded the maximum pod and chaff yields and was superior to other intercropping systems. Fingermillet + groundnut combination recorded the second highest productivity in terms of grain or pod and straw or chaff yields which were also greater than those of other intercropping systems. Intercropping pigeonpea with fingermillet also produced more grain or seed and straw or stick yield than sole cropping of fingermillet.

An application of 60, 30 and 30 or 30, 15 and 15 kg N, P_2O_5 K_2O/ha resulted in significantly higher grain or seeds/pod and straw or stick or chaff yields (Table 3) of different crops than the control treatment. The treatment 60, 30 and 30 kg N, P_2O_5 and K_2O/ha resulted the highest grain or seed or pod and straw or stick or chaff yields and was significantly superior to those at 30, 15 and 15 kg N, P_2O_5 and K_2O/ha. Sole groundnut gave the highest pod and chaff yields at high fertility level and was followed by grain or seed or pod and straw or stick or chaff yields of intercropping groundnut and pigeonpea with fingermillet at the same fertility level. Similar beneficial effects of fertilizer application on productivity of cereal–legume intercropping systems were also obtained by Ikramullah *et al.* (1994) and Singh and Arya (1999).

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