Improving productivity and profitability of clusterbean (*Cyamopsis tetragonoloba* (L.) Taub) + sesame (*Sesamum indicum* L.) intercropping system with optimum row ratio & balanced fertilization under arid region of Gujarat

Samrath Lal Meena*, Shamsudheen, M. and Devi Dayal

Central Arid Zone Research Institute, Regional Research Station,
Kukma, Bhuj (Gujarat) – 370 105
E-mail: dr_slmeena@yahoo.co.in (Corresponding author*)

ABSTRACT

A three year field study was conducted during rainy (*kharif*) season of 2005, 06 & 07 at the research farm, central Arid Zone Research Institute, Regional Research Station, Kukma-Bhuj to find out possibility of increasing production of pulses and oilseeds through intercropping system in relation to spatial arrangement of crops and integrated nutrient supply. The soil of the experimental site was gravelly-sandy loam with shallow depth, EC from 2 to 6.38 dS/m and pH from 8.4 to 9.2 with 0.25% organic carbon, 7.35 kg P_2O_5 and 215 kg K_2O ha^{-1}. Treatments consisting of 15 combinations of cropping systems, viz. sole clusterbean, sole sesame, clusterbean + sesame in 1:2, 1:1 and 2:1 row proportion and nutrient management i.e. control, 40 kg N/ha and 20 kg N + 5 t FYM (farmyard manure)/ha applied to the crops were tested in randomized block design and replicated thrice. The grain yield of clusterbean was significantly higher under sole cropping (710 kg/ha) compared to that of intercropping (495.1 kg/ha). However, clusterbean equivalent yield (919 kg/ha), net returns (Rs 7440/- per ha) and benefit: cost ratio (1.80) were higher with clusterbean + sesame (2:1) intercropping system over sole crop of clusterbean (710 kg/ ha, Rs 5945/- per ha and 1.68, respectively). Irrespective of cropping systems, application of 20 kg N/ha + 5 tonne FYM/ha recorded significantly higher clusterbean-equivalent yield (1036 kg/ha), net return (Rs. 11171/- per ha,) & benefit: cost ratio (2.14) over 40 kg N/ha alone and absolute control Addition of 5 t FYM/ha along with 20 kg N/ha resulted in 8.5 and 9.8% higher uptake of N over 40 kg N/ha and control, respectively. Intercropping of clusterbean with sesame in the row ratio of 2:1 fertilized with 20 kg N + 5 tonne FYM/ha may be recommended to get more economic benefit and sustained yield in arid region of Gujarat.

Key words: Clusterbean and sesame inter cropping, row rates, fertilizer.

Introduction

Clusterbean is a major rainfed crop of arid zone, mostly grown as a mixed crop with pearl millet, mothbean and sesame but the productivity is low (1). Plant population and spatial arrangement in intercropping have important effects on the balance of competition between component crops and their productivity. Intercropping of oilseed and pulse crops is one of the ways to increase their production because intercropping is more advantageous than sole cropping of either oilseeds or pulses (2).

The greatest limitation of increasing in productivity of these crops is inadequate supply of nutrients since the soils of arid region are poor in native fertility (3). The continuous application of inorganic fertilizers even in balanced form may not sustain soil fertility and productivity. However, judicious use of chemical fertilizers in combination with organic manures is required to improve the soil health as well as to achieve sustainable crop production (4). Farmyard manure (FYM) is the proven source of nutrition to agricultural crops. Thus, balance fertilization along with sound crop husbandry offers a great scope for increasing productivity. A lot of information is available on cereal + legume intercropping but it lacks for legume + oilseed system. The information on comparative performance, nutrient mana-gement, competition relations and sustainability of the system in arid region of Gujarat is lacking. Keeping this in view, an experiment was undertaken to assess yield performance of the crops under different row ratio and nutrient management and evaluate economics of the system for Kachchh region of arid Gujarat.

Materials and Methods

A field experiment was laid out at the research farm, Central Arid Zone Research Institute, Regional Research Station, Kukma, Bhuj, Kachchh, Gujarat during rainy (*kharif*) season of 2005 to 2007, that is located between 23°12' to 23° 13' N latitude and 69°47' to 69°48' E longitude. The soil of the experimental site was gravelly sand to loamy sand in texture with shallow depth (21 cm). The soil was low in organic C (0.25%), available N (121 kg/ha^{-1}), available P (7.35 P_2O_5 mg/kg soil), and medium in available K (215 kg K_2/ha^{-1}) with pH 8.6. The region is characterized by low and erratic rainfall, high temperature, high wind velocity and high potential evapotranspiration. A total rainfall received during the cropping period (June to October) was 238.2, 689.4 and 701.6 mm in 2005, 2006 and 2007, respectively, compared with the average annual rainfall of 340 mm. In the first year (2005) of experimentation the yield of both the crops were adversely affected due to low and erratic rainfall. Cropping season of 2006 and 2007 was quite normal for the growth of both the crops and comparatively higher yields were obtained owing to adequate and well distribution of rainfall. However, the yield of both the crops was slightly low in 2007 as compared with 2006 because of continuous rainfall during maturity stage. Treatments consisting of 15 combinations of cropping systems, viz. sole clusterbean, sole sesame, clusterbean + sesame in 1:2, 1:1 and 2:1 row proportions and nutrient management i.e. control, 40 kg N/ha and 20 kg N + 5 t FYM/ha applied to the crops, were tested in randomized block design and replicated thrice. The net plot size of 4.0 x 4.5 m and spacing of 45 x 15 cm were adopted for both the crops and were sown in the last week of June in all the years of experimentation. A common recommended dose of phosphorus and potash was applied to the crops at the time of sowing. The cultivars used in the study were 'RGC–936' (clusterbean) and 'GUJ–1' (sesame). The remaining agronomic practices were followed as per recommendations for the region. The economics was calculated on the basis of prevailing market prices of different inputs and outputs. The clusterbean equivalent yield was calculated by converting the seed yield of sesame into clusterbean yield on the basis of existing market price of the crops. The yields were further used for computation of land-equivalent ratio (LER), as suggested by Willey (5). Sustainable yield index (SYI) and sustainable value index (SVI) were calculated as per the procedure described by Singh *et al.* (6). Chemical analysis for estimation of N was done by micro Kjeldahl method.

Results and Discussion

Growth and yield

Clusterbean

Sole clusterbean recorded significantly lower plant height and yield attributing characters than that recorded in its intercropping with sesame. Plant height and yield attributing parameters of clusterbean i.e. pods/plant, seeds/pod, 1000-seed weight and harvest index were significantly higher under intercropping system than sole cropping (Table 1). Among the intercropping treatments clusterbean with sesame under 2:1 row ratio recorded higher plant height, yield attributes and seed yield (Table 2) of clusterbean than other row ratios of 1:1 and 1:2 in all three 3 years of experiment and could recover maximum (78%, on mean basis) of its sole crop seed yield, owing to higher plant density of main crop and complementary effect of intercrop. Similar trend of results, on chickpea based intercropping systems, was observed by Ahlawat *et* *al.* (7). Application of 20 kg N/ha along with FYM 5 t/ha recorded signifi-cantly higher plant height, number of pods/plant, seeds/pod, 1000-seeds weight, harvest index (Table 1) and seed yield (589) of clusterbean and was 33% more over control (Table 2). This might be due to increased availability of nutrients to the crop plant through combined use of organic and inorganic sources (8).

Sesame

Plant height and yield attributing parameters of sesame were better under intercropping system than sole stand but sesame crop produced higher seed yield of 215 kg/ha (mean basis) in sole stand. The lower seed yield in inter-cropping systems might be due to lesser number of plants per unit area. Among intercropping systems, plant height, capsules/plant, seeds/capsule, 1000-seed weight and harvest index (Table 1), and seed yield (Table 2) of sesame were significantly higher in 1:2 row ratio than other ratios. This could be attributed to the variations in the magnitude of competition among component crops grown in various proportions. The results are conformity with the findings of Sarkar *et al.* (9). The integrated nutrient supply system of farmyard manure at 5 tonne with 20 kg N/ha favourably improved plant height, yield attributes, harvest index and seed yield of sesame and produced the highest seed yield which was 16 and 24% higher over application of 40 kg N/ha and control, respectively. This may be ascribed to the better macro and micronutrient availability as well as physical condition of the soil. These findings support the results of Singh (10) and Imayavaramban *et al.* (11).

Clusterbean equivalent yield

All the intercropping systems, irrespective of the row ratios had more system productivity in terms of clusterbean equivalent yield compared to sole clusterbean (Table 2). Higher clusterbean equivalent yield under various row patterns was due to additional yield of sesame and better utilization of natural resources, viz., light, space, nutrients, etc. than sole stand. Among different intercropping patterns, 2:1 row ratio gave maximum clusterbean equivalent yield of 919 kg/ha which was 29% higher over sole cropping. The differential behavior in clusterbean equivalent yield was on account of productivity of crops in intercropping systems and their relative market prices (12). This revealed a greater degree of efficiency and compatibility of sesame in clusterbean. The fertilizer application (20 kg N + 5 t FYM/ha) to component crops improved the equivalent yields of system due to proper nourishment and less competition for nutrients.

Table 1. Effect of row ratio and nutrient management on plant height, yield attributes and harvest index of clusterbean and sesame (mean of 3 years)

Treatment	Plant height (cm)		Pods or capsules/ plant		Seeds/pod or capsule		1000-seed weight (g)		Harvest index (%)	
	Cluster bean	Sesame	Cluster bean	Sesame	Cluster bean	Sesame	Cluster bean	Sesame	Cluster bean	Sesame
Cropping system										
Sole cropping	54.4	35.3	31.1	10.7	5.5	31.2	27.4	2.0	24.29	17.38
Clusterbean+sesame (1:2)	60.3	45.9	38.5	17.8	6.0	34.4	29.2	2.1	26.13	19.00
Clusterbean+sesame (1:1)	63.5	43.3	42.1	16.0	6.4	35.5	29.1	2.2	26.67	18.27
Clusterbean+sesame (2:1)	67.3	42.2	47.6	15.2	6.6	35.8	30.7	2.2	27.12	18.03
SEm ±	1.2	0.5	1.4	0.5	0.2	1.4	0.4	0.1	0.13	0.21
CD (P= 0.05)	3.5	1.9	4.7	1.3	0.7	4.1	1.2	NS	0.38	0.67
Nutrient management										
Control	52.4	38.3	32.6	12.8	6.2	33.3	28.5	2.0	24.65	17.96
40 kg N/ha	69.3	49.0	55.4	22.8	6.7	39.6	31.3	2.2	28.31	19.48
20 kg N + 5 t FYM/ha	75.5	52.3	64.0	26.3	7.3	45.4	33.4	2.3	28.47	20.14
SEm ±	1.5	1.0	2.1	0.8	0.3	1.6	0.6	0.9	0.06	0.18
CD (P= 0.05)	4.6	2.8	6.4	2.7	0.9	4.7	1.9	NS	0.19	0.54

Table 2. Effect of row ratio and nutrient management on seed yield, clusterbean equivalent yield, land equivalent ratio, N uptake, economics and sustainability of clusterbean and sesame intercropping (mean of 3 years)

Treatment	Seed yield (kg/ha)		CEY (kg/ ha)	LER	Total N uptake (kg/ha)			Net returns (Rs/ha)	B: C ratio	Sustainability	
	Cluster-bean	Ses-ame			Cluster-bean	Ses-ame	Comb-ined			SYI	SVI
Cropping system											
Sole cropping	710	215	710	1.00	55.1	22.2		5945	1.68	0.51	0.52
Clusterbean + sesame (1:2)	433	156	867	1.32	32.6	14.8	47.0	7172	1.77	0.73	0.73
Clusterbean + sesame (1:1)	493	126	879	1.33	36.0	13.6	49.5	6918	1.75	0.72	0.72
Clusterbean + sesame (2:1)	589	102	919	1.38	39.7	13.0	52.7	7440	1.80	0.74	0.76
SEm ±	26	7	11		1.1	0.4	0.9	143	0.01		

...gement on plant height, yield att-
...ean and sesame (mean of 3 years)

	Seeds/pod or capsule		1000-seed weight (g)		Harvest index (%)	
	Cluster bean	Sesame	Cluster bean	Sesame	Cluster bean	Sesame
	5.5	31.2	27.4	2.0	24.29	17.38
	6.0	34.4	29.2	2.1	26.13	19.00
	6.4	35.5	29.1	2.2	26.67	18.27
	6.6	35.8	30.7	2.2	27.12	18.03
	0.2	1.4	0.4	0.1	0.13	0.21
	0.7	4.1	1.2	NS	0.38	0.67
	6.2	33.3	28.5	2.0	24.65	17.96
	6.7	39.6	31.3	2.2	28.31	19.48
	7.3	45.4	33.4	2.3	28.47	20.14
	0.3	1.6	0.6	0.9	0.06	0.18
	0.9	4.7	1.9	NS	0.19	0.54

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...ratio, N uptake, economics and sustai-
...e intercropping (mean of 3 years)

Total N uptake (kg/ha)			Net returns (Rs/ha)	B: C ratio	Sustainability	
...ter-...an	Ses-ame	Comb-ined			SYI	SVI
.1	22.2		5945	1.68	0.51	0.52
.6	14.8	47.0	7172	1.77	0.73	0.73
.0	13.6	49.5	6918	1.75	0.72	0.72
.7	13.0	52.7	7440	1.80	0.74	0.76
.1	0.4	0.9	143	0.01		

CD (P= 0.05)	78	21	33		3.7	1.1	3.0	431	0.04		
Nutrient management											
Control	445	124	799	1.21	34.0	12.7	46.7	6479	1.74	0.75	0.75
40 kg N/ha	579	153	976	1.48	39.4	13.9	53.3	9131	1.93	0.80	0.81
20 kg N + 5t FYM/ha	644	173	1036	1.56	41.0	14.8	55.7	11171	2.14	0.81	0.82
SEm ±	18	6	19		0.4	0.3	0.7	315	0.02		
CD (P= 0.05)	56	18	57		1.4	0.8	2.1	948	0.07		

Land equivalent ratio

All the intercropping systems had land-equivalent ratio greater than unity (Table 2). The maximum land-equivalent ratio was recorded under 2:1 row ratio followed by 1:1 and 1:2 ratios. Application of 20 kg N + 5 t FYM/ha also recorded the highest land-equivalent ratio (1.56) among the nutrient management practices.

Total N uptake

Sole clusterbean crop removed maximum quantity of N (55.0 kg/ha) which was at par with intercropping in 2:1 ratio (Table 2). Among the intercropping systems, 2:1 ratio removed significantly highest quantity of N than other ratios. Addition of 5 t FYM/ha along with 20 kg N/ha resulted in 8.5 and 9.8% higher uptake of N over 40 kg N/ha and control, respectively. This might be due to additional amount of nutrients supplied by farmyard manure as well as the beneficial effects of organic matter addition, which were derived in connection with the physical and chemical properties of the soil (11).

Economics

All the intercropping systems were more remunerative than the sole clusterbean with higher net monetary returns and benefit: cost ratio. Among the intercropping cropping systems, planting of clusterbean + sesame (2:1) row proportion appeared more net return of Rs. 7440 per ha over sole cropping of clusterbean (Table 2) with B: C ratio of 1.80. The highest net return (Rs. 11171 per ha) and B: C ratio (2.14) over 40 kg N/ha alone (Rs. 9131 per ha, 1.93) and absolute control (Rs. 6479 per ha, 1.74), respectively, were accrued with the application of 20 kg N + 5 t FYM/ha. This is close conformity with the findings of Kumar (12) and Singh (10) under different intercropping systems with nutrient management. This system was economically viable intercropping with the higher net returns.

Sustainability

The sustainable yield index (SYI) and sustainable value index (SVI) were higher with clusterbean + sesame under 2:1 (0.74, 0.76) row ratio (Table 2). This was followed by 1:2 (0.73, 0.73) and 1:1 (0.72, 0.72), indicating that the intercropping system of 2:1 was more stable than the others. Bastia *et al.* (2008) also reported higher sustainability of rice based cropping systems with different oilseeds and pulses. The highest SYI (0.81) and SVI (0.82) indices were observed under the application of 20 kg N/ha with 5 t FYM/ha followed by 40 kg N/ha alone (0.80, 0.81) and absolute control (0.75, 0.75), respectively.

Thus it was concluded that an intercropping of clusterbean with sesame in the row ratio of 2:1 may be followed for fetching higher yield and monetary advantages and better utilization of resources in arid region of Gujarat. Application of 20 kg N with 5 tonne farmyard manure/ha may be recommended for the system as an alternative of 40 kg N/ha dose to reduce the chemical fertilizer as well as to get more economic benefit and sustained yield.

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