



Effect of intercropping on productivity of the system and available nutrient status of soil

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Abstract : The intercropping of maize and French bean was studied to increase productivity per unit area to feed ever increasing population without deteriorating soil nutrient status. The treatments comprised of 3 row ratios (1:1,1:2 and 2:2) for both grain and vegetable purpose French bean, 4 sole crops (French bean for grain and vegetable, soybean and maize). Total number of treatments were eleven. Intercropping of maize + French bean in 1:2 row ratio either for grain or vegetable recorded significantly higher maize equivalent yield (7897 and 8027 kg ha⁻¹, respectively), land equivalent ratio (1.35 and 1.38, respectively), system productivity index (7452 and 7318, respectively), than other row ratios of intercropping and sole crops of maize and French bean. Where, maize + French bean in 1:2 row ratio for grain recorded significantly higher area time equivalent ratio (1.21), protein (0.75 x 10⁶ g ha⁻¹), carbohydrate (3.91 x 10⁶ g ha⁻¹) and energy yield (20.57 x 10⁶ k cal ha⁻¹) than maize + French bean for vegetable in all the row ratios. The available N, P₂O₅ and K₂O status was improved by growing soybean and French bean in 1:2 row ratio with maize (221.33 and 245.43 kg ha⁻¹, 36.42 and 35.32 kg ha⁻¹ and 366.45 and 369.62 kg ha⁻¹, respectively) compared to sole maize (221.33, 32.28 and 361.58 kg ha⁻¹, respectively).

Key Words : Intercropping, Row ratio, Production efficiencies of the system, Energetics, Available nutrients

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INTRODUCTION

The present food production in India is 221 million tonnes and its production has to be increased to 294 million tonnes by 2020. Reduced per capita availability of land due to increasing population forcing us to produce more per unit area through multiple cropping systems. In Northern Transition Zone of Karnataka, maize (*Zea mays* L.) is predominate crop among the *Kharif* (rainy season) crops. Being wider spaced, maize provides an opportunity for introducing a short duration pulse crop like French bean as an intercrop in additive series since the rainfall received in the zone is in excess of single crop need. Moreover, such a system helps in efficient utilization of natural resources (space, moisture and light) to harness maximum productivity per unit area. Further, to avoid adverse effect on main crop by addition of intercrop, suitable

adjustment in plant population and crop geometry has to be worked out. Experiments carried out elsewhere in India clearly indicated that urdbean, soybean, French bean and cowpea as intercrops in maize had no detrimental effect on main crop. However, information on comparison of productivity of French bean as vegetable and grain with maize in Karnataka is meagre. Hence, this experiment was conducted.

MATERIALS AND METHODS

The experiment was conducted at Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad during 2005-06 and 2006-07 during rainy season. In maize + French bean intercropping, French bean was grown as intercrop with maize in additive series in three row ratios viz., 1:1 (50% population of French bean), 1:2 (66% population

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of French bean) and 2:2 (50% population of French bean). In 1:1 row ratio, 60x30 cm row spacing for maize and one row of French bean between two rows of maize, in 1:2 row ratio, 90 cm x 20 cm row spacing for maize and two rows of French bean between two rows of maize and in 2:2 row ratio, 90/30 x 30 cm paired row planting of maize, two rows of French bean between two pairs of maize. In all the row ratios, 30cm row spacing for French bean maintained and there were 11 treatments. The experiment was laid out in Randomized Block Design. The available N, P₂O₅, K₂O of soil was 220, 32 and 360 kg ha⁻¹, respectively. Protein, carbohydrate and energy yield were calculated by using economic yield ha⁻¹ and contents of energetics (Gopalan *et al.*, 1978) in the economic yield components. Standard procedures were followed for the available nutrient status of soil.

RESULTS AND DISCUSSION

In the intercropping system, the productivity of a system depends not only on the efficiency of individual component crop but also on how well these crops complement each other in time and space (Willey *et al.*, 1981). It is a common knowledge and observation that when a tall cereal component like maize intercropped with a short stature legume component like French bean, the beneficial effects accrue both from the point of better utilization of aerial atmosphere and from the stand point of improved utilization of underground resources. Therefore, the overall productivity of maize based system depends partly on the efficiency of maize crop itself and partly on how well maize fits with French bean and vice-versa. The effective use of growth resources in an intercropping system could be quantified through land equivalent ratio (LER). The values exceeding unity imply the benefit of growing the crops together (Pilbeam *et al.*, 1994). Among the various row ratios, maize+ French bean for vegetable and grain in 1:2 row ratio recorded significantly higher LER (1.38 and 1.35, respectively) than others except maize + soybean (1.35), a recommended check. The higher LER with maize + French bean (1:2) intercropping was due to good growth of both crops as there was least competition for growth resources and greater complementarity (Table 1). Willey and Osiru (1972) stated that at high population pressures, the mixtures give greatest yield advantage. This partly explains greater biological efficiency of intercropping in 1:2 row ratio (66 % sole optimum population). Such an increase in LER of intercropping system was observed by the earlier workers in maize + French bean (Pandita *et al.*, 2000, Padhi, 2001; Hugar and Palled, 2008). Further, area time equivalent ratio (ATER) which considers the duration of individual crops and the system was also significantly higher in maize + French bean for grain in 1:2 row ratio than in 1:1 or 2:2 row ratio indicating higher per day productivity from the system. The grain crop recorded significantly higher ATER than vegetable crop which indicated

Table 1 : Efficiencies of maize+ French bean intercropping system as influenced by row ratios and purpose of the French bean

Treatments	Maize Grain yield (t/ha)	Average Grain yield (t/ha)	System productivity	Maize yield (t/ha)	French bean yield (t/ha)	Grain yield (t/ha)	Vegetable yield (t/ha)	Energy yield (t/ha)	Protein yield (t/ha)	Average Grain yield (t/ha)	Protein yield (t/ha)
Maize	15.81	1.28	59/1	0.72	3.85	0.20	3.85	1.835	2.05	33.21	3.62/1
Maize + French bean (1:1)	18.91	1.35	73/3	0.75	3.91	0.20	3.91	2.057	2.31/5	35.32	3.66/5
Maize + French bean (1:2)	15.31	1.31	70/3	0.73	3.86	0.20	3.86	2.013	2.21/5	32.21	3.61/3
Maize + French bean (2:1)	17.60	1.30	70/3	0.63	3.65	0.19	3.65	1.891	2.31/6	33.16	3.63/6
Maize + French bean (2:2)	18.21	1.38	71/3	0.61	3.66	0.19	3.66	1.901	2.02/2	36.51	3.69/3
Maize + soybean (1:2)	16/6	1.33	71/3	0.63	3.63	0.19	3.63	1.885	2.36/25	31.53	3.63/3
Maize + soybean (1:1)	16/9	1.35	70/3	0.50	3.61	0.19	3.61	2.113	2.15/3	36.12	3.69/3
Sole French bean (1:1)	68/3	1.0	7/3	0.73	1.1	0.02	1.1	6.52	2.35/28	33.56	3.62/5
Sole French bean (2:1)	64/5	1.0	7/3	0.72	0.91	0.01	0.91	4.02	2.02/1	32.18	3.63/5
Sole soybean	78/3	1.0	7/3	0.61	0.71	0.01	0.71	8.15	2.16/32	31.61	3.63/3
Sole maize	59/9	1.0	9/1	0.62	3.69	0.20	3.69	1.885	2.21/33	32.28	3.61/3
S.S.	1/1	0.01	6/3	0.01	0.03	0.01	0.03	0.26	1.80	0.61	1.23
C.C. (0.05)	1/2	0.03	7/1	0.02	0.10	0.01	0.10	0.78	5.50	1.16	3.55

that intercropping of French bean for grain in maize utilized resources available per unit land area and time more efficiently than vegetable French bean. This was possibly due to greater temporal and spatial complementarities. In the present investigation, significantly higher system productivity index (SPI) was obtained in maize + French bean for grain and vegetable in 1:2 row ratio (7452 and 7318, respectively) and maize + soybean (7309) than the other row ratios of maize + French bean for grain and vegetable. These observations strengthened further through the evaluation of maize equivalent yield (MEY) of the cropping systems (Table 1). Maize equivalent yield was significantly higher in maize + French bean in 1:2 row ratio either grown for grain (7897 kg ha⁻¹) or vegetable (8027 kg ha⁻¹) compared to other sole and other intercropping systems (4883 – 7646 kg ha⁻¹). This could be due to higher seed / green pod yield from French bean and higher market prices for French bean. Similar results were also reported by Pandita *et al.* (2000) in maize + French bean.

The evaluation of the intercropping systems through energetics is more stable and meaningful as it indicates the energy yield from the systems which does not fluctuate with the market prices since it is based on the nutritional value of the system. Interestingly, though maize equivalent yield of maize + French bean intercropping in 1:2 row ratio for grain and vegetable were at par, energetics revealed significant differences. Protein yields of French bean grown for grain in all the row ratios (0.72 - 0.75 x 10⁶ g ha⁻¹) were at par but were superior to vegetable French bean irrespective of row ratios (0.63 - 0.6490 x 10⁶ g ha⁻¹). Grain French bean in 1:2 row ratio recorded 17.18 per cent higher protein yield than maize + vegetable French bean in the same row ratio (Table 1). Protein, carbohydrate and energy yields were also significantly higher in maize + grain French bean in 1:2 row ratio compared to all the row ratios of vegetable bean. This was due to lower protein, carbohydrate and energy content in vegetable crop (1.77 g, 4.50 g and 26 k cal / 100 g edible portion, respectively) than the grain crop (22.90 g, 60.60 and 346 k cal / 100 g edible portion, respectively). Maize + French bean for grain in 1:2 row ratio recorded 5.96 and 7.41 per cent higher carbohydrate yield than sole maize and maize + soybean, respectively.

The available N, P₂O₅ and K₂O status was improved by growing soybean and French bean in 1:2 row ratio with maize

(231.45 and 245.43 kg ha⁻¹, 36.42 and 35.32 kg ha⁻¹ and 366.45 and 369.62 kg ha⁻¹, respectively) compared to sole maize (221.33, 32.28 and 361.58 kg ha⁻¹, respectively).

Conclusion:

Intercropping of maize + French bean for grain in 1:2 row ratio recorded significantly higher area time equivalent ratio, protein, carbohydrate and energy yield than maize + French bean for vegetable in all the row ratios. Available soil nutrient status was not affected by growing maize and French bean simultaneously on the same field.

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