Indian Journal of Agronomy **52** (1) : 36–39 (March 2007)

Response of sunflower (*Helianthus annuus*) and french bean (*Phaseolus vulgaris*) intercropping to different row ratios and nitrogen levels under rainfed conditions of temperate Kashmir

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Received: June 2006

ABSTRACT

A field experiment was conducted at the research farm of Faculty of Agriculture, SKUAST-K Regional Research Station, Wadura in Kashmir during rainy (*kharif*) season 2002 and 2003, to study the response of sunflower (*Helianthus annuus* L.) and french bean (*Phaseolus vulgaris* L.) intercropping to different row ratios (1:1 and 2:2) and nitrogen levels (0, 40, 80 and 120 kg/ha) under rainfed conditions. Intercropping reduced the values of growth parameters, yield attributes and seed yield of both sunflower and french bean compared with their sole crops. Both the intercroppings recorded significantly higher sunflower-equivalent yield (SEY), net income and benefit: cost ratio than their sole stands. Intercropping of sunflower + french bean under 2:2 row ratio recorded significantly higher SEY (1,231 kg/ha), land-equivalent ratio (1.25), net income (Rs 13,138/ha) and benefit: cost ratio (1.95), and also indicated a modest competitive ratio (2.10:0.48), followed by sunflower + french bean in 1:1 ratio. Both sunflower and french bean in sole and intercropping responded favourably up to 80 kg N/ha only for leaf-area index, dry-matter accumulation, yield attributes, seed yield, N uptake, net income and benefit: cost ratio. The interaction effects of the factors showed that mean SEY responded to N application up to 80 kg/ha in 2:2 row ratio of sunflower+ french bean.

Key words : Intercropping, Sunflower, French bean, N uptake, Competition function, Economics

Sunflower with high oil percentage is quite suited as a rainy season (*kharif*) oilseed crop in the Kashmir region. Being a widely-spaced crop, it offers an opportunity for intercropping where legumes of short stature like french bean (*Phaseolus vulgaris* L.) can be grown. Spatial arrangement in intercropping is an important factor for better yield advantage. The greatest limitation for increasing the productivity of these crops is inadequate supply of nutrients. The nutrients, mainly nitrogen, contribute significantly in improving the yield of crops. Keeping this in view, an experiment was undertaken to find out the possibility of increasing production of oilseeds and pulses through intercropping system by adopting appropriate spatial arrangement of crops and nitrogen application.

MATERIALS AND METHODS

The field experiment was conducted during *kharif* 2002 and 2003 at the research farm of Faculty of Agriculture, SKUAST-K, Regional Research Station, Wadura, Baramulla (34°17' N and 74°33' E, at 1,524 m above mean sea-level). The soil was silty-clay loam, classified Typic Hapludalfs with pH (1:2.5) 7.10 and electrical conductivity (1:2.0) 0.35 dS/m. The available soil N, P and K were 353.5, 18.7 and 273.6 kg/ha respectively. The treatments were four cropping systems (sole sunflower, sole french bean, sunflower + french bean 1:1 and sunflower + french bean 2:2) and four levels of nitrogen (0, 40, 80 and 120 kg/ha), replicated thrice in randomized block design. Crop varieties were 'Morden' sunflower and 'French Yellow' french bean. Both the crops were sown in the first week of May during the two years of experimentation. Sunflower was sown in uniform rows of 60 cm, at a plant-to-plant distance of 30 cm, and between two rows of sunflower a row of french bean was sown under 1:1 row ratio. In paired rows sunflower was sown at a row distance of 45 cm, leaving 75 cm between paired rows (45-75 cm) and plant-to-plant spacing of 30 cm within a row. French bean was sown at recommended planting design. The seed rate was 20 and 60 kg/ha for sunflower and french bean respectively. A recommended dose of phos-

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phorus @ 60 kg/ha for sunflower and 50 kg/ha for french bean, was applied as per area occupied by them and nitrogen was given as per treatment. Sunflower and french bean were harvested respectively on 18 August and 22 July in the first season, and 19 August and 25 July in the second season. The total rainfall during the crop season was 172.8 mm in 2002 and 123.4 mm in 2003. Mean maximum and minimum temperatures were respectively 29.0° and 13.6° C in the first season, and 27.8° and 13.4° C in the second season. The yields of intercrops were calculated on the basis of proportionate area, and their economics and sunflower-equivalent yield were worked out on the basis of existing market price. The pooled data were computed for competition functions like land-equivalent ratio and competition ratio.

RESULTS AND DISCUSSION

Effect of intercropping

Sunflower

Plant height, leaf-area index (LAI), dry-matter accumulation (DMA), 1,000-seed weight and seed yield of sunflower showed significant variation due to planting patterns (Tables 1, 2). Growth, yield parameters and yield were less under the intercropping system compared with those under sole cropping. The different row ratios of sunflower with french bean had no effect on plant height, leaf-area index, head diameter and 1,000-seed weight. However, planting of crops in paired row (2:2) recorded significantly higher DMA and seeds/head compared with alternate row (1:1). This indicated that the paired row facilitated proper growing condition for the growth of sunflower in comparison with alternate row arrangement. This finding corroborates that of Sarkar *et al.* (1997).

The seed yield of sunflower was significantly higher in sole cropping than in intercropping under both the planting patterns due to the absence of competition and limited disturbance to the habitat. Seed yield of intercropped sunflower decreased by 21.6 and 15.7 per cent under 1:1 and 2:2 row ratios compared with sole sunflower respectively. However, plant population of sunflower was maintained at 100 per cent under intercropping. Lower reduction in the seed yield of paired row-planted sunflower compared with 1:1 ratio might be due to more space, light penetration and more uptake of N. The association of two rows of french bean with paired-row of sunflower gave higher seed yield of the main crop than association of single row of french bean intercropped with normal-planted sunflower under rainfed conditions of temperate Kashmir. This was due to improvement in dry-matter accumulation and seeds/head of sunflower, owing to N-fixation and higher leaf-area index of french bean, resulting in reduced evapo-transpiration.

Table 1. Growth and yield attributes of sunflower + french bean intercropping system as influenced by nitrogen levels (mean data of 2 years)

Treatment	Plant height (cm)		Leaf-area index		Dry-matter accumulation (q/ha)		Head diameter (cm) or pod length (cm)		Seeds/head or seeds/pod		1,000-seed or 100-seed weight (g)	
	S	F	S	F	S	F	S	F	S	F	S	F
Cropping system												
Sole sunflower	127.3		1.87		26.65		17.4		402		38.75	
Sole french bean		24.5		2.56		32.13		11.4		5.9		31.7
Sunflower + french bean (1:1)	124.5	20.7	1.30	1.56	19.36	12.27	15.5	8.7	291	4.0	35.61	28.3
Sunflower + french bean (2:2)	121.6	22.4	1.40	2.01	22.09	15.12	15.0	9.5	345	4.7	34.87	30.1
CD (P=0.05)	4.2	1.5	0.11	0.17	1.29	1.63	0.8	0.6	17	0.3	1.76	1.6
Nitrogen (kg/ha)												
0	115.0	22.8	0.91	1.24	12.24	10.02	14.6	10.3	288	4.2	32.87	27.4
40	123.5	25.8	0.98	1.52	21.13	13.15	15.7	11.2	328	5.3	35.26	29.3
80	127.0	27.0	1.28	2.06	21.62	15.93	17.8	11.6	334	6.7	37.67	32.6
120	132.1	28.8	1.22	1.77	18.37	15.25	15.2	12.0	308	6.4	34.81	32.1
CD (P=0.05)	5.4	1.7	0.09	0.27	1.97	1.84	0.9	0.7	20	0.5	1.92	1.8

S = Sunflower, F = frenchbean

Table 2. Seed yield, N uptake, sunflower-equivalent yield, competition functions and economics of sunflower + french bean intercropping systems as influenced by nitrogen levels (mean data of 2 years)

Treatment	Seed yield (q/ha)		Total N uptake (kg/ha)			Sunflower-equivalent yield (q/ha)	Land-equivalent ratio	Competitive ratio		Net income (Rs/ha)	B:C ratio
	S	F	S	F	C			S	F		
Cropping system											
Sole sunflower	9.81		54.75		54.75	9.82				8,662	1.67
Sole french bean		7.31		52.16	52.16	10.06				9,474	1.74
Sunflower + french bean (1:1)	7.69	2.55	30.80	17.58	48.38	11.22	1.13	2.25	0.45	10,720	1.76
Sunflower + french bean (2:2)	8.27	2.92	43.44	24.22	67.66	12.31	1.25	2.10	0.48	13,138	1.95
CD (P=0.05)	0.23	0.22	2.00	1.28	2.88	0.41				542	0.07
Nitrogen (kg/ha)											
0	6.40	3.14	16.70	12.20	28.90	8.02	1.19	1.87	0.54	4,733	1.37
40	9.56	4.29	34.65	24.88	59.53	11.61	1.16	2.27	0.44	12,255	1.92
80	9.74	5.02	41.10	28.13	69.28	12.51	1.16	2.14	0.47	14,101	2.04
120	8.64	4.59	39.88	26.59	66.47	11.27	1.26	2.42	0.42	10,906	1.78
CD (P=0.05)	0.27	0.27	2.22	1.55	2.88	0.41				542	0.07

S = Sunflower, F = Frenchbean; C = combined

French bean

The sole crop of french bean showed maximum plant height, LAI, DMA pod length, seeds/pod and 100-seed weight than when grown as intercrop. French bean planted under paired row gave significantly higher yield attributes than alternate planting. Makhdoomi *et al.* (2002) made similar findings. The seed yield of intercropped french bean decreased significantly by 65 and 60 per cent under 1:1 and 2:2 planting patterns compared with its sole stands. Among the intercropping treatments, paired-row planting of french bean with sunflower recorded significantly higher seed yield of french bean due to lesser competition for space and nutrients. Sole stands of sunflower and french bean absorbed significantly greater N than their stands under intercropping systems. Maximum combined uptake of N was recorded when sunflower + french bean were grown in 2:2 row ratio, due to greater dry-matter accumulation in this system.

Effect of nitrogen

Sunflower

The growth parameters such as plant height, LAI, DMA head diameter, seeds/head and 1,000-seed weight; and the seed yield recorded marked increase up to 80 kg N/ha, and were on a par with 40 kg N/ha in respect of seeds/head and seed yield (Tables 1, 2). Better growth due to adequate N might have helped bear promising architecture of yield attributes and lower sterility percentage. Yadav *et al.* (1998) reported that the increase in seed yield with 80 kg N/ha over the control was 52.2 per cent.

French bean

All the growth parameters yield attributes showed improvement up to 80 kg N/ha only, whereas plant height increased significantly up to 120 kg N/ha (Table 1). Seed yield markedly increased up to 80 kg N/ha as a result of improved growth and consequent increase in yield attributes. Singh and Verma (2002) also reported that french bean needs application of 10 tonnes/ha FYM in combination with 90, 45 and 22.5 kg/ha N, P and K respectively. The uptake of N by sunflower and french bean increased with the increase in the dose of N from 40 kg to 80 kg/ha. However, the difference in the uptake of N by crops between 80 and 120 kg N/ha was not significant.

Sunflower-equivalent yield (SEY)

The highest SEY was recorded under of paired-row sunflower + french bean and the lowest in sole sunflower (Table 2). This was mainly due to additional advantage of intercrop yield and higher economic value of french bean. Among the cropping systems paired row sunflower + french bean gave 9.7 per cent higher yield than 1:1 pro-

portion. Our results are in conformity with those of Sarkar *et al.* (1997). SEY increased with increase in N level significantly up to 80 kg/ha, which was 56.0 and 7.8 per cent more than the control and 40 kg N/ha, respectively.

Competition function

The mean land-equivalent ratio (LER) in these two years ranged from 1.13 to 1.25, indicating biological sustainability of intercropping over sole cropping (Table 2). Sunflower + french bean (2:2) intercropping system recorded the maximum, LER of 1.25, indicating that the system as a whole was more productive, giving 25 per cent more yield. This indicates that paired-row intercropping was more efficient in utilizing the natural resources than sole cropping of the component crops. Competition ratio for sunflower was lower in paired sunflower + french bean than in alternate row of sunflower + french bean, indicating that sunflower + french bean grown in 2:2 row ratio system were more efficient than in 1:1 ratio. French bean offered less competition to sunflower crop when sown in 1:1 row ratio. An increase in the dose of N increased the LER up to the highest dose of 120 kg N/ha with a value of 1.26, whereas competition ratio was influenced up to 80 kg N/ha. It indicates that 120 kg N/ha utilized land more efficiently but it faces more crowd and competition among the component crops of the system.

Economics

The sunflower + french bean planting in 2:2 row ratio recorded significantly higher net income and benefit: cost ratio than 1:1 row ratio (Table 2). This could be attributed to better symbiosis between sunflower and french bean and also to better use of resources in 2:2 ratio compared with those in 1:1 row ratio. Simon *et al.* (1993) also recorded higher income from sunflower and groundnut intercropping than their sole crop. Sunflower+french bean in 1:1 row ratio could not prove economically viable and profitable, perhaps due to high competition as revealed by its higher value of the competition ratio of sunflower. Among the N levels, there was steady increase in net income and benefit : cost ratio with increase in N level from 0 kg to 80 kg/ha.

Interaction

The interaction effect of cropping system and N levels had significant effect on sunflower-equivalent yield (Table 3). The sole stands of sunflower and french bean registered higher mean SEY up to 80 kg N/ha. However, when 80 kg N/ha was applied to sunflower + french bean intercropping system (2.2), it gave significantly higher SEY, which was on a par with that of 1:1 and 2:2 row ratios of sunflower + french bean under 40 kg N/ha.

Table 3. Sunflower-equivalent yield (q/ha) under different cropping systems as influenced by N levels (mean data of 2 years)

Cropping system	Nitrogen (kg/ha)			
	0	40	80	120
Sole sunflower	7.54	11.01	11.34	9.38
Sole french bean	7.02	10.36	11.92	10.94
Sunflower + french bean (1:1)	8.04	8.93	13.05	11.86
Sunflower + french bean (2:2)	9.46	13.17	13.71	12.88
CD (P=0.05)			0.52	

Thus intercropping of sunflower + french bean in 2:2 row ratio with 80 kg N/ha proved highly productive and remunerative system over either of the sole crops as well as their intercropping in 1:1 row ratio at different levels of nitrogen application for rainfed conditions of temperate Kashmir.

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