Indian Journal of Agricultural Sciences 76 (1): 29-32, January 2006

Evaluation of *Phaseolus vulgaris* as intercrop with vegetables for enhancing productivity system and profitability under high hill dry temperate conditions of north-western Himalayas

AKHILESH SHARMA[1], J J SHARMA[2], M C RANA[3] and SONIA SOOD[4]

Choudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur 176 062

Received : 21 July 2004

Key words: Intercropping, Vegetables, *Phaseolus vulgaris*, Productivity, Economics, Competition function

Garden pea (*Pisum sativum* L.) and potato (*Solanum tuberosum* L.) are the major off-season vegetable crops grown in Lahaul valley located in high hill dry temperate regions of north-western Himalayas. The area remains under snow during winter having only single growing season during summers (April - September). With changing scenario and heavy losses in pea and potato cultivation due to disease infestation, farmers have switched over to crop diversification to some extent by growing carrot (*Daucus carota* L.), cabbage (*Brassic oleracea* var *capitata* L.f.), cauliflower (*Brassica oleracea* var *botrytis* L.) and tomato (*Lycopersion esculentum* L. Mill. nom. cons.) as off-season crops. The cultivation of vegetables involve heavy expenditure as well as time, high degree of risk depriving off the growers sometimes from regular stable returns. Intercropping of *rajmash* and French bean (*Phaseolus vulgaris* L.) with space planted vegetable crops might help in stabilizing the farmer's income and increases production per unit area. Potato + *rajmash* and cabbage + *rajmash* intercropping systems are being popular among the farmers of dry temperate region without following an appropriate spatial arrangement which inturn leads to increased inter- and intra-plant competition for two most limited inputs, i e moisture and nutrients in the ecosystem. Intercropping under fragile environmental conditions ensures stability in yield and minimizes risk of crop loss due to weather aberrations. Fast growing legume crops have determinate growth habit with less canopy to cover the ground and thus offer a possibility to grow them as intercrop in space planted vegetables to utilize the space and other resources efficiently. Keeping all above aspects in view, the present investigation was undertaken to evaluate the *rajmash* and French bean in association with different vegetables along with comparing them with commercial grown garden pea and carrot for increasing the production potential of vegetable-based intercropping systems.

[1-4]Assistant Professor, Department of Vegetable Science and Floriculture, [2]Chief Scientist, [3]Assistant Professor, Department of Agronomy

A field experiment was conducted during the summer season of 2000 and 2001 at the experimental farm of the Highland Agricultural Research and Extension Centre, Kukumseri (Lahaul and Spiti), Himachal Pradesh. The soil was loamy sand having 0.70% organic carbon, 340 kg/ha available nitrogen, 26 kg/ha phosphorus and 270 kg/ha potassium with pH 6.8. The 16 treatments comprised of intercropping of pulse type 'Triloki' *rajmash* and vegetable type 'Contender' Frenchbean with 4 different vegetables, namely 'Golden Acre' cabbage, 'Kufri Chandramukhi' potato, 'Him Pragati' tomato and 'Pusa Snowball K 1' cauliflower along with the sole stand of all these crops and major cash crops of the area, ie 'Azad P1' garden pea and 'Nantes' carrot were arranged in randomized block design (Table 1) replicated thrice. The sowing/transplanting of cabbage (45 cm × 40 cm), potato (60 cm × 20 cm), tomato and cauliflower (60 cm × 45 cm), French bean and *rajmash* (30 cm × 10 cm), garden pea and carrot (30 cm × 5 cm) were done on 2 June and 28 May during the year 2000 and 2001 respectively. One row each of *rajmash* and French bean was sown in between the rows of the main crop. The recommended packages of practices were followed for raising the main crops. The pea-equivalent yield was calculated using the prevalent prices available to farmers at crop harvest. The land-equivalent ratio, aggressivity, relative crowding coefficient and competition ratio were computed as suggested by Willey (1979), Mc Gilchrist (1965), Hall (1974) and Willey and Rao (1980) respectively. The data for individual years and pooled over 2 years were used for statistical analysis.

The yields of cabbage, potato, tomato and cauliflower were the highest in their sole stands owing to less competition for space, light, moisture and nutrients in both the years (Table 1). Similar findings were also observed by Tiwari *et al.* (2002). Sole potato yield reduced considerably in 2000 compared with the intercropping with French bean. Almost all the intercropping systems (Table 1) except cabbage + *rajmash* led to significantly higher total productivity in terms of pea-equivalent yields than the sole crop mainly owing to higher

Table 1 Yield and economics in vegetable-based intercropping system

Treatment	Crop yield (tonnes/ha)			Pea equivalent yield (tonnes/ha)			Net returns (Rs million ha)			Benefit : cost ratio		
	2000	2001	Pooled	2000	2001	Pooled	2000	2001	Pooled	2000	2001	Pooled
Cabbage + *rajmash*	39.30 (1.62)	44.14 (2.18)	41.72 (1.90)	11.43	13.4	12.44	0.14	0.17	0.15	2.94	3.27	3.11
Cabbage + French bean	56.72 (1.37)	54.11 (1.47)	55.42 (1.42)	15.86	15.28	15.57	0.22	0.20	0.21	4.08	3.72	3.90
Cabbage	63.68	63.34	63.51	14.15	14.07	14.11	0.19	0.19	0.19	4.11	3.84	3.98
Potato + *rajmash*	21.80 (1.25)	17.36 (1.39)	19.58 (1.32)	6.92	6.17	6.55	0.07	0.05	0.06	2.15	1.85	2.00
Potato + French bean	25.66 (0.84)	24.08 (0.84)	24.87 (0.84)	7.56	7.21	7.39	0.08	0.07	0.07	2.35	2.16	2.26
Potato	24.93	24.93	24.93	5.54	5.54	5.54	0.05	0.05	0.05	1.99	1.92	1.96
Tomato + *rajmash*	47.77 (0.86)	55.79 (0.88)	51.78 (0.87)	14.71	16.89	15.80	0.19	0.23	0.21	3.73	4.06	3.89
Tomato + French bean	48.10 (0.64)	53.44 (0.64)	50.77 (0.64)	14.78	16.26	15.52	0.20	0.22	0.21	3.75	3.90	3.85
Tomato	50.91	61.29	56.10	14.14	17.03	15.58	0.19	0.24	0.22	3.98	4.51	4.24
Cauliflower + *rajmash*	24.0 (1.35)	17.54 (2.08)	20.77 (1.72)	12.92	11.27	12.1	0.17	0.13	0.15	3.47	2.81	3.14
Cauliflower + French bean	23.81 (0.69)	15.55 (0.87)	19.68 (0.78)	12.11	8.84	10.47	0.15	0.09	0.12	3.25	2.21	2.73
Cauliflower	24.15	18.09	21.12	10.74	8.04	9.39	0.13	0.08	0.11	3.22	2.23	2.72
Pea	11.31	13.47	12.39	11.31	13.47	12.39	0.15	0.18	0.17	3.63	4.04	3.84
Carrot	24.71	36.45	30.58	8.24	12.15	10.19	0.10	0.17	0.14	3.37	4.56	3.97
Rajmash	2.86	3.92	3.39	4.76	6.53	5.64	0.05	0.08	0.07	2.38	3.09	2.74
French bean	4.24	4.55	4.40	9.42	10.11	9.77	0.13	0.14	0.14	4.71	4.79	4.75
CD ($P = 0.05$)			1.30	0.99	0.80	0.02	0.02	0.01	0.43	0.28	0.25	

Values given in the parenthesis are of corresponding intercrop

Prevalent market prices of different commodities (Rs 1 800, 600, 400, 400, 500, 800, 3 000, 4 000 for green pea, carrot, cabbage, potato, tomato, cauliflower, *rajmash* and French bean seed respectively)

yield recovery than expected from component crops as well as higher economic value of the produce of intercrops. However, tomato-based intercropping was at par with sole stand of tomato. Among the intercropping systems, tomato grown in association with *rajmash* recorded highest yield that was at par with those of tomato + French bean, cabbage + French bean and sole tomato. However, these equivalent yields were significantly higher than the commonly grown pea, potato and carrot. Prasad *et al.* (2001) reported higher production with intercropping system. Among the intercrops, the yield of French bean was higher than the *rajmash* because of its profuse branching habit and higher pods/plant. However, *rajmash* as intercrop in vegetables excelled French bean which might be attributed to the variation in the growth rhythm of these crops and also due to shading effect of main crops on French bean.

On the basis of net returns (Table 1), tomato as sole crop was found to be the most remunerative and was at par with tomato + *rajmash*, cabbage + French bean and tomato + French bean. Due to semi-determinate growth habit of tomato, tomato and intercrops or *vice-versa* affected the proper growth of each other and resulted in comparable production with the sole crop. However, their net returns were significantly higher than the commercially grown pea, carrot and potato. These systems recorded 30.3, 28.5, 26.7 and 24.8% higher net returns in tomato, tomato + *rajmash*, cabbage + French bean and tomato + French bean respectively compared with the pea over the years. These findings are in consonance with those of Adeniyi (2001), Tiwari *et al.* (2002), Anwar *et al.* (2003) and Saini *et al.* (2003). The higher benefit: cost ratio in French bean, carrot and pea was due to low-cost of interventions involved in their cultivation compared to transplanted vegetable crops and higher economic value of the produce.

Land-equivalent ratio of all the intercropping system were greater than the unity indicating greater biological efficiency in utilization of land, space and time by intercrops and thereby yield advantage over the respective sole crops (Table 2). The highest land equivalent ratio of 1.89 was recorded in cauliflower + *rajmash* (pooled data) indicating the complimentarity of the combination. Main crops having higher

Table 2 Competition function of vegetables with *Phaseolus vulgaris* intercropping system

Treatment	Land equivalent ratio			Aggressivity			Relative crowding coefficient			Competition ratio		
	2000	2001	Pooled	2000	2001	Pooled	2000	2001	Pooled	2000	2001	Pooled
Cabbage + *rajmash*	1.54	1.59	1.56	0.003	—0.08	—0.04	1.01	1.44	1.23	0.68	0.78	0.73
				(0.30)	(0.19)	(0.24)	(2.10)	(2.01)	(2.06)	(1.47)	(1.27)	(1.37)
Cabbage + French bean	1.42	1.51	1.47	0.39	0.20	0.30	5.09	3.68	4.39	1.76	1.46	1.61
				(—0.11)	(0.07)	(-0.02)	(0.76)	(0.76)	(0.76)	(0.59)	(0.76)	(0.68)
Potato + *rajmash*	1.76	1.31	1.53	0.03	0.09	0.05	3.49	1.15	2.32	1.01	1.22	1.12
				(0.04)	(—0.08)	(—0.02)	(1.55)	(1.10)	(1.33)	(1.01)	(0.87)	(0.94)
Potato + French bean	1.42	1.34	1.38	0.63	0.60	0.62	—17.50	14.18	—1.66	2.61	2.68	2.65
				(—0.19)	(—0.60)	(—0.40)	(0.49)	(0.45)	(0.47)	(0.35)	(0.38)	(0.36)
Tomato + *rajmash*	1.54	1.36	1.45	0.34	0.46	0.40	7.59	5.07	6.33	1.57	2.03	1.80
				(—0.06)	(—0.16)	(—0.11)	(0.87)	(0.59)	(0.73)	(0.64)	(0.50)	(0.57)
Tomato + French bean	1.25	1.16	1.20	0.65	0.60	0.62	8.55	6.81	7.68	3.15	3.12	3.14
				(-0.25)	(—0.24)	(—0.24)	(0.35)	(0.33)	(0.34)	(0.32)	(0.32)	(0.32)
Cauliflower + *rajmash*	1.75	2.20	1.89	0.24	0.03	0.14	77.92	16.01	56.97	1.46	0.94	1.20
				(0.07)	(0.08)	(0.07)	(1.80)	(2.28)	(2.04)	(0.74)	(0.75)	(0.75)
Cauliflower + French bean	1.31	1.24	1.28	0.67	0.48	0.57	34.30	3.06	18.68	3.08	2.27	2.68
				(—0.25)	(—0.12)	(—0.18)	(0.39)	(0.47)	(0.43)	(0.33)	(0.44)	(0.38)
Sole stand of each of above crop, pea and carrot	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CD ($P = 0.05$)	0.22	0.20	0.14	0.20	0.18	0.13				0.31	0.34	0.23
				(0.46)	(0.48)	(0.32)				(0.17)	(0.28)	(0.16)

Values given in the parenthesis are of corresponding intercrop

competitive ratio except cabbage with *rajmash* appeared to be more competitive than the intercrop. The lowest competition was recorded in cabbage associated with *rajmash* compared with the highest in tomato with French bean (3.14) in the respective years and pooled over the years. This may be due to compact growth habit of cabbage plant resulting in low competition with *rajmash* for light and space. The negative aggressivity of intercrops except *rajmash* with cabbage and cauliflower in all the arrangements indicated poor competitiveness of intercrops than the vegetables which had positive aggressivity in all the combinations except cabbage with *rajmash*. Vegetable crops have vigorous and rapid initial growth than the intercrops which might have offered more competition for moisture, nutrients and radiation causing more yield reduction in intercrops than the area replaced in main crop and in consequence resulting in negative aggressivity for intercrops. The relative crowding coefficient was more than unity in all intercropping combinations except potato + French bean. The highest relative crowding coefficient was noticed in cauliflower + French bean showing the highest yield advantage from this combination.

Thus, vegetable-based intercropping system resulted in yield as well as monetary gains compared with their sole cultivation and commercially grown pea, carrot and potato. An intercropping of tomato + *rajmash*, cabbage + French bean, tomato + French bean and tomato as the sole crop gave the highest production and net returns.

SUMMARY

A field experiment was conducted during the summer season of 2000 and 2001 at Highland Agricultural Research and Extension Centre, Kukumseri (Lahaul and Spiti), Himachal Pradesh with the aim to stabilize the farmers' income and increased production/unit area. *Phaseolus vulgaris* L., namely *rajmash* and French bean were evaluated as intercrops with cabbage (*Brassica oleracea* var. *capitata* L.), potato (*Solanum tuberosum* L.), tomato (*Lycopersicon esculentum* L. Mill. nom. cons.) and cauliflower (*Brassica oleracea* var *botrytis* L.) along with their sole stands as well as cash crops of the area, ie garden pea (*Pisum sativum* L.) and carrot (*Daucus carota* L.). It was found that sole stand of each crop gave higher yield than their respective intercropped stands. Tomato intercropped with *rajmash* gave the maximum yield and was at par with those of tomato and cabbage with French bean and sole tomato but significantly higher than the major cash crops pea, potato and carrot. These systems also proved more remunerative and gave higher net returns/rupee invested. Land-equivalent ratio of all the intercropping systems were greater than unity indicating greater biological efficiency in utilization of land, space and time by intercrops and there by yield advantage over the respective sole crops. The intercrops had negative aggressivity except *rajmash* with cabbage indicated poor competitiveness of intercrops. The relative crowding coefficient was more than unity in almost all the intercropping systems. Thus, vegetable-based intercropping systems resulted in yield and monetary gains compared to their sole crop. An intercropping of *rajmash* or French bean with tomato and French bean with cabbage gave the highest production and net returns which were equally comparable with the sole tomato.

REFERENCES

Adeniyi O R. 2001. An economic evaluation of intercropping with tomato and okra in a rain forest zone of Nigeria. *Journal of Horticultural Science and Biotechnology* **76**(3) : 347–9.

Anwar M M, Hussain T M B and Islam S M F. 2003. Comparative profitability of potato-pointed gourd intercropping and potato-teasel gourd sequential cropping in Rangpur district, Bangladesh. *Economic Affairs*, Calcutta **48**(1) : 46–51.

Hall R L. 1974. Analysis of the nature of interference between plants of different species. I. Concept and extension of de Wit analysis to examine effects. *Australian Journal of Agricultural Research* **25** : 739–47.

McGilchrist C A. 1965. Analysis of competition experiment. *Biometrics* **21** : 975–85.

Prasad R, Singh R, Singh S and Pal M. 2001. Studies on intercropping potato with Fenugreek. *Acta Agronomica Hungarica* **49**(2) : 189–91.

Saini L K, Singh M and Kapoor M L. 2003. Relative profitability of intercropping vegetable crops in autumn planted sugarcane. *Sugar Technology* **5**(1–2) : 95–7.

Tiwari R S, Agarwal A, Sengar S C and Agarwal A. 2002. Effect of intercropping on yield and economics of fennel (*Foeniculum vulgare* Mill.). *Crop Research*, Hisar **23**(2): 369-74.

Willey R W. 1979. Intercropping, its importance and research needs. I. Competition and yield advantage. *Field Crops Abstract* **32**(1): 1–10.

Willey R W and Rao M R. 1980. A competitive ratio for qualifying competition between intercrops. *Experimental Agriculture* **16** : 117–25.