International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(5): 2533-2536

Received: 18-07-2018
Accepted: 20-08-2018

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Effect of intercropping of vegetables with seed spices on yield and economics under Northern Karnataka region

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Abstract
A field experiment was carried out to study the effect of intercropping of seed spices with vegetables to find out suitable intercrop combination for increasing productivity and returns during 2013-14, 2014-15 & 2015-16 at the All India Co-ordinated Research Project on Vegetable crops, Regional Horticultural Research and Extension Center, Dharwad.(Karnataka) during Rabi season. The experiment comprising of fifteen treatments viz., Pea + Fennel (1:1), Pea + Coriander (1:1), Cabbage + Fennel (1:1), Cabbage + Coriander (1:1), Cabbage + Ajwain (1:1), Carrot + Fennel (1:1), Carrot + Coriander, Carrot + Ajwain, sole pea, sole cabbage, sole carrot, sole fennel, sole coriander and sole Ajwain are laid in randomized block design with three replications. results based on three years pooled data revealed that, out of fifteen different treatments, the treatments with sole crops alone recorded highest yield compared to inter crop treatments, however after perusal of data related to economics of production it was observed that cabbage + funnel inter cropping system was most remunerative as it recorded highest net returns and B:C ratio (Rs-110680 and 1.58) followed by inter cropping of pea with funnel (Rs-83450 and 1.39). Thus inter cropping of cabbage with funnel in 1:1row ratio may recommended for getting higher net return and B: C ratio followed by pea +funnel.

Keywords: Seed spice, intercropping, vegetables, yield, economics

Introduction
Population of human being is burgeoning and India being second largest populous country of the world, demand for food, fodder and fuel is increasing. Thus it is estimated that the vegetable requirement of our country is 225 million tons by 2020 (Anon, 2011). It is also alarming that per capita land resources in India are very limited (0.12 ha) which will further be decreased. In such situation it is not possible to increase production by bringing additional area under cultivation. Hence effective land utilization through intensive cropping is usually needed. Realizing all these intercropping of compatible crops can be of great value in achieving the improved productivity per unit area per unit time and insurance against total crop failure under aberrant weather conditions (Mullick, *et al*., 1993). Inclusion of vegetables like radish (*Raphanus sativus* L.) and fenugreek (*Trigonella foenum-graecum* L.) as intercrop has been reported to enhance the productivity and profitability per unit area in winter maize (*Zeya mays* L.) as compared to its sole cropping (Singh and Kumar, 2002) [10]. Considering the all these facts the present study has been under taken to study the effect of intercropping of seed spices with vegetables on yield and economics.

Material and Methods:
The present investigation was carried out for three years at the All India Vegetable Improvement Project AICRP on (Vegetable crops), Regional Horticultural Research and Extension Centre, Dharwad. (Karnataka) during three consecutive rabi season of 2013-14, 2014-15 & 2015-16. The soil was shallow red embedded with small sand and gravel with P^H 6.5 - 6.9 with medium available nitrogen, phosphorus and potash contents. The experiment was laid out with randomized block design with three replications and fifteen treatments viz., T_1- Pea + Fennel (1:1), T_2-Pea + Coriander (1:1), T_3-Pea+Ajwain, T_4-Cabbage + Fennel (1:1), T_5- Cabbage + Coriander (1:1), T_6-Cabbage + Ajwain (1:1), T_7-Carrot + Fennel (1:1), T_8-Carrot + Coriander, T_9-Carrot + Ajwain, T_{10}-sole pea, T_{11}-sole cabbage, T_{12}- sole carrot,

T_{13}-sole fennel, T_{14}-sole coriander and T_{15}-sole Ajwain are laid. The vegetable crops viz., pea (Var. Arka Ajit), cabbage (Var. pride of India), and carrot (Var. Nantes) were sown at a spacing of 60x10 cm, 60x30 cm and 60x05cm respectively and in-between the rows the spice crops viz., coriander (Var.Dharwad-3), Fennel (Var. Ajmer fennel-1) and Ajwain (Var. Gujarat Ajwain -1) were sown in a gross plot size of 3.0m x 3.6m. All the vegetables and spices were sown directly except cabbage crop.30 days old cabbage seedlings were transplanted. Coriander, fennel and Ajwain were accommodated in between the rows of base crops of vegetables and also all the vegetables and spices as sole crop. The recommended package of practices was followed in vegetables and spices in sole crops and in intercropping system 100 percent of recommended dose of fertilizer of base crops viz., pea, cabbage and carrot and 50 percent dose of intercrops viz., coriander, fennel and Ajwain were applied. 50 percent of recommended N and full P and K was applied at the time of sowing of vegetables and seed spices crop and remaining 50 percent N was applied at 30 DAS. Irrigation was applied as per the requirement of vegetables and seed spices crops. The yield of component crop was estimated based on the marketable yield obtained per plot in kg is converted in to yield q/ha. Harvesting seed spices was done at maturity. The cabbage equivalent yield (CEY) was calculated using following formula

$$CEY = \left(\text{Cabbage yield (q/ha.)} + \frac{\text{Yield of inter crop (seed spices)} \times \text{price of inter crop (seed spices)}}{\text{Marketable Price of cabbage}}\right)$$

Statistical analysis: Three year data on yield were pooled and analyzed statistically after following the method suggested by Panse and Sukhatme (1978) [8].

Results and Discussion

Yield of vegetables and seed spices

Pooled data over three year revealed that, maximum yields were recorded in all the sole crops viz., sole cabbage, sole pea, sole carrot, sole fennel, sole coriander and sole ajwain may be due to efficient utilization of space and light interception along with nutrient up take and availability of applied nutrients ultimately increased the yield when compared with intercrop yield. (Choudhuri and Jana (2012) [3]. Among the intercropping treatments marketable yield of all the vegetables as well as seed spices significantly varied all the three years. Intercropping of all the vegetables with fennel in 1:1 ratio exhibited the higher vegetable yield of respective inter crops compared with ajwain and coriander during three year as well as in pool. Further examination of results revealed that among vegetables, cabbage exhibited higher marketable yield over carrot and pea in intercropping with fennel ajwain and coriander (Table-1). The higher yield of all the vegetables intercropping with fennel may be due to initial slow growth and erect growing habit of fennel which allowed sufficient availability of sunlight, water and nutrients to vegetables resulting in higher photosynthesis accumulation leading to higher marketable yield. Similar results were also recorded by Mehta *et al*. (2017) [5, 7] reported higher yield of vegetables in intercropping of fennel with cabbage in 1:1 ratio.

System productivity

Among all the intercropping system, three year pooled data reveal that the highest system productivity in terms of cabbage equivalent yield was obtained in intercropping of cabbage with fennel in 1:1 row ratio (177.10q/ha) (Table-1), followed by intercropping of carrot with fennel (163.54 q/ha) and lowest cabbage equivalent yield was recorded in pea with ajwain intercrop (69.89 q/ha). Among sole crops, lowest cabbage equivalent yield (43.78 q/ha) was observed in sole Ajwain. The maximum value for cabbage yield in cabbage and fennel is due to higher yield of the main crop i.e. cabbage and grater market price of the component crop i.e. fennel. The results are in agreement with the findings of Choudhuri and Jana (2012) [3] and Bhati (1992) [2].

Economics

The data on economics of intercropping of vegetables with seed spice are presented in Tables-2a and 2b.

The economic analysis of different cropping system revealed that cabbage +fennel inter cropping system was Inter crop combination had showed higher economic returns than sole crop except cabbage + ajwain combination when compared to sole cabbage. Intercropping of vegetables with fennel exhibited the higher gross return, net return and BCR. Among all the intercropping system, intercropping of cabbage + fennel 1:1 row ratio recorded highest net returns and BCR ratio (Rs 110680 and 1.58, respectively), followed by intercropping of pea + fennel 1:1 row ratio (Rs 83450 and 1.39, respectively),sole ajwain was found least economical (Rs 10975 and 0.32 respectively).Among intercropping system pea + ajwain 1:1 row ratio found least remunerative as it recorded lowest net return and B:C ratio (Rs 45042 and 0.78 respectively). Among all the intercrop combinations, cabbage grown with fennel in 1:1 row ratio was found most remunerative which might be due to maximum cabbage equivalent yield, higher price of fennel. These results are in conformity with those reported by Mehta *et al*. (2017) [5, 7] in fennel and Choudhuri and Jana (2012) [3] also reported that cabbage with pea resulted higher net return and BCR.

Thus it can be inferred that intercropping of cabbage with fennel in 1:1 row ratio is better for realizing higher cabbage equivalent yield which ultimately giving higher gross return, net return and BCR than all other treatments. Based on the performance of the present experiment intercropping of cabbage with fennel was found best combination to maximize yield and remuneration of cabbage growing farmers of northern Karnataka region.

Table 1: Effect of intercropping of vegetables with seed spices on marketable yield of vegetables, grain yield of seed spices and cabbage equivalent yield during 2013-14,2014-15,2015-16 and pooled

	Vegetables yield (q/ha)				Grain Yield of Spice (q/ha)				Cabbage equivalent yield (q/ha			
Treatments	2013-14	2014-15	2015-16	pooled	2013-14	2014-15	2015-16	Pooled	2013-14	2014-15	2015-16	pooled
T1- Pea + Fennel	34.07	40.74	44.08	39.63	9.78	8.44	9.30	9.17	102.51	99.84	109.15	103.83
T2-Pea + Coriander	36.67	31.67	37.41	35.25	9.30	9.89	10.33	9.84	83.15	82.97	89.07	85.06
T3-Pea + Ajwan	30.37	32.78	34.07	32.41	6.00	5.56	7.19	6.25	66.37	66.12	77.19	69.89
T4-Cabbage + Fennel	107.04	127.96	130.37	121.79	7.00	7.81	8.88	7.90	156.06	182.68	192.55	177.10
T5-Cabbage + Coriander	102.96	99.44	96.30	99.57	6.89	8.41	8.63	7.98	137.41	141.48	139.45	139.45
T6-Cabbage + Ajwan	99.26	103.52	102.22	101.67	5.52	6.11	5.96	5.86	132.38	140.18	138.00	136.85
T7- Carrot + Fennel	84.81	115.56	118.22	106.20	8.59	8.33	6.88	7.94	144.97	173.89	171.76	163.54
T8-Carrot + Coriander	76.67	105	114.26	98.64	9.07	10.74	11.11	10.31	122.05	158.70	169.81	150.19
T9-Carrot + Ajwan	77.04	87.78	94.07	86.30	6.04	6.26	6.89	6.40	113.28	125.34	135.41	124.68
T10-Sole Pea	51.67	45.93	54.07	50.56	--	--	--	--	103.33	91.85	108.15	101.11
T11- Sole Cabbage	116.67	173.7	175.56	155.31	--	--	--	--	116.67	173.70	175.56	155.31
T12- Sole Carrot	106.11	157.78	166.37	143.42	--	--	--	--	95.50	142.00	149.73	129.08
T13- Sole Fennel	--	--	--	--	11.19	12.96	14.07	12.74	78.28	90.72	98.51	89.17
T14- Sole Coriander	--	--	--	--	10.89	13.41	12.44	12.25	54.45	67.03	62.22	61.23
T15- Sole Ajwan	--	--	--	--	6.96	7.30	7.63	7.30	41.78	43.78	45.78	43.78
S.Em±	4.812	8.611	5.88	7.43	0.66	1.04	0.86	0.47	6.56	8.96	7.83	6.70
CD(0.05)	14.11	25.55	17.26	21.79	1.95	3.06	2.53	1.97	19.00	25.96	22.70	19.42
CV%	10.83	15.90	10.48	14.42	14.28	20.63	16.41	9.90	11.00	13.07	10.93	10.06

Sale price of Cabbage @ Rs 10/kg, Carrot @ Rs 9/kg, Pea @ Rs 20/kg, Fennel @ Rs 70/kg, Coriander @ Rs 50/kg and Ajwain @ Rs 60/kg.

Table 2a: Effect of intercropping of vegetables with seed spices on marketable yield of vegetables, grain yield of seed spices and cabbage equivalent yield during 2013-14,2014-15,2015-16 and pooled.

Sr. No	Treatments	Cost of cultivation (Rs/ha)				Gross return (Rs/ha)			
		2013-14	2014-15	2015-16	pooled	2013-14	2014-15	2015-16	pooled
1	T1- Pea + Fennel	59910	58910	61260	60026	136600	140591	91980	123057
2	T2-Pea + Coriander	56620	56620	60260	57833	119840	112784	66060	99561
3	T3-Pea + Ajwan	56060	56060	59660	57260	96740	98888	51620	82416
4	T4-Cabbage + Fennel	67900	68300	71650	69283	156040	169867	146954	157620
5	T5-Cabbage + Coriander	64610	66010	70650	67090	137410	131533	88060	119001
6	T6-Cabbage + Ajwan	64050	65450	70050	66516	132320	129833	88374	116842
7	T7- Carrot + Fennel	65790	64790	67740	66106	136459	150781	154855	147365
8	T8-Carrot + Coriander	62500	62500	66740	63913	114353	137703	91644	114566
9	T9-Carrot + Ajwan	61940	61940	66140	63340	105576	107778	59863	91072
10	T10-Sole Pea	47660	47660	50560	48626	103340	91851	55680	83623
11	T11- Sole Cabbage	55650	57050	60950	57883	116670	156330	61020	111340
12	T12- Sole Carrot	53540	53540	57040	54706	95499	126224	41959	87894
13	T13- Sole Fennel	43550	42550	45350	43816	78330	90720	34780	67943
14	T14- Sole Coriander	35245	35245	38345	36278	54450	67050	19205	46901
15	T15- Sole Ajwan	31465	31465	42540	35156	41760	43800	10295	31951

Table 2b: Effect of intercropping of vegetables with seed spices on marketable yield of vegetables, grain yield of seed spices and cabbage equivalent yield during 2013-14,2014-15,2015-16 and pooled.

Sr. No	Treatments	Net returns (Rs/ha)				BCR			
		2013-14	2014-15	2015-16	pooled	2013-14	2014-15	2015-16	pooled
1	T1- Pea + Fennel	76690	81681	91980	83450	1.28	1.38	1.50	1.39
2	T2-Pea + Coriander	63220	56164	66060	61814	1.11	0.99	1.10	1.07
3	T3-Pea + Ajwan	40680	42828	51620	45042	0.72	0.76	0.87	0.78
4	T4-Cabbage + Fennel	88140	101567	142334	110680	1.29	1.48	1.98	1.58
5	T5-Cabbage + Coriander	72800	65523	88060	75461	1.12	0.98	1.25	1.12
6	T6-Cabbage + Ajwan	68270	64383	88374	73675	1.06	0.98	1.26	1.10
7	T7- Carrot + Fennel	70669	85991	86818	81159	1.07	1.32	1.28	1.22
8	T8-Carrot + Coriander	51853	75203	91644	72900	0.80	1.20	1.37	1.12
9	T9-Carrot + Ajwan	43636	45838	59863	49779	0.70	0.74	0.91	0.78
10	T10-Sole Pea	55680	44191	55680	51850	1.16	0.92	1.10	1.06
11	T11- Sole Cabbage	61020	99280	61020	73773	1.09	1.74	1.00	1.28
12	T12- Sole Carrot	41959	72684	41959	52200	0.78	1.35	0.74	0.96
13	T13- Sole Fennel	34780	48170	34780	39243	0.79	1.13	0.77	0.90
14	T14- Sole Coriander	19205	31805	19205	23405	0.53	0.90	0.50	0.64
15	T15- Sole Ajwan	10295	12335	10295	10975	0.32	0.39	0.24	0.32

Acknowledgement
The authors are grateful to the University of Horticultural Sciences Bagalkot and IIVR, Varanasi. (India) for providing land and financial assistance to conduct experiments.

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References

1. Annonymous Vision 2030, ICAR, New Delhi, 1967, 2-3.
2. Bhati DS. Intercropping in fennel (*Foeniculum vulgare*). Indian J Agricultural. Sciences. 1992; 62(3):218-219
3. Choudhuri, Jana JC. Effect of intercropping on yield and economics of cabbage. Journal of crop and weed. 2012; 8(1):155-157.
4. Khurana SC, Bhatia AK. Intercropping of onion and fennel with potato. J. the-Indian- Potato –Association. 1995; 22(3-4):140-145.
5. Meena SS, Lal G, Mehta RS, Meena RD, Kumar N, Tripathi GK. Comparative study for yield and economics of seed spices based cropping system with fruit and vegetable crops International J Seed Spice. 2017; 7(1):35-39
6. Mehta RS, Meena SS, Lal G, Aishwath OP. Fennel (*Foeniculum vulgare* Mill.) based cropping system for higher system productivity. International J. Seed Spice, 2015; 5(1):56:62.
7. Mehta RS, Meena SS, Lal G. Effect of of intercropping seed spice with vegetable for enhancing system profitability. International J. Seed Spice. 2017; 7(2):33-39.
8. Panse VC, Sukhatme PV. Statistical methods for agricultural workers. Indian council of Agricultural Research, New Delhi, 1978.
9. Singh B, Solanki RK. Status of seed spice research and development in India. Indian Journal of Agricultural Science. 2015; 85(2):151-156.
10. Singh SN, Kumar A. Production potential and economics of winter maize based intercropping systems. Annals of Agricultural Research. 2002; 23(4):532-534.
11. Tiwari RS, Ankur A, Sengar SC, Agarwal A. Effect of intercropping on yield and economics of fennel (*Foeniculum vulgare* Mill.), Crop Research Hissar. 2002; 23(2):369-374.