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FIRB intercropping of vegetables and seed spices with wheat for higher productivity and profitability of small and marginal farmers

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Abstract

A field experiment was conducted for two consecutive years commencing from 2014-2015 to 2015-2016 at ICAR-Indian Institute of Wheat and Barley Research, Karnal, Haryana, India to assess the productivity and profitability of vegetables and seed spices intercropping with wheat under bed planting. Pooled analysis showed that radish planted on bed recorded maximum wheat equivalent yield (113.55 q/ha), which was significantly higher than all other treatments. Among the intercrops, wheat on bed +radish in furrow produced maximum wheat equivalent yield (92.46 q/ha), which was 36.37 % higher than sole wheat crop. This was followed by wheat + turnip intercrop with 77.98 q/ha wheat equivalent yield. Growing of other four intercrops like wheat + cauliflower, wheat + cabbage, wheat + coriander, wheat + fenugreek was not feasible in furrows probably owing to shading effect of wheat crop. Maximum net return obtained in sole radish crop on bed followed by wheat on bed + radish in furrows intercrop, which was 96.5% and 27.4% higher than sole wheat crop, respectively. Therefore, selective vegetables can be easily grown in furrows under bed planted wheat, which will be boon to small and marginal farmers.

Keywords : Economics, intercropping, seed spices, vegetables, wheat equivalent yield

1. Introduction

Enormous competition for natural resources like land, water, nutrients etc compels to have higher production per unit area per unit time and per unit inputs. Hence, it is immense important to increase productivity per unit area of available land in order to feed the burgeoning population of India. One of the possible measures to resolve this problem might be productivity maximization per unit area through multiple cropping (Seran and Brintha, 2010; Khan *et al*., 2014). Efficiency of available resource utilization can be increased with intercropping (Tilman *et al*., 2002; Gao and Wu, 2014) by taking advantages in peak resource demand for nutrient, water and sunlight. To maximize land use and production and achieving the ultimate goal of agriculture, *viz*. yield; intercropping is an advanced spatio-temporal intensification agronomic technique that allows two or more crops to yield from the same land area at same time (Aziz *et al*., 2015). According to 2011 censes, approximately 85% farmers in India belongs to small and marginal category, particularly in north eastern plain zone, who practice wheat seeding manually, either line sowing or broadcasting, can also sow wheat under bed planting. Bed planting is a system in which crops are sown on top of ridges. Bed planter is used to form the raised beds of appropriate dimension, seeding and placing the fertilizer in one go. Generally, crops are seeded on the top portion of bed (35 cm width) and in case of wheat three rows having a distance of 17 cm apart are sown. The furrow width is generally 30-35 cm which is used for irrigation and drainage.

Some time additional crops like sugarcane, mentha, radish, turnip and other vegetables may be grown in furrows. Though, furrow area can be better called as input management zone and ridge or bed area as crop management zone. Alternate ridges and furrows reduces runoff, improves percolation, increases the surface area for capturing rainfall and sunlight and facilitates drainage in case of excess rainfall (Sayre and Moreno Ramos, 1997).

Generally, small and marginal farmers are growing many crops on their small land holdings for their home consumption. Bed planting provides opportunity to grow vegetables and seed spices in furrows along with wheat as main crop without requiring any additional land or input. In this way, farmers' family workers will also be engaged in harvesting/picking/cutting of vegetables and spices in whole crop season, which can be used for home consumption and/or selling in the local market for getting additional income through remunerative price. Keeping this objective in mind, the proposed study was undertaken with the aim to maximise the productivity and profitability of small and marginal farmers by intercropping of vegetables and seed spices with wheat.

2. Materials and methods

A field study was conducted to examine the comparative productive efficiency and feasibility of vegetable and seed spices intercropping with wheat in Rabi season commencing from 2014-15 to 2015-16 at research farm of ICAR-Indian Institute of Wheat and Barley Research, Karnal, Haryana (Latitude 290 43' N, longitude 760 58' E and altitude 245 m). The experimental soil was sandy clay loam in texture (14.8 % clay), low in organic carbon (0.35 %) and available N (147 kg/ha), medium in available P (17.5 kg/ha) and available K (165 kg/ha) content. The experiment was laid out in a randomized complete block design with three replications. The treatments were intercropping of cauliflower, cabbage, radish, turnip, coriander and fenugreek with wheat and all these crops were also grown as sole. In all the intercropping treatments main crop was grown on the top of bed whereas intercrops of vegetables and spices were grown in furrows. All the sole crops were grown on the top of the bed. The intercrops were fertilized @ 150 kg N and 60 kg P_2O_5 and 40 kg K_2O/ha as fertilizer requirement of main crop i.e. wheat whereas the sole crops were fertilized as per recommended package and practices for that particular crop. All the phosphorus and 1/3 nitrogen were applied at the time of sowing as basal dose, 1/3 N was applied with first irrigation (21- 25 DAS) and remaining 1/3 N was applied at maximum tillering stage (45 DAS). The crops were kept free from weeds by giving two hoeing with `Kasola' (hand hoe). All other agronomic practices were kept uniform for all the treatments. Wheat equivalent yield was calculated for each treatment by taking minimum support price of wheat crop. Minimum support price of wheat was taken as Rs 1400/q and prevailing market prices of wheat straw, vegetables and spices were taken into consideration. Cost of cultivation was calculated by taking into account the prevailing price of inputs like fertilizer, seed, irrigations, tillage operations, transportation charges, management charges, rental value of land and depreciation cost of implements. Returns were calculated by taking minimum support price of wheat and market price of vegetables and spices. Net returns were calculated by subtracting cost of cultivation from gross returns. Benefit : cost ratio was calculated by dividing gross returns with cost of cultivation. Rainfall received during January to April was much more in 2014-15 as compared to 2015-16. This was the reason for low production in 2014-15 as compared to 2015-16. Additionally, minimum temperature in 2015-16 during grain filing period was more conducive than previous year for crop growth and development (Table 1).

Table 1. Rainfall, temperature and relative humidity pattern in 2014-15 and 2015-16 during wheat growing season

Month	Rainfall (mm)		Temperature				Relative Humidity	
			Minimum (^{0}C)		Maximum (^{0}C)			
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Nov	0.0	15.1	10.5	12.7	27.8	27.8	30.0	66.8
Dec	6.6	0.0	7.0	7.6	18.9	21.7	57.0	73.0
Jan	40.5	0.0	6.8	6.7	15.7	17.8	75.0	81.2
Feb	105.8	0.0	9.5	8.0	22.4	22.5	56.0	68.2
March	26.0	45.7	12.8	12.6	25.6	27.7	54.0	67.0
April	63.4	0.0	18.0	17.8	33.1	36.4	35.0	39.2

3. Result and discussion

Perusal of data from Table 2 revealed that bed planted sole vegetables and seed spices produced higher yield than intercrops. Among intercrops, radish grown in furrows recorded higher yield in both the years with mean yield of 71.96 q/ha followed by turnip (31.45 q/ha) as compared to other intercrops. It is interesting to note that none of the intercrops showed negative effect on wheat yield and it ranged from 40.55 to 44.48 q/ha. Maximum wheat yield was obtained where radish was grown in furrows. Other intercrops like cauliflower, cabbage, coriander and fenugreek didn't survive in furrows due to shading effect of wheat crop. Even, in both the years, coriander and fenugreek production under intercrops was zero.

Results presented in Table 3 showed that sole radish raised on bed produced maximum and significantly higher wheat equivalent yield (113.55 q/ha) than all other treatments including inter crops. This was followed by wheat + radish intercrop with 94.26 q/ha wheat equivalent yield which was 36.37% higher than sole wheat crop and significantly higher than all other treatments except sole radish on bed. During 2014-15, sole crop of radish on bed produced maximum and significantly higher wheat equivalent yield (142.06 q/ha) than all other treatments whereas in 2015-16 wheat + radish intercrop recorded maximum wheat equivalent yield (87.24 q/ha). Wheat + turnip intercrop also produced 77.98 q/ha wheat equivalent yield which was 12.8% higher than pure sole wheat crop yield. From pooled basis, other intercrops or pure vegetables and spices on bed recorded similar or lower wheat equivalent yield as compared pure sole wheat crop. Growing of intercrops of cauliflower, cabbage, coriander and fenugreek in furrows with wheat didn't survive owing to shading effect of wheat crop, which resulted at par wheat equivalent yield as compared with sole wheat. However, Wasaya *et al.* (2013) from Pakistan reported that wheat and fenugreek intercrop produced maximum production under flat planting whereas in this situation fenugreek was sown in furrows to save the additional land required for the intercrop. This might be the reason for failure of fenugreek. Similarly Khatun *et al.* (2012) from Bangladesh reported that wheat and coriander intercropping in 1:1 ratio was more productive under flat planting. Our finding didn't corroborate the results of these authors due to growing of intercrops in furrows under bed planting.

Table 2. Yield (q/ha) of wheat and various intercrops in different years

Treatment	2014-15		2015-16		Mean	
	Wheat	Intercrops	Wheat	Intercrops	Wheat	Intercrops
Wheat + Cauliflower	40.80	0.00	44.25	3.24	42.53	1.62
Wheat+ Cabbage	37.65	0.00	43.46	4.17	40.55	2.08
Wheat + Radish	43.90	85.00	45.06	58.93	44.48	71.96
Wheat + Turnip	41.59	15.51	44.03	47.40	42.81	31.45
Wheat + Coriander	36.55	0.00	46.41	0.00	41.48	0.00
Wheat +Fenugreek	37.28	0.00	48.88	0.00	43.08	0.00
Wheat	34.33	0.00	49.53	0.00	41.93	0.00
Cauliflower	0.00	115.55	0.00	104.32	0.00	109.93
Cabbage	0.00	166.75	0.00	131.10	0.00	148.92
Radish	0.00	397.76	0.00	238.10	0.00	317.93
Turnip	0.00	83.18	0.00	165.18	0.00	124.18
Coriander	0.00	11.46	0.00	5.48	0.00	8.47
Fenugreek	0.00	11.16	0.00	9.49	0.00	10.33

Maximum total return (₹1,58,965 per ha), net return (₹1,07,165 per ha) and B: C ratio (3.07) was recorded in sole radish grown on bed, which was 64.27%, 96.47% and 34.06% higher than pure wheat crop on bed, respectively. Among the intercropping treatments, maximum gross returns (₹ 1,09,174 per ha) and net returns (₹ 69,495 per ha) was recorded when wheat was sown on the top of bed and radish in furrow, which was 12.8% and 27.41% higher than sole wheat crop, respectively. Net return in wheat +cauliflower inter crop was negative due to very meager or zero production in furrows and higher cost of cultivation. In contrast, all the intercrops with wheat as well as pure crops showed higher cost of cultivation than pure sole wheat crop. Wasaya *et al.* (2013) from

Pakistan reported that wheat and fenugreek intercrop produced maximum net income (₹ 33,647 per ha) under flat planting as compared to sole cropping (₹ 24,791 per ha) whereas, in this situation fenugreek intercrop was not profitable as compared to sole wheat crop.

On the basis of two years study, it can be concluded that taking additional crop of radish and turnip in furrows along with wheat on top of bed provided additional income which can be very much beneficial to farmers particularly for small and marginal farmers. This practice may not only give employment in lean season to maximise the profit of farmers but also improve health of farming family due to inclusion of vegetables in their diet. For adopting this practice one has to be very cautious for selection of intercrops in furrows as all the crops didn't survive in the shade of growing wheat plants.

Table 3. Wheat equivalent yield and economics of different intercrops and pure sole crops

Treatments	Wheat equivalent yield (q/ha)			Economics (Rs/ha)			B: C
	2014-15	2015-16	Pooled	Gross return	Cost of cultivation	Net return	
Wheat + Cauliflower	69.51	70.30	69.90	97863	66475	31388	1.47
Wheat+ Cabbage	66.46	65.98	66.22	92706	66475	26231	1.39
Wheat + Radish	101.29	87.24	94.26	131970	62475	69495	2.11
Wheat + Turnip	73.12	82.85	77.98	109174	62475	46699	1.75
Wheat + Coriander	66.92	69.32	68.12	95369	57475	37894	1.66
Wheat +Fenugreek	65.07	72.78	68.92	96494	57475	39019	1.68
Wheat	63.07	75.17	69.12	96768	42225	54543	2.29
Cauliflower	41.27	37.26	39.26	54967	55800	-833	0.99
Cabbage	59.55	46.82	53.19	74462	55800	18662	1.33
Radish	142.06	85.03	113.55	158965	51800	107165	3.07
Turnip	29.71	58.99	44.35	62089	51800	10289	1.20
Coriander	81.85	39.17	60.51	84710	46800	37910	1.81
Fenugreek	47.83	40.69	44.26	61964	46800	15164	1.32
C D (5 %)	10.41	8.27	6.47	-	-	-	-

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