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Research Article

Intercropping of canola and mustard with wheat for higher profitability

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Abstract

A field experiment was conducted during winter seasons of three years from 2010-2011 to 2012-2013 to assess the productivity and profitability of canola and mustard intercropping with wheat in different ratios. Pooled analysis of data recorded over three years revealed that the significantly highest wheat equivalent yield (69.88 q/ha) was recorded in wheat : canola intercropping system in 6:2 ratio followed by wheat : mustard intercropping system (62.33 q/ha) in same ratio. Wheat equivalent yield increase in wheat+canola in 6:2 ratio was to the tone of 47.9 % than yield obtained from sole wheat. Wheat+canola and wheat+mustard intercropping in 6:2 ratio exhibited 1.61 and 1.53 land equivalent ratio (LER), respectively which was higher than the values recorded in other intercropping systems. The highest gross return (Rs 97833/ ha), net return (Rs 46133/ ha) and B: C ratio (1.89) was obtained under wheat +canola in 6: 2 ratio followed by wheat + mustard in same ratio.

Keywords: Wheat, canola, mustard, intercropping, land equivalent ratio (LER), wheat equivalent yield and economics

1. Introduction

Intercropping improves the agronomic output and economic efficiency of a cropping system through effective use of resources in space and time as compared to monocrop. Earlier intercropping of mustard with wheat was a regular practice. But due to popularisation of combine harvesting its area has decreased. Intercropping is an advanced agro-technique and is considered to be an effective and potential mean of increasing crop production per unit area and time, particularly for farmers with small land holdings. Alternative crops to wheat, such as winter oilseeds and grain legumes are becoming more prevalent in the wheat zone. This reflects the need for producers to diversify and an awareness of the benefits of sound crop rotations on wheat yield. Alternative crops can increase the yield of subsequent wheat crops by depriving soil-borne wheat pathogens of a host (Kollmorgen *et al.,* 1983) and are often referred to as break crops. A better understanding of the magnitude and mechanisms of break-crop effects on wheat yield would allow management to maximize the potential benefits within a cropping sequence.

In order to feed the world's population, it is imminent to increase productivity per unit area of available land or to increase the land area under production, which seems to be shrinking by the day. Intercropping is an advanced agronomic technique that allows two or more crops to yield from the same area of land (Aziz *et al.,* 2015). Generally farmers cultivate oilseed and pulses on marginal lands which leads to lower yields. According to 2011 censues, approximately 85% farmers in India are small and marginal farmers, particularly in north eastern plain zone, who perform wheat seeding manually, either line sowing or broadcasting, can also sow canola or mustard in similar fashion. Canola or mustard intercropping in different combination can boost the oilseed production without jeopardising the wheat yield (Srivastava and Bohra, 2006 and Srivastava *et al.,* 2007). This will also reduce the burden of edible oil import, which is major portion of india's agricultural imports. Keeping this in mind, a study was undertaken to investigate the feasibility of intercropping canola and mustard with wheat to maximise the productivity and profitability of small and marginal farmers.

2. Materials and methods

A field study to examine the productive efficiency and feasibility of canola and mustard intercropping with wheat was conducted for three consecutive winter seasons from 2010-11 to 2012-13 at ICAR-Indian Institute of Wheat and Barley Research, Karnal (Latitude 29^0 43' N, longitude 76^0 58' E and altitude 245 m). The soil of the experimental site

was sandy clay loam in texture (15 % clay), low in organic carbon (0.37 %) and available N (145 kg/ha) and medium in available P (17.2 kg/ha) and available K (155 kg/ha) content. The experiment was laid out in a randomized complete block design with three replications. The treatments included pure crops of wheat, canola and mustard and wheat: canola and wheat: mustard intercropping systems both in 6:1 and 6: 2 ratios. The canola (GSE 6), mustard (Pusa bold) and wheat (DPW 621-50) were sown as per treatment on the same day. The intercrops were fertilized @ 150 kg N and 60 kg P_2O_5 and 40 kg K_2O/ha.; whereas, the pure crops were fertilized as per recommended package and practices. Entire quantity of phosphorous and potassium and 1/3 nitrogen was applied at the time of sowing while remaining nitrogen was applied in two equal splits at first irrigation and second irrigation . The crops were kept free from weeds by giving two hoeing with `*Kasola* ' (hand hoe). The canola and mustard crop were thinned to minimize intra-row competition. All other agronomic practices were kept uniform for all the treatments. Wheat equivalent yield was calculated for each treatment by using minimum support price of each crop, which was Rs 1400/ quintal for wheat and Rs 3000/ quintal for canola/mustard. Cost of cultivation was calculated by taking into account the prevailing price of inputs like fertilizer, seed, herbicides, irrigations, tillage operations, transportation charges, management charges, rental value of land and depreciation cost of implements. 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. Land equivalent ratio calculation (Mead and Willey, 1980) and statistical analysis was performed as per standard procedure.

3. Results and discussion

Perusal of data presented in Table 1 showed that the highest mean wheat yield (48.6 q/ha) was recorded in wheat: canola in 6:1 ratio treatment followed by pure wheat crop (47.22 q/ha) and wheat: canola in 6:2 ratio (46.46 q/ha). On the other hand, lowest wheat yield was recorded in wheat: mustard in 6:2 ratio (38.95 q/ha). Similarly highest yields of canola (17.59 q/ha) and mustard (16.17 q/ha) were recorded from their sole crops followed by 6:2 and 6:1 ratio crops, respectively. Wheat yield under sole crop during first year was low as compared to intercropping. This was due to the lodging of sole wheat crop during the first year of study. Wheat equivalent yield was also significant both on yearly as well as pooled basis with significantly highest wheat equivalent yield (69.88 q/ha) recorded in wheat : canola intercropping system in 6:2 ratio followed by wheat :mustard intercropping in same ratio. Singh and Dawson (2014) also observed that wheat and mustard in 8: 2 ratio gave the maximum yield advantage and was more remunerative than other intercrops. Similarly, an experiment was conducted at Varanasi where Srivastava *et al.* (2007) reported that wheat + mustard in 8:2 and 5:1 ratio proved to be more profitable. Khan *et al.* (2012) reported that wheat + hybrid canola in 4: 2 ratio was more productive and remunerative. Both, wheat + canola and wheat + mustard in 6:1 ratio recorded significantly higher equivalent wheat yield than sole crops and former one (58.85 q/ha) recorded significantly higher wheat equivalent yield than latter one (52.41 q/ha). Similar findings were also reported by Pandey and Singh (2015). Lowest equivalent wheat yield was recorded in mustard sole crop (34.65 q/ha). Each year wheat + canola in 6:2 ratio exhibited the highest wheat equivalent yield followed by wheat +mustard in same ratio. Singh *et al.* (2014) reported that wheat : mustard in 9: 1 ratio produced highest mustard equivalent yield. Yield attributes of wheat were also affected by various intercropping treatments (Table 2). Generally, wheat in intercrops showed higher earhead/m^2 (422 to 464) and thousand grain weight (36.14 to 37.52 g) than wheat in sole crop. Contrary to it number of grains/earhead were higher in wheat sole crop (33.49) as compared to intercrops (26.26 to 30.46). Probably more space in intercops situations provided more tillering and grain development behaviour.

Table 1. Effect of various intercropping systems on yield of wheat, canola and mustard and wheat equivalent yield.

Treatments	Wheat yield (q/ha)				Canola / mustard yield (q/ha)				Wheat equivalent yield (q/ha)			
	2010-11	2011-12	2012-13	Mean	2010-11	2011-12	2012-13	Mean	2010-11	2011-12	2012-13	Mean
Wheat sole	43.09	58.23	40.35	47.22	-	-	-	-	43.09	58.23	40.35	47.22
Canola sole	-	-	-	-	16.58	18.70	17.48	17.59	35.52	40.08	37.46	37.69
Mustard sole	-	-	-	-	16.47	18.96	13.08	16.17	35.29	40.64	28.04	34.65
Wheat:Canola (6:1)	50.35	54.71	40.75	48.60	4.30	4.86	5.19	4.78	59.57	65.12	51.87	58.85
Wheat:Mustard (6:1)	47.55	40.32	34.94	40.94	4.88	6.08	5.10	5.35	58.01	53.34	45.86	52.41
Wheat:Canola (6:2)	45.69	55.36	38.33	46.46	11.70	10.81	10.28	10.93	70.76	78.53	60.35	69.88
Wheat:Mustard (6:2)	42.48	35.82	38.54	38.95	10.38	12.72	9.64	10.91	64.72	63.07	59.21	62.33
CD (P=0.05)									3.77	7.81	8.37	3.59

Table 2. Effect of various intercropping systems on yield attributes of wheat

Treatments	Earhead/m^2				1000 grain weight (g)				Grains/ earhead			
	2010-11	2011-12	2012-13	Mean	2010-11	2011-12	2012-13	Mean	2010-11	2011-12	2012-13	Mean
Wheat sole	412	412	405	409	33.53	33.53	38.43	35.16	31.39	42.55	26.54	33.49
Canola sole	-	-	-	-	-	-	-	-	-	-	-	-
Mustard sole	-	-	-	-	-	-	-	-	-	-	-	-
Wheat:Canola (6:1)	465	465	402	444	34.77	34.77	39.81	36.45	31.45	34.24	25.70	30.46
Wheat:Mustard (6:1)	440	440	385	422	35.68	35.68	40.85	37.40	30.34	25.78	22.67	26.26
Wheat:Canola (6:2)	467	467	460	464	34.43	34.43	39.56	36.14	28.46	34.57	21.16	28.06
Wheat:Mustard (6:2)	423	423	435	427	35.67	35.67	41.20	37.52	28.25	23.83	21.72	24.60

Table 3. Land equivalent ratio and economics of various intercropping systems

Treatments	Land Equivalent Ratio				Economics (Rs/ha)			
	2010-11	2011-12	2012-13	Mean	Gross Returns	Cost of cultivation	Net return	B:C
Wheat sole	-	-	-	-	66113	54500	11613	1.21
Canola sole	-	-	-	-	52763	47750	5013	1.10
Mustard sole	-	-	-	-	48517	47750	767	1.02
Wheat:Canola (6:1)	1.43	1.20	1.31	1.31	82390	51700	30690	1.59
Wheat:Mustard (6:1)	1.40	1.01	1.26	1.22	73371	51700	21671	1.42
Wheat:Canola (6:2)	1.77	1.53	1.54	1.61	97833	51700	46133	1.89
Wheat:Mustard (6:2)	1.62	1.29	1.69	1.53	87266	51700	35566	1.69

Land equivalent ratio was highest in wheat+canola intercropping system in 6: 2 ratio (1.61) followed by wheat +mustard in same ratio (1.53) while these systems grown in 6:1 ratio gave lower values for land equivalent ratio though they also gave higher than 1. It showed that about 53 to 61 % more area will be required to be put under for sole crops of wheat to produce same wheat equivalent yield. This factor indicates that these intercrops are much more remunerative. Similar results have also been reported by Ali *et al.* (2000) and Singh *et al.* (2014). Wheat+canola intercropping in 6: 2 ratio gave the highest gross return (Rs 97833/ ha), net return (Rs 46133/ ha) and B: C ratio (1.89), which was 47.9, 297.3, and 56.2 % higher gross return, net return and B: C ratio, respectively obtained from the sole wheat crop. These observations are in the agreement of findings of Ali *et al.* (2000).

On the basis of three years study it can be concluded that farmers can get significantly higher productivity and profitability by adopting wheat +canola/mustard intercrop in 6:2 ratio.

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