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YIELD PERFORMANCE OF LENTIL AS A MIXED CROP WITH RAPESEED

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Abstract

Mixed crop cultivation of lentil and rapeseed could be a promising technology for yield maximization. The field experiment was carried out at multilocation testing site, Kashinathpur, Pabna during the rabi season of 2011-12 and 2012-13 to verify the performance of rapeseed as mixed crop with lentil at different seeding ratios. The treatment comprises for the experiment were T_1: Sole lentil (100%), T_2: Sole rapeseed (100%), T_3: Lentil (100%) + Rapeseed (10%), T_4: Lentil (100%) + Rapeseed (20%), T_5: Lentil (100%) + Rapeseed (30%) and T_6 :Farmers' practice :Lentil (100%) + Rapeseed (15%). The highest lentil equivalent yield (2.22 t ha^{-1} in and 2.48) and maximum land equivalent ratios (1.27 and 1.28) were observed in T_4 treatment in 2011-12 and 2012-13, respectively.. It was noted that all the mixed cropping systems produced higher equivalent yield and LER than that of their corresponding sole crops. . Cost and return analysis showed that the highest net return (Tk. 127774 ha^{-1}) was found in T_4 treatment while sole rapeseed gave the lowest net return (Tk. 60540 ha^{-1}). Net return was always higher under mixed cropping system than that of sole cropping. The highest benefit cost ratio 3.48 was recorded from Lentil (100%) + Rapeseed (20%) where as the minimum (1.39) from soli rapeseed..

Introduction

Lentil (*Lens culinaris*) is one of the important pulse crops, which ranks the first position regarding area and production in Bangladesh (BBS, 2010). It is one of the most important sources of protein both as food and feed. It also produces more stable yield and can be grown with minimum care. Lentil is generally grown as sole crop but it can also be grown as mixed or intercrop with maize, mustard, wheat, barley etc. On the other hand, mustard (*Brassica spp*.) is an important oil crop, which also ranks first position among the oil crops in Bangladesh (BBS, 2010).

Mixed cropping is the agricultural practice of cultivating two or more crops in the same piece of land at the same time (Ofori and Stern, 1987; Anil *et al*., 1998). It offers effective weed suppression, pest and disease control, and use of soil resources under organic farming systems (Bulson *et al*., 1997; Theunissen, 1997; Jensen *et al*., 2005). An ideal intercropping or mixed cropping system should aim to i) produce higher yields per unit area through better use of natural resources, minimizing the incidence of insect pests, diseases weeds and improving the nitrogen economy in legume associations, ii) Offer greater stability and crop insurance in production under aberrant weather condition, iii) Meet the domestic need of farmers and animal iv) provide an equitable distribution of farm resources (Ali, 1990). So, this trial was planned to evaluate the technological feasibility and economic validity of mixed cropping lentil with rapeseed at different seeding rates of rapeseed.

Materials and Methods

The experiment was carried out at MLT site, Kashinathpur, Pabna in the rabi season of 2011-12 and 2012-13. The soils of the experimental areas belong to the High Ganges River Flood Plain under AEZ-11.

The soils of the experimental plots were sandy clayey loam in texture. The experiment was laid out in Randomized Complete Block (RCB) design with six dispersed replications. It was consisted with six treatments as follows: T_1: Sole lentil (100% lentil), T_2: Sole rapeseed (100 % rapeseed), T_3: Lentil (100%) + Rapeseed (10%), T_4: Lentil (100%) + Rapeseed (20%), T_5: Lentil (100%) + Rapeseed (30%) and T_6: Lentil (100%) + Rapeseed (15%). Seed rate 30 Kg ha^{-1} for lentil and 10 Kg ha^{-1} for rapeseed was considered for crop, respectively. To obtain 10, 15, 20, 30% rapeseed, amount of seed mixed with lentil was calculated as 1, 1.5, 2.0 and 3.0 kg ha^{-1}. The calculated amounts of rapeseed were mixed with 30 kg of lentil seeds separately for achieving different treatment combinations (i.e. T_3, T_6, T_4 and T_5 treatments). Seeds of lentil (BARIMasur7) and rapeseed (BARISarisha14) were sown on 10th to17th November in 2011 and 2nd to 5th November in 2012 as broadcast. The unit plot size was 7.5m x 4m. The lands were fertilized with 19, 16, 20, 7, 1.5 and 1.5 kg N-P-K-S-Zn-B ha^{-1} respectively for sole lentil and mixed cropping and 115, 34, 43, 27, 2.5 and 2.5 kg N-P-K-S-Zn-B ha^{-1} for sole rapeseed. All the fertilizers of entire amount was applied during final land preparation as basal except T_2 (sole rapeseed) as one third urea was applied as top dress at about 30 DAS on 20th to 22nd December, 2011 and 2nd to 5th December, 2012.

The treatments were evaluated in terms of land equivalent ratio (LER) using the following formula of Willey (1981).

$$LER = \frac{\text{Yield of intercropped lentil}}{\text{Yield of solecropped lentil}} + \frac{\text{Yield of intercropped rapeseed}}{\text{Yield of solecropped rapeseed}}$$

Also, rapeseed yields were converted into lentil equivalent yield as per Anjeneyula *et al.* (1982). Lentil yield equivalent

$$Y = \frac{Y_l \times P_l}{P_m}$$

Where, Y_l = Yield of lentil, P_l and P_m = Market prices of lentil and rapeseed, respectively.

The recorded data were statistically analyzed following Gomez and Gomez (1984). All types of variable production cost are recorded to find out the benefit cost ratio (BCR).

Results and Discussion

Yield and yield attributes of lentil

The results revealed that most of the yield attributes of lentil were significantly influenced due to mixed cropping with rapeseed except plant population (Table 1). Higher plant height (48.10 cm in 2011-12 and 50.63 cm in 2012-13) was obtained from T_1 treatment followed by T_3. The maximum number of pod $plant^{-1}$ (57.18 in 2011-12 and 46.55 in 2012-13) was recorded in T_1 which was statistically identical to T_3, T_4 and T_6 treatments and the lowest number of pod $plant^{-1}$ from T_5 treatment. Pods $plant^{-1}$, number of seeds pod^{-1} was found significant in all the treatment combination in 2011-12 but statistical similarity in 2012-13 except T_5 treatment. In 2011-12 cropping season, 1000- seed weight was statistically similar in T_1, T_3, T_4 and T_6 but numerically higher 1000 seed weight (18.55g) was obtained from T_3 and the lower (17.87g) from T_5 treatment where as in 2012-13 while maximum in T_1 (18.91 g) followed by T_3 (18.33 g), T_4 (18.32 g) and T_6 (18.23 g) and the lowest (17.26 g) in T_5 treatment. T_1 treatment produced the highest seed yield (1.90 t ha^{-1}) in 2011-12 and 2.04 t ha^{-1} in 2012-13. The maximum seed yield in T_1 might be due to cumulative effect of yield contributing characters i.e. number of pod $plant^{-1}$, number of seeds pod^{-1} and 1000- seed weight.

Table 1. Seed yield and yield attributes of lentil as a mixed crop with rapeseed

Treatments	Plant height (cm)		Plant population m^{-2}		Number of pods $plant^{-1}$	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
T_1	48.10	50.63	119.96	126.1	57.18	46.55
T_3	42.93	45.19	114.57	124.1	53.80	45.78
T_4	42.29	44.52	118.48	123.1	48.56	45.70
T_5	39.16	41.22	110.70	121.2	39.44	43.84
T_6	40.36	42.48	114.97	122.2	51.33	44.42
$LSD_{(0.05)}$	2.512	0.643	NS	NS	11.74	0.198
CV (%)	3.99	6.26	10.33	4.25	12.66	6.8

Table 1. (Continued)

Treatments	Number of seeds pod^{-1}		1000- seed weight (g)		Seed yield (t ha^{-1})	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
T_1	1.68	1.65	18.32	18.91	1.90	2.04
T_3	1.75	1.65	18.55	18.33	1.73	1.91
T_4	1.72	1.65	18.25	18.32	1.80	1.91
T_5	1.67	1.55	17.87	17.26	1.57	1.59
T_6	1.70	1.65	18.53	18.23	1.78	1.82
$LSD_{(0.05)}$	0.053	0.038	0.241	0.107	0.038	0.174
CV (%)	2.47	2.89	3.69	2.50	7.10	5.60

Yield and yield attributes of rapeseed

Data as presented in the Table 2 revealed that yield and yield contributing characters of rapeseed were differed significantly different. There was an increasing trend of plant population with the increase of seed ratio in all the treatments. The maximum plant population (84.94 and 99.40) was observed in T_2 treatment followed by T_5 and the lowest plant population (10.40 and 22.21) from T_3 treatment in 2011-12 and 2012-13,respectively. The maximum number of siliqua $plant^{-1}$ (45.00) were found in T_3 which was statistically similar to T_6, T_4 and T_5 and the minimum (30.43) from T_2 treatment during 2011-12. Similar trend was observed in 2012-13. In 2011-12, the highest number of seeds $siliqua^{-1}$ (32.34) was obtained from T_4 followed by T_6 as well as the lowest (29.83) was recorded from T_2. More or less similar results were recorded in 2012-13. From two years result showed that there was no significant difference among the treatment regarding 1000- seeds weight (g) but numerically higher 1000- seeds weight (2.93 g in 2011-12 and 2.79 g in 2012-13) was observed in T_3 followed by T_2 and T_6 but the lower (2.75 g in 2011-12 and 2.73 g in 2012-13) from T_5 treatment. The maximum seed yields 1.65 t ha^{-1} and 2.12 t ha^{-1} were obtained in T_2 followed by T_5 due to higher plant population where as the minimum seed yield (0.50 t ha^{-1} in 2011-12 and 0.55 t ha^{-1} in 2012-13) was obtained from T_3 treatment, which were statistically similar to T_6.

Table 2. Seed yield and yield attributes of rapeseed as a mixed crop with lentil

Treatments	Plant height (cm)		Plant population m^{-2}		No. of siliquae $plant^{-1}$	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
T_2	74.71	82.64	84.94	99.40	30.43	30.48
T_3	78.16	86.46	10.40	22.21	45.00	34.50

T_4	76.13	84.22	20.94	30.80	39.63	33.92
T_5	72.72	80.44	33.37	39.20	37.50	31.14
T_6	78.42	83.44	16.33	26.01	41.73	33.68
$LSD_{(0.05)}$	0.975	2.19	2.776	2.257	9.357	2.063
CV (%)	7.63	6.45	5.77	6.87	12.89	5.70

Table 2. (Continued)

Treatments	No. of seeds siliqua^{-1}		1000-seed weight (g)		Seed yield (t ha^{-1})	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
T_2	29.83	28.66	2.90	2.77	1.65	2.12
T_3	30.67	29.98	2.93	2.79	0.50	0.55
T_4	32.34	28.38	2.77	2.76	0.53	0.72
T_5	30.20	27.64	2.75	2.73	0.62	0.82
T_6	30.90	29.92	2.80	2.77	0.50	0.63
$LSD_{(0.05)}$	0.059	1.668	NS	0.042	0.059	0.261
CV (%)	5.11	4.30	7.72	3.65	6.29	12.08

Lentil equivalent yield and land equivalent ratio (LER)

Data presented in the Table 3 revealed that the equivalent yield of lentil was differed from each other among the treatments in both the consecutive years. The maximum lentil equivalent yield (2.22 t ha^{-1}) was obtained from T_4 followed by T_6 and T_3 and the lowest lentil (1.30 t ha^{-1}) in T_2 treatment in 2011-12. Similar trends were observed in 2011-12. The highest lentil equivalent yield (2.48 t ha^{-1}) was obtained from T_4 followed by T_6 and T_3 and the lowest lentil equivalent yield (1.67 t ha^{-1}) was recorded in T_2 treatment. It was noted that all the mixed cropping system produced higher equivalent yield than that of their corresponding sole crops. Results from both the years indicated that T_4 treatment was found higher yield advantageous as well as profitable over other treatments. Similar observations in different mixed/intercropping systems were reported by other authors (Ali *et al*., 2007, Patra *et al*., 2000; Islam *et al*., 2008 and Alom *et al*., 2008). The maximum land equivalent ratio (LER) 1.27 and 1.28 were observed in 2011-12 and 2012-13, respectively from the T_4 treatment followed by T_6 . It is noted that all the mixed cropping systems showed higher LER than sole crop. It could be said that a farmer may increase his land use efficiency by 27 to 28% from mixed cropping systems from growing one hectare of land than that of their traditional sole crops cultivation. The results are in agreement with that of Santalla *et al*. (2001), Basak *et al*. (2006), Razzaque *et al*. (2007) and Alom *et al*. (2008).

Table 3. Lentil equivalent yield and land equivalent ratio (LER) of mixed cropping entil with rapeseed

Treatments	2011-12				2012-13			
	Seed yield (t ha^{-1})		Lentil equivalent yield (t ha^{-1})	LER	Seed yield (t ha^{-1})		Lentil equivalent yield (t ha^{-1})	LER
	Lentil	Rapeseed			Lentil	Rapeseed		
T_1	1.90	-	1.90	1.00	2.04	-	2.04	1.00
T_2	0.00	1.65	1.30	1.00	-	2.12	1.67	1.00
T_3	1.73	0.50	2.13	1.21	1.91	0.55	2.34	1.20
T_4	1.80	0.53	2.22	1.27	1.91	0.72	2.48	1.28
T_5	1.57	0.62	2.05	1.20	1.59	0.82	2.23	1.17
T_6	1.78	0.50	2.18	1.24	1.82	0.63	2.32	1.19

Cost benefit analysis

Data of cost and return analysis (average of two years) are presented in the Table 4. It showed that the highest gross return (Tk.164500 ha^{-1}) and net return (Tk.127774 ha^{-1}) were found maximum in T_4 followed by T_6 and T_3 while sole rapeseed produced the lowest gross return (Tk.103950 ha^{-1}) as well as net return (Tk.60540 ha^{-1}). The cost of cultivation was found higher in sole rapeseed cultivation as it required more fertilizers, irrigation and labour costs than that of lentil cultivation. Net return was higher than mixed cropping system than that of sole cropping. Many investigators also reported higher net return in mixed/intercropping systems than sole crop (Quayyum and Maniruzzaman, 1995; Sarker and Pal, 2004; Basak *et al*., 2006; Razzaque *et al*., 2007; Pyare *et al.*, 2008 and Alom *et al*., 2008). The highest benefit cost ratio (3.48) was recorded from T_4 where as the minimum BCR (1.39) from T_2 treatment.

Table 4. Cost and return analysis obtained from the experimentation (average of two years)

Treatments	Lentil equivalent yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Total cost (Tk. ha^{-1})	Net return (Tk. ha^{-1})	Benefit cost ratio (BCR)
T_1	1.97	137900	36464	101436	2.78
T_2	1.49	103950	43410	60540	1.39
T_3	2.24	156450	36595	119855	3.28
T_4	2.35	164500	36726	127774	3.48
T_5	2.14	149800	36857	112943	3.06
T_6	2.25	157500	36661	120840	3.30

Price of Input (Tk. kg^{-1})		Price of output (Tk. kg^{-1})	
Seed	110	Lentil grain	70.0
Urea	20.0	Rapeseed	55.0
TSP	24.0		
MoP	15.0		
Gypsum	10.0		
$ZnSO_4$	130.0		
Boric acid	130.0		

Conclusion

Lentil equivalent yield was increased with the increase in percent of rapeseed up to 20% with 100% lentil and thereafter it declined with further increment in seeds. All the mixed crop combinations showed higher gross return as well as net return than the respective sole crops. Considering the yield and return it can be concluded that treatment T_4 viz. 100% lentil with 20% rapeseed (30 kg lentil with 2.0 kg rapeseed per hectare) was the most profitable one compared to other treatments when grown as mixed crop. Furthermore, mixed cropping was found more profitable than the sole.

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