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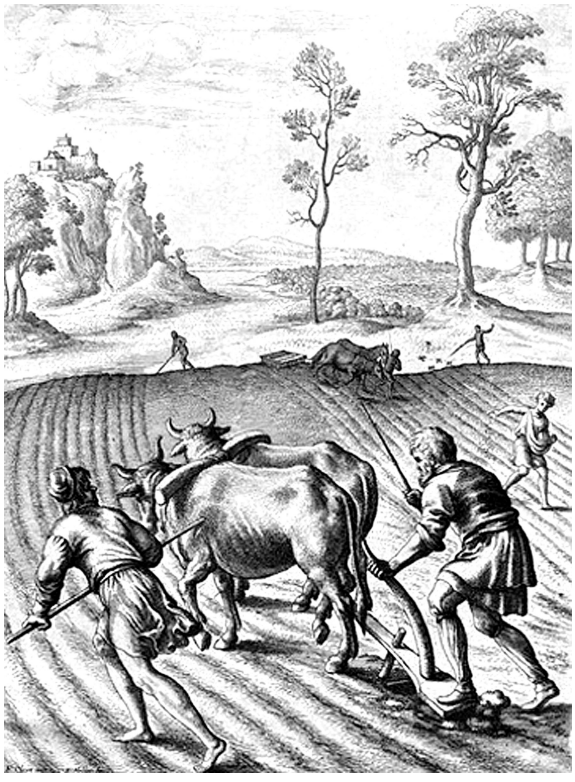

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Evaluation of Mixed and Intercropping of Lentil and Wheat

Nargis Akter, Md. A. Alim, M. Mahbubul Islam, Zabun Naher, Maksuder Rahman and [1]A.S.M. Iqbal Hossain
Bangladesh Jute Research Institute, Manik Mia Avenue, Dhaka-1207
[1] Patuakhali Science and Technology University, Patuakhali, Bangladesh

Abstract: The experiment was carried out to evaluate the performance of lentil-wheat mixed and intercropping system. Positive variation in different yield contributing characters except 1000seed weight of lentil and wheat to 40% of wheat seed rate and 1:1 line sowing were noticed indicating the agronomic suitability of mixed and intercropping of lentil and wheat in those practices. Line sowing performed better than sole broadcast sowing. All mixed seed rate decreased lentil yield but LER was increased in all the treatments over the sole crop lentil as broadcast. The maximum LER (1.52), monetary advantage (63%), benefit cost ratio (1.84) were achieved in lentil and 40% wheat as mixed cropping system.

Key words: Mixed crop, intercrop, lentil, wheat, yield, economics

INTRODUCTION

Mixed and intercropping have some advantages e.g. better use of growth resources, control of weeds, pests and diseases and greater stability of yield in case of environmental hazards over the monoculture of the companion crops. The merit of intercropping have been maintained by Ram[1] as (1) additional income from companion crop (2) insurance against failure of the main crop and (3) quick growth of companion crop tends to suppress weeds. In intercropping system the important determinants are judicious selection of crops which are compatible, having minimum competition and give maximum total yield[2]. A careful selection of the companion crop could maintain the balance of nutrients status. The beneficial effect of legume and non-legume association for soil fertility amelioration through biological nitrogen fixation has been reported by various workers[3-6].

The superiority of mixed/intercropping over sole crops for a number of species is a widely accepted practice. Mixed cropping of lentil with wheat is a prevailing practice in Bangladesh. But the farmers here do not properly follow the principles of mixed cropping. Actually, the dwarf crop lentil should be taken as a major crop by allowing the full of its population to grow and the tall crop wheat should be incorporated in such a way that its population as a whole do not interfere the profitability of the mixed and intercropping system. Thus, the proportion of the seed rates of wheat used in the combination may be a determinant to yield and profitability. Further, intercropping of lentil with wheat in terms of paired row cropping may show some advantages in comparison with the performance of sole and mixed cropping. In every year a huge amount of pulse seeds are imported from abroad and it is increasing day by day. This clearly means that the existing cropping practice, which is, on the whole a pure culture, cannot meet up the demand of the nation. The reason is that the pulse crops apparently are lagging behind while competing with winter vegetables or wheat in terms of profitability. If the research project undertaken can generate a technology that a combination of population of wheat with lentil is more profitable compared with their sole cropping. The farmers of the country might then interest in growing more lentil crops. This can lead a way to grow more pulses to keep fit the pulses of the nation. Moreover, still now research works have conducted individually on mixed or inter cropping in the country. Study on performance of different practices has yet not been done.

Therefore, the present study is aimed at determining the performance and yield advantages and economic gains from the variable seed rate ratios of wheat as mixed/intercropping within the base crop lentil.

MATERIALS AND METHODS

The experiment was conducted at the Agricultural farm, Bangladesh Agricultural University, Mymensingh in 1996-1997 under Old Brahmaputra flood plain agro ecological zone with the following treatments:

T_1 : Lentil 100% + 0% Wheat (Broadcast)
T_2 : Lentil 100% + 20% Wheat (Mixed crop)
T_3 : Lentil 100% + 40% Wheat (Mixed crop)
T_4 : Lentil 100% + 60% Wheat (Mixed crop)

Corresponding Author: Mr. M. Mahbubul Islam, Bangladesh Jute Research Institute, Manik Mia Avenue, Dhaka-1207, Bangladesh

T_5 : Lentil 100% + 80% Wheat (Mixed crop)
T_6 : Lentil 0% + 100% Wheat (Broadcast)
T_7 : 1:1 row system of lentil : wheat (Intercrop)
T_8 : 2:1 row system of lentil : wheat (Intercrop)
T_9 : 3:1 row system of lentil : wheat (Intercrop)
T_{10} : 1:0 row system of lentil : wheat (Line sown sole lentil)
T_{11} : 0:1 row system of lentil : wheat (Line sown sole wheat)

The experiment was laid out in a randomized complete block design (RCBD) with four replications. The plot was 1.6x12.5 m^2 with irrigation canal of 0.5m wide and 0.15 mm depth was made around block to provide irrigation water.

Seed rate used for wheat and lentil were 130 and 35 kg ha^{-1} respectively. Different fertilizers for sole wheat were Urea, TSP, MP, Gypsum @ of 180, 140, 40 and 110 kg ha^{-1}, respectively. The whole amount of TSP, MP, Gypsum and 2/3rd of urea were applied as basal dose at final land preparation. Rest one third of urea was applied as top dressing before irrigation. Different fertilizers such as urea, TSP and MP for sole lentil and mixed intercropped situation were applied at the rate of 49.4, 98.8 and 49.4 kg ha^{-1}, respectively. The crop was sown on 5/12/96, weeding were done twice, once on 10/01/97 next on 25/01/97. The top dressing of urea was done prior to irrigation.

The plot was irrigated shallowly on 26/12/96. No major insects and pests and disease infestation were observed in experimental crops. All crops were harvested in 25th March 1997 at full maturity. The data of different yield contributing characters were analyzed statistically[7].

The increase in productivity per unit area of mixed and intercrops was calculated in terms of land equivalent ratio (LER) using the following formula[8]:

$$LER = \frac{\text{Intercrop yield of lentil}}{\text{Sole crop yield of lentil}} + \frac{\text{Intercrop yield of wheat}}{\text{Sole crop yield of wheat}}$$

Monetary advantage was used for economic performance of the mixed and intercrops. It was calculated using formula of Willey[9].

$$\text{Monetary advantage} = GR \times \frac{LER - 1}{LER}$$

Where,
GR = Gross return and LER = Land equivalent ratio.

$$\text{Benefit cost ratio was calculated as, } BCR = \frac{\text{Gross margin}}{\text{Cost of cultivation}}$$

RESULTS AND DISCUSSION

In lentil, the highest performance on plant height, branches/plant, fertile pods/plant, infertile pods/plant, seeds/plant and 1000 seeds weight were achieved in T_4, T_3, T_{10}, T_4, T_{10} and T_4 successively (Table 1). In higher doses of mixed cropping and 2:1 and 3:1 intercropping yield contributing characters were decreased (Table 1). In case of fertile pods, infertile pods and 1000 seeds weight there was no significant difference among the treatments i.e. lentil yield potential and seed quality were not significantly affected by the mixed and intercropping in comparison with sole cropping (Broadcast and line sowing) treatment. The highest yield of lentil, 1278 kg ha^{-1} was obtained in sole line sowing (T_{10}) which was followed by T_1 (1201 kg ha^{-1}), T_3 (1175 kg ha^{-1}), T_4 (1070 kg ha^{-1}) and the lowest yield (601 kg ha^{-1}) was obtained from T_5 i.e. Lentil 100+80% wheat i.e. in higher doses of mixed cropping decreases the yield (Table 1).

The yield reduction in mixed and intercropping might be due to shading effect of the taller wheat and higher competition for moisture, space and light and nutrition among the crop plants[10,11].

In case of wheat, the highest performance in the yield contributing characters like plant height, effective tillers $plant^{-1}$, non effective tillers $plant^{-1}$, panicle length, seeds $plant^{-1}$ and 1000 seeds weight were achieved in T_6, T_4, T_7, T_5 and T_8 successively. But effective tillers and seeds per plant were not significantly affected among the treatments (Table 2), which indicates some yield contributing characters are influence in higher doses of mixed and intercropping.

The highest wheat yield (2704 kg ha^{-1}) was in T_{11} and the lowest (735 kg ha^{-1}) was in T_9. In both the crop the higher yield was achieved in line sowing than broadcast sowing. This may be due to higher aeration and desirable spread of canopy for efficient utilization of solar energy for photosynthesis[12].

In the mixed cropping treatments the different percentage of land equivalent ratio (6.00 to 52.00%)(Table 3) indicated that the mixed cropping increased the productivity per unit area in comparison with the sole cropping of lentil. In intercropping treatments the percentage of land equivalent ratio (12.00 to 17.00%) (Table 3) indicating the increased productivity but it was not identical. The performance of wheat in mixed cropping was higher than that of intercropping. This might be for beneficial action from the associated legumes. Some early pot studies suggested that legumes could excrete nitrogen from root nodules and thus benefit the associated cereals[13-15].

Table 1: Effect of mixed cropping and intercropping patterns on yield attributes of lentil.

Treatments	Plant Height (cm)	Branches Per plant	Fertile pods per plant	Infertile pods per plant	Seeds per plant	1000 seeds weight (g)	Seed yield (kg ha^{-1})
T_1 (Lentil-broadcast)	26.20a	2.78ab	24.15a	1.25a	36abc	16.86a	1201cd
T_2 (L 100% + 20% W)	29.98ab	2.83ab	24.65a	1.35a	38abc	15.34a	1175c
T_3 (L 100% + 40% W)	33.35cd	3.25b	27.65a	1.15a	41abc	15.71a	1070c
T_4 (L 100% + 60% W)	35.70d	2.98ab	22.90a	1.00a	37abc	18.00a	895b
T_5 (L 100% + 80% W)	33.55d	2.60a	21.40a	1.15a	32ab	17.47a	601a
T_6 (Wheat-broadcast)	Data are of wheat yield attributes and sown in table 2.						
T_7 (1:1 row-intercrop)	30.30bc	3.00ab	27.00a	1.05a	42bc	17.98a	692a
T_8 (2:1 row-intercrop)	27.95ab	2.75ab	26.40a	1.10a	41abc	15.48a	893b
T_9 (3:1 row-intercrop)	28.55ab	3.00ab	23.07a	1.38a	30a	16.40a	964b
T_{10} (Line sowing-lentil)	27.50ab	2.88ab	29.23a	1.65a	47c	15.04a	1278d
T_{11}(Line sowing-wheat)	Data are of wheat yield attributes and sown in table 2.						
CV %	7.8	12.3	15.8	11.9	11.2	14.3	9.2

Letters in a column indicate significant difference at 5% level by DMRT

Table 2: Effect of mixed cropping and intercropping patterns on yield attributes of wheat.

Treatments	Plant Height (cm)	Effective tiller per plant	Non effective tiller per plant	Panicle length (cm)	Seeds per plant	1000 seeds weight (g)	Seed yield (kg ha^{-1})
T_1 (Lentil-broadcast)	Data are of lentil yield attributes and sown in table 1.						
T_2 (L 100% + 20% W)	80.40ab	6.23a	2.75ab	8.40a	138a	51.20d	791a
T_3 (L 100% + 40% W)	82.41abc	6.43a	2.65ab	9.39abc	168a	43.62b	1455e
T_4 (L 100% + 60% W)	88.07 bc	6.65a	3.23ab	9.45bc	190a	37.73a	908b
T_5 (L 100% + 80% W)	87. 03 c	5.95a	3.58b	9.70bc	179a	36.97a	1312c
T_6 (Wheat-broadcast)	89.15 bc	5.48a	3.35ab	9.84c	160a	37.87a	2302f
T_7 (1:1 row-intercrop)	85.09 abc	6.25a	2.40a	9.00abc	147a	45.83bc	1382d
T_8 (2:1 row-intercrop)	77.12 a	6.00a	2.43ab	9.15abc	152a	48.73cd	941b
T_9 (3:1 row-intercrop)	74.22 a	5.08a	3.05ab	8.71abc	116a	48.52cd	735a
T_{10}(Line sowing-lentil)	Data are of lentil yield attributes and sown in table 1.						
T_{11}(Line sowing-wheat)	84. 56abc	5.25a	3.23ab	9.29abc	114a	47.34c	2704g
CV %	6.4	11.4	13.7	7.3	19.4	4.8	5.8

Letters in a column indicate significant difference at 5% level by DMRT

Table 3: Gross return (GR), Land equivalent ratio (LER), Monetary advantage and Benefit Cost Ratio (BCR)

Treatments	L.E.R.	G.R.	Monetary advantage	B.C.R.
T_1 (Lentil-broadcast)	1.00	18519.00	-	1.28
T_2 (L 100+20% W)	1.32	24182.50	5862.42(39%)	1.61
T_3 (L 100+20% W)	1.52	27759.00	9496.50(63%)	1.84
T_4 (L 100+20% W)	1.13	20771.00	2389.64(16%)	1.34
T_5 (L 100+20% W)	1.06	18607.00	1053.22(7%)	1.17
T_6 (Wheat-broadcast)	1.00	17633.00	-	1.09
T_7 (1:1row-ntercrop)	1.17	21300.50	3094.94(18%)	1.20
T_8 (2:1row-ntercrop)	1.15	20968.25	2734.98(15%)	1.16
T_9 (3:1row-ntercrop)	1.12	20539.00	2200.60(13%)	1.15
T_{10} (Line sowing-lentil)	1.00	19783.00	-	1.34
T_{11} (Line sowing-wheat)	1.00	20766.50	-	1.14

In the different treatments it was clear that the lentil yield decreased due to mixed or intercropping (Table 1 and 2) but its land equivalent ratio increased in all the mixed/intercropping in relation to their sole crop (Table 3). The pattern of yield reduction collaborates with the results in other experiments of lentil mixed and intercropped with mustard[16] and lentil intercropped with wheat[17].

The highest monetary advantage was obtained (63%) in the treatment T_3 i.e. Lentil 100+40% wheat. It was revealed that the treatment lentil 100% + wheat 40% had the highest land equivalent ratio (1.52) indicating 52% area advantage over sole cropping of lentil. The results showed that the highest gross return (27,759.00 Tk ha^{-1}) was also recorded from the same treatment followed by lentil 100+20% wheat (i.e. in the treatment T_2 scoring 24182.50 Tk ha^{-1}). Moreover, the treatment contributed the highest benefit cost ratio (1.84) which was followed by lentil 100+20% wheat (1.61) (Table 3).

Mozibul *et al.*[10] reported similar results from lentil intercropping with jute. Gangwar and Karla[18] and Quayum[19] obtained the highest net income by intercropping of maize with legumes and maize with chickpea, respectively.

In conclusion, the mixed cropping of lentil with 40% wheat seed rate would be the appropriate seed rate with base crop lentil for higher total production and income and be remunerative to the farmers.

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