Bangladesh Agron. J. 2019, 22 (1): 1-6

EFFECT OF SOIL TEST BASED FERTILIZER PACKAGE FOR YIELD AND ECONOMIC RETURN OF LENTIL + MUSTARD MIXED CROPPING SYSTEM IN CHARLAND OF PABNA

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(**Received:** 21 December 2017, **Accepted:** 16 September 2019)

Keywords: Mixed cropping, char land, lentil, mustard, lentil equivalent yield, economic return

Abstract

The experiment was conducted at char Sadipur the char land of Pabna during the *Rabi* season of 2013-14 and 2014-15 to determine appropriate fertilizer dose for enhancing production and economic return from Lentil+ Mustard mixed cropping system. The experiment was laid out in a randomized complete block design with 3 dispersed replications. Eight soil test based fertilizer packages viz.,T_1: N_{20} P_{24} K_{20} S_{18} Zn_2 $B_{1.5}$, T_2: N_{25} P_{24} K_{20} S_{18} Zn_2 $B_{1.5}$, T_3: N_{25} P_{30} K_{20} S_{18} Zn_2 $B_{1.5}$, T_4: N_{25} P_{24} K_{25} S_{18} Zn_2 $B_{1.5}$, T_5: N_{20} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$, T_6: N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$, T_7: N_{15} P_{18} K_{15} S_{14} $Zn_{1.5}$ B_1kg ha^{-1}kg ha^{-1} and T_8: native nutrient (control) were tested for lentil + mustard mixed cropping system. Soil test based N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$ (T_6) showed better performance on crop growth and yield of lentil and mustard in lentil+ mustard mixed cropping system in both the year. The highest lentil yield 0.70 t ha^{-1} in 2013-14 and 0.95 t ha^{-1} in 2014-15 was obtained from soil test based N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$ (T_6). Similarly, maximum lentil equivalent yield (1233 Kg ha^{-1}in 2013-14 and 1280Kg ha^{-1} in 2014-15) was also obtained from the same treatment. The maximum gross margin (Tk. 31639 ha^{-1} in 2013-14 and Tk. 32480 ha^{-1} in 2014-15) was recorded from soil test based N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5.}$ So, application of soil test based fertilizer increases lentil and mustard yield as mixed crop as well as income of the farmers.

Introduction

In Bangladesh the lands of char area are not suitable for all crops and all seasons. In Pabna, there is a vast area of char land under AEZ-11. Nutrient status of char land is poor due to coarse textured soils, low water holding capacity, low nutrient content, river bank erosion and flooding. Farmers of char land in Pabna generally grow lentil and mustard as mixed crop where they use local variety with no or limited fertilizers. For this reason, the yield of lentil and mustard in this region is much below than that of potential yield level. Balanced fertilization can play a major role to enhance the present yield level. Experimental evidences reveal that the crop is highly responsive to different fertilizers and its yield can be increased remarkably through the judicious fertilization (BARI, 1988; Mohamed,1984; Roy and Singh, 1986; Kazi *et al.*, 2002). Fertilizer recommendation solely based on crop response data often fails to show economic viability. In this context, Perrin *et al.* (1979) reported that response of yield should be supported by economic evaluation for judicious fertilizer recommendation. Since the application of optimum dose of fertilizer is important for increasing the yield of lentil and mustard mixed cropping system,

but very limited information in this regard is available in Bangladesh, the present study was undertaken to determine the optimum fertilizer dose of lentil and mustard mixed crop in char land.

Materials and Methods

The experiment was conducted at char land of Char Sadipur areas of Pabna during *Rabi* season of 2014-15 to 2015-16. The experimental site was in Gopalpur soil series belonging to the High Ganges River Floodplain Soils (AEZ-11). Before starting the experiment, initial composite soil samples (0-15 cm depth) were collected from the experimental plots and were analyzed. The analytical result indicated that soil was sandy loam with very low organic matter content (0.82%) and slightly alkaline in nature. N content of soil was very low and P, S and Zn content of the soil were low. K content of the soil was medium (Table 1).

Table 1. Nutrient status of the initial soil sample (0-15cm depth) of experimental plots at Char Sadipur, Pabna

Soil properties	Values	Interpretation
Soil pH	8.1	Slightly alkaline
Organic matter content (%)	0.82	Very low
Total N (%)	0.05	Very low
Available P (µg/g soil)	11.3	Low
Available S (µg/g soil)	9.2	Low
Available Zn (µg/g soil)	0.57	Low
Exchangeable K (meq%)	0.17	Medium

Eight treatments consisted of T_1: N_{20} P_{24} K_{20} S_{18} Zn_2 $B_{1.5}$ (STB), T_2: N_{25} P_{24} K_{20} S_{18} Zn_2 $B_{1.5}$, T_3: N_{25} P_{30} K_{20} S_{18} Zn_2 $B_{1.5}$, T_4: N_{25} P_{24} K_{25} S_{18} Zn_2 $B_{1.5}$, T_5: N_{20} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$, T_6: N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$, T_7: N_{15} P_{18} K_{15} S_{14} $Zn_{1.5}$ B_1kg $ha^{-1}$and T_8: native nutrient (control that is without fertilizer).

The experiment was laid out in randomized complete block (RCB) design with three replications. The unit plot size was 5m x 4m.The land was prepared by power tiller and laddering. After completion of land preparation, the entire amount of all fertilizers was applied as per treatment specification. The seeds of lentil and mustard were broadcasted in each plot on 10 November in 2013-14 and 15 November in 2014-15 maintaining the same ratio of 80:20 for lentil + mustard mixed crop in both the season. Two times weeding were done at vegetative stage for better growth of the crops. Rovral 50 WP @ 2.5 g L^{-1} was applied 3 times at 7-10 days interval from flowering until pod formation to control stem phylum disease of lentil. Other intercultural operations were done when required. Mustard was harvested on 5 February in 2013-14 and 10 February in 2014-15 while lentil was harvested on 23 February in 2013-4 and 27 Februaryin 2014-15 cropping season. Other intercultural operations were done when required. Necessary data on days to flowering, days to maturity, yield and yield contributing characters were collected and analyzed through statistical analytical package with MSTAT C software. The productivity of mixed cropping system was estimated by calculating their lentil equivalent yield (LEY) using formula given by Ahlawat and Sharma(1993), where

$$\text{LER} = \frac{\text{Yield of mustard (t/ha)} X \; Price\ of\ mustard\ grain\ (Tk./t)}{Price\ of\ lentil\ grain\ (Tk./t)}$$

Cost and return analysis of different treatments were done for gross margin.

Results and Discussion

Plant height and yield contributing characters of lentil in lentil + mustard mixed cropping system have been presented in Table 2a. Significant variation in Plant height, No. of pods plant^{-1}, No. of seed pod^{-1}, and 1000-seed weight were observed-in different treatments. The highest plant height (27cm and 30.7cm) was measured from N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$ (T_6) treatment, which was significant irrespective of years and the lowest plant height (20.1cm and 21.87cm) was measured in T_8 (control). In case of number of seeds pod^{-1}there was no significant difference among the treatments except T_4 and control in 2013-14 and only control in 2014-15 cropping season. Higher 1000-seed weight was observed from T_6, T_5, T_4 and T_2 but T_5 was not higher in 2013-14 and the lowest 1000-seed weight (24.83g and 18.07g)-from control (T_8). Performance of T_3 regarding yield contributing parameters is poor though N and P level was used in higher dose compare to other treatments might be due to lower dose of K. Char land soil is light textured soil and contain very low N, P, K, S, Zn and B. For that application of higher dose of N, P and K show higher growth and yield contributing characters. This results are supported by Anonymous (2009) as it reported that application of N, P, B and Rhizobium inoculum significantly enhanced the positive growth and yield parameters of lentil.

Table 2a. Plant Height and Yield contributing parameters of lentil in lentil + mustard mixed cropping system at Char Sadipur, Pabna during the *rabi* season of 2013-14 and 2014-15

Treatment	Plant height (cm)		No. of pods plant^{-1}		No. of seed pod^{-1}		1000- seed weight (g)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
T_1	24.43 de	23.17 c	26.90 bc	30.00bcd	1.83 ab	1.70abc	19.40 b	25.17 bc
T_2	26.40 bcd	24.57bc	27.00 bc	36.33 ab	1.83 ab	1.70abc	20.13 a	25.67 ab
T_3	27.73 abc	24.47bc	31.33 ab	34.60abc	1.83 ab	1.70abc	19.63 b	25.00 bc
T_4	28.90 ab	25.07 b	31.00 ab	29.57 cd	1.90 a	1.63 bc	19.93 ab	25.67 ab
T_5	25.43 cd	24.03bc	32.63 ab	30.40bcd	1.93 a	1.70abc	20.73 a	25.50 bc
T_6	30.70 a	27.00 a	38.33 a	38.40 a	1.90 a	1.76 a	20.80 a	26.33 a
T_7	23.80 de	23.47bc	23.47 bc	26.73 de	1.80 ab	1.73 ab	18.63 bc	25.33 bc
T_8	21.87 e	20.10 d	20.30 c	21.63 e	1.70 b	1.60 c	18.07 c	24.83 c
CV(%)	6.51	4.03	18.34	12.47	4.89	4.30	3.50	1.80

T_1: N_{20} P_{24} K_{20} S_{18} Zn_2 $B_{1.5}$ (STB), T_2: N_{25} P_{24} K_{20} S_{18} Zn_2 $B_{1.5}$, T_3: N_{25} P_{30} K_{20} S_{18} Zn_2 $B_{1.5}$, T_4: N_{25} P_{24} K_{25} S_{18} Zn_2 $B_{1.5}$, T_5: N_{20} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$, T_6: N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$, T_7: N_{15} P_{18} K_{15} S_{14} $Zn_{1.5}B_1$ kg ha^{-1}and T_8: native nutrient (control)

Yield of lentil and mustard in mixed cropping system have been presented in Table 2b. In 2014-15 maximum stover yield of lentil (0.75 t ha^{-1} and 0.79 t ha^{-1}) was found from N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$ (T_6) treatment, which was statistically similar to T_5 and T_3 while minimum stover yield 0.31 t ha^{-1} from control (T_8). In 2013-14, the maximum stover yield was observed from the treatment N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$ (T_6) followed by T_5, T_4 and T_3 and the minimum stover yield was found from the control treatment which was statistically similar to the treatment T_7 (Table 2b). However, the highest seed yield 0.95 t ha^{-1} was attained from N_{25}

P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$ (T_6) which was significantly higher than other treatments in 2014-15 cropping season but in 2013-14 cropping season, the highest seed yield (0.70 t ha^{-1}) was found from the treatment T_6 which was statistically similar with T_5, T_4 and T_3. On the contrary, control (T_8) treatment provided the lowest lentil yield (0.41 t ha^{-1} and 0.21 t ha^{-1}). The cumulative contribution of potential yield traits might be the reason for higher seed yield from N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$ (T_6). In contrast, poor crop growth and yield traits resulted in the lowest seed yield in control (T_8). Maximum lentil yield increased (132% and 233%) over control was obtained from N_{25} P_{38} K_{31} S_{18} Zn_3 $B_{1.5}$ (T_6) in 2014-15 and 2013-14 respectively. The overall results indicate that in char land conditions soils are dominated with sand particles and low organic matter which causes deficiency in nutrient availability in soil and make imbalance in subsequent plant uptake. Therefore, 100% fertilizer package plus 25% additional nutrients specially N,P and K that is fertilizer dose N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$ enhance optimum plant growth and development and higher yield in lentil. Anonymous (2009) reported that balanced application of N, P, K, S, Zn and B significantly increased the yield of lentil over control. The results obtained in this experiment are supported by the findings of Mondal *et al.* (2010); Bhuiyan *et al.* (2008) and Singh *et al.* (2004) found that yield of lentil increases when fertilizer was applied as soil test based.

In case of mustard as mixed crop, similar trend was observed as lentil in both the season. The maximum mustard seed yield (0.38 t ha^{-1} and 0.66 t ha^{-1}) was recorded from N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$ (T_6). The exclusion of fertilizer that is control (T_8) plot resulted in the lowest seed yield (Table 2b). The seed yield of lentil is higher in second year than first year while the seed yield of mustard is higher in first year than second year. It might be due to mixed cropping by which two crops sharing their yield that is when one crop performs better then another crop could perform poor. Bhowal *et al.* (2014) also found that when lentil perform better then mustard's performance was not good enough in mixed cropping system.

Table 2b. Stover yield, seed yield of lentil and mustard in lentil + mustard mixed cropping system at Char Sadipur, Pabna during the *Rabi* season of 2013-14 and 2014-15

Treatments	Stover yield of lentil (t ha^{-1})		Seed yield of lentil (t ha^{-1})		Seed yield of mustard (t ha^{-1})		% Yield increase of lentil over control (T_8)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
T_1	0.41 c	0.51 bc	0.43 cd	0.73 b	0.25 d	0.20 cd	105	78
T_2	0.45 c	0.55 bc	0.47 bc	0.74 b	0.28 d	0.22 bcd	124	80
T_3	0.60 b	0.63 ab	0.56 abc	0.78 b	0.38 c	0.23 bc	167	90
T_4	0.60 b	0.61 b	0.56 abc	0.74 b	0.51 b	0.25 b	167	80
T_5	0.66 b	0.65 ab	0.61 ab	0.75 b	0.46 bc	0.26 b	190	83
T_6	0.79 a	0.75 a	0.70 a	0.95 a	0.66 a	0.38 a	233	132
T_7	0.33 cd	0.45 cd	0.38 d	0.60 c	0.25 d	0.19 d	81	46
T_8	0.23 d	0.31 d	0.21 e	0.41 d	0.06 e	0.04 e	-	-
CV(%)	13.36	13.82	19.20	8.64	15.98	24.51		

T_1: N_{20} P_{24} K_{20} S_{18} Zn_2 $B_{1.5}$ (STB), T_2: N_{25} P_{24} K_{20} S_{18} Zn_2 $B_{1.5}$, T_3: N_{25} P_{30} K_{20} S_{18} Zn_2 $B_{1.5}$, T_4: N_{25} P_{24} K_{25} S_{18} Zn_2 $B_{1.5}$, T_5: N_{20} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$, T_6: N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$, T_7: N_{15} P_{18} K_{15} S_{14} $Zn_{1.5}$ B_1 kg $ha^{-1}$and T_8: native nutrient (control)

However, maximum lentil equivalent yield (1280 Kg ha^{-1} and 1233 Kg ha^{-1}) was found from N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$ (T_6) which is 355% and 176% higher over control in 2013-14 and 2014-15 cropping season, respectively while minimum lentil equivalent yield (271 Kg $ha^{-1}$and 463 Kg ha^{-1}) was found from control (T_8)

plot (Table 2c). The results of this experiment indicate that soil health in char land is relatively poor which does not provide proper nutrient backup to the crops. Due to having very low organic matter and plant nutrition, higher rate of fertilizer management results in higher crop yield.

Table 2c. Lentil equivalent yield and % increase of lentil equivalent yield over control in lentil+ mustard mixed cropping system at Char Sadipur, Pabna during the *Rabi* season of 2013-14 and 2014-15

Treatments	Lentil equivalent yield (Kg ha^{-1})		% Lentil equivalent yield increase over control (T_8)	
	2013-14	2014-15	2013-14	2014-15
T_1: $N_{20}P_{24}K_{20}S_{18}Zn_2B_{1.5}$	641	913	137	97
T_2: $N_{25}P_{24}K_{20}S_{18}Zn_2B_{1.5}$	705	939	160	103
T_3: $N_{25}P_{30}K_{20}S_{18}Zn_2B_{1.5}$	878	994	224	115
T_4: $N_{25}P_{24}K_{25}S_{18}Zn_2B_{1.5}$	971	966	258	109
T_5: $N_{20}P_{30}K_{25}S_{18}Zn_2B_{1.5}$	991	986	266	113
T_6: $N_{25}P_{30}K_{25}S_{18}Zn_2B_{1.5}$	1233	1280	355	176
T_7: $N_{15}P_{18}K_{15}S_{14}Zn_{1.5}B_1$	585	771	116	67
T_8: Control	271	463	-	-

Economic return from lentil + mustard mixed cropping

Cost and return analysis demonstrated that gross margin (Tk.32480 ha^{-1} and Tk.31639 ha^{-1}) was obtained from N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$ (T_6) in 2014-15 and 2013-14, respectively followed by T_4 and T_5 fertilizer management packages (Table 3). Probably higher production and gross return (Tk.83200 ha^{-1} and Tk.80145 ha^{-1}) from this T_6 treatments resulted in higher economic return. Negative gross margin was recorded from control (T_8) in both the year but T_1, T_2 and T_3 in 2013-14 cropping season due to poor yield from those treatments and gross return which was lower than the total variable cost.

Table 3. Cost and return analysis of lentil + mustard mixed cropping system influenced by fertilizer packages at Char Sadipur, Pabna during the *Rabi* season of 2013-14 and 2014-15

Treatments	Gross return (Tk. ha^{-1})		Total variable cost (Tk. ha^{-1})		Gross margin (Tk. ha^{-1})	
	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14
T_1	59345	41665	49670	47367	9675	-5682
T_2	61035	45825	49870	47565	11165	-1740
T_3	64610	57070	50560	48346	14050	8724
T_4	62790	63115	50030	47725	12760	15390
T_5	64090	64415	50520	48308	13570	16107
T_6	83200	80145	50720	48506	32480	31639
T_7	50115	38025	47620	45278	2495	-7253
T_8	30095	17615	41540	39010	-11445	-21395

T_1: N_{20} P_{24} K_{20} S_{18} Zn_2 $B_{1.5}$ (STB), T_2: N_{25} P_{24} K_{20} S_{18} Zn_2 $B_{1.5}$, T_3: N_{25} P_{30} K_{20} S_{18} Zn_2 $B_{1.5}$, T_4: N_{25} P_{24} K_{25} S_{18} Zn_2 $B_{1.5}$, T_5: N_{20} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$, T_6: N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$, T_7: N_{15} P_{18} K_{15} S_{14} $Zn_{1.5}$ B_1 kg $ha^{-1}$and T_8: native nutrient (control)

Market Price (Tk kg^{-1}): Lentil: Grain=65.00 [1], Straw=5.00, Mustard: Grain=45.00 [1], Straw=1.00

Conclusion

The findings could be concluded that fertilizer packages exerted significant effect on yield and yield attributes of lentil and mustard in mixed cropping system. Soil test based fertilizer N_{25} P_{30} K_{25} S_{18} Zn_2 $B_{1.5}$ showed better performance on crop growth and yield of lentil and mustard as mixed cropping system in char land of Pabna. The maximum economic return in terms of gross return and gross margin was also recorded in the same fertilizer package.

References

Ahlawat, I.P.S. and R.P. Sharma. 1993. Agronomic Terminology, Indian Society of Agronomy, New Delhi, India, 3rd edition.

BARI (Bangladesh Agricultural Research Institute). 1988 Annual Report for 1988, Joydebpur, Gazipur-1701, Bangladesh. pp.215-218.

Bhowal, S.K., M.M.U. Chowdhury, M.S. Bhuiyan, A.H.M.A. Faisal, I.S.M. Farhad and S.K. Bhowmik. 2014. Yield and Yield Attributes of Lentil (*Lens esculenta*) as ab Mixed Crop with Mustard (*Brassica campestris*). Sci. Agri. 8(2): 76-79.

Bhuiyan, M.A.H., D. Khanam, N.E. Ali, M.K. Zaman and M.S. Islam. 2008. Response of lentil to bio fertilizer and chemical fertilizers in the farmer's field. Annual Research Report, 2007-2008, Soil Science Division, BARI, Gazipur.pp.36-39.

Kazi, B. R. 2002. Effect of irrigation frequencies on growth and yield of soybean. 2(6): 661-662.

Kumar, S. and M.Singh. 2009. 25 Years of Pulses Research at IIPR, 1984-2009. Indian Institute of Pulses Research, Kanpur 208024, India.pp.62-65.

Mohamed, S. A. 1984. Effect of irrigation water and fertilization on yield and water use efficiency of corn plants in Fayoum Governorate. Moshtohor, Egypt Annual Agril. Sci. 20(2): 221-235.

Mondal, R.H., B. Anwar, M. Rafiuddin and M.A. Hossain. 2010. Integrated nutrient management for sustaining soil fertility and yield of Lentil-Mungbean-T. Aman cropping pattern. Annual Research Report, 2009-2010, Pulses Research Centre, Gazipur.pp. 82-86.

Perrin, R. K., Winkelmen, D.L., Moscardi, E.R. and Anderson, J.R. 1979. Economic Training Manual. Information Bulletin No. 27. CIMMYT, Mexico. p.5

Roy, R.K. and K.S. Singh. 1986. Response of pop-corn (*Zea mays*) to plant population and nitrogen. Indian J. Agron. 31(1): 87-92.

Singh, S.K., S.C. Varma and R.P. Singh. 2004. Residual effect of organic and inorganic sources of nutrients in lowland rice on succeeding lentil. Indian J. Agric. Res. 38(2): 121-125.