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EFFECTS OF ROW SPACING ON DIFFERENT LENTIL VARIETIES UNDER STRIP TILLAGE SEEDING SYSTEM

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Abstract

Lentil is an important legume crop grown by three or four time tillage operations with post sowing irrigation after monsoon rice harvest. Strip tillage is a climate smart tillage technology where residual soil moisture can be utilized for plant growth and development. This study was conducted at Regional Agricultural Research Station, Ishurdi, Bangladesh in two consecutive years of 2020 and 2021 to find out the optimum row spacing for specific lentil variety under strip tillage seeding system. Four row spacing (S_1= 20 cm, S_2= 25 cm, S_3= 30 cm, S_4= 40 cm) and three varieties of lentil (V_1= BARI Masur-8, V_2= BARI Masur-7, V_3= BARI Masur-6) were assigned in a factorial Randomize Complete Block Design with three replications. The trend of lentil seed yield was recorded as BARI Masur-8 > BARI Masur-7 > BARI Masur-6 and seed yield decreased with increasing row spacing for all varieties. The results showed that 25 cm row spacing for BARI Masur-8, 20 cm row spacing for BARI Masur-6 and BARI Masur-7 were found suitable row spacing at strip tillage seeding systems. Among the lentil varieties, BARI Masur-8 showed better performance than others due to higher yield attributes and seed yield.

Keyword: BARI Masur, Seed yield, Strip tillage system, Soil moisture

Introduction

Recently, conventional as well as deep tillage system is being replaced by strip tillage technology in worldwide, including Bangladesh. Strip tillage is a climate-smart tillage technology that increases crop productivity while decreasing planting costs. Residual soil moisture can also be harvested using the strip tillage technique by planting rabi crops after the monsoon rice harvest.

Strip tillage technologies are more viable in drought stress areas where seeding operations and initial plant establishment can be carried out with residual soil moisture available immediately after monsoon rice harvest (Bell and Johansen, 2009). Many research reports suggest that strip tillage lentil cultivation is possible (Zaman *et al.*, 2019 and 2020). Lentils are placed in first position according to area coverage (40% of total pulse area) and production (45% of total pulse production). It is cultivated across the country, covering an area of 1.41 lakh hectares with a production of 1.77 lakh

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metric tons with an average yield of 1.26 t/ha (BBS 2021). However, the annual growth rates of the area decreased by 0.152%, while the growth rates of production (2.62%) and yield (2.77%) significantly increased during 2000-01 to 2019-20 due to the introduction of improved lentil varieties and management technologies (Miah *et al.*, 2021). Due to lack of desired plant population, its average yield in the country1130 kg ha^{-1} is quite low as compared to its yield potential 1800-2000 kg ha^{-1}. Optimum plant population density of lentil is an important factor to realizing the potential yields as it directly affects plant growth. According to Parveen and Bhuiya (2010), seed rate is one of the most important factors influencing lentil growth, yield, and quality. The choice of sowing row spacing is an important agronomic practice influencing plant density and crop establishment. Yield of lentil can be increased by using proper row spacing. Though Pulse Research Center, Bangladesh Agricultural Research Institute (BARI) suggested row spacing of lentil for deep tillage or conventional tillage where 3 to 4 times tillage operation was done. But in strip tillage seeding system, there was no finding of row to row spacing for lentil. Since information on these aspects is lacking in Bangladesh, therefore the present investigation was carried out to find out the optimum row spacing of specific variety under conservation agriculture system specially strip tillage.

Materials and Methods

Experimental site

The experiment was conducted in two consecutive years of 2019-20 and 2020-21 at the agro ecological zone of High Ganges River Floodplain (AEZ # 11), Regional Agricultural Research Station, Ishurdi, Pabna (24.03° N; 89.05° E; 16 AMSL) in Bangladesh.

Soil characteristics

The textural class of soil is sandy clay loam. The soil pH was 7.2 that represented neutral soil according to their pH value, organic matter 0.98% that indicated poor organic matter content soil, field capacity of soil 28.5%, permanent wilting point of 13% and bulk density of 1.49 g cm-3 were observed at the experimental plot. Available reports indicate that most soils of Bangladesh have low organic matter content. About 70% of the net cultivable areas in high and medium-high lands have a soil organic matter content of less than 2% (Banglapedia 2021).

Climatic parameter

Climatic parameter like monthly decade wise average maximum-minimum temperature and average total rainfall of the study area are shown in figure 1. Temperature data are collected from the experimental plot and rainfall data are collected from weather station of Agricultural Research Station, BARI, Ishurdi which is located around 300 meter distance from the experimental plot. Precipitation is very low and unevenly distributed. In this area of Bangladesh, winter crops are fully dependent on irrigation except pulses crop. Post-sowing irrigations are required for pulse crops when seeds are sown using both conventional and deep tillage methods. However, strip tillage systems do not require post sowing irrigation for soil moisture utilization.

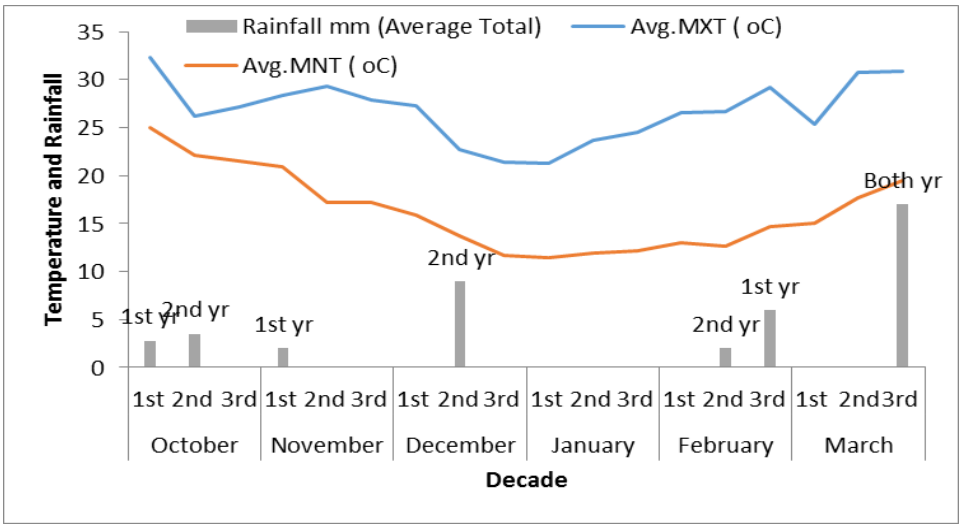

Fig. 1. Climatic parameter of growing period

Soil moisture determination

Soil samples were taken from the effective root zone of the lentil plant, which is 0 - 45 cm. The root zone was divided into three sections, *viz.* 0 - 15, 15 - 30 and 30 - 45 cm. Soil samples were collected from these three sections with the help of an auger. Collected sample was mixed each other's and the fresh weight of the soil sampled was recorded immediately with the help of a portable weighing balance. After being weighed, the samples were stored in soil sampling cores, which were then placed in an electric oven for 24 h at 100°C. The dry weight of the samples was recorded after oven drying. Soil moisture contents were then calculated as under:

$$Soil\ moisture\ content(\%) = \frac{Fresh\ weight\ of\ soil\ sample}{Dry\ weight\ of\ soil\ sample} \times 100$$

Water table depth was also measured about 9.62 m in dry season (Mid-January to April) and day by day declining.

Treatments and experimental design

Four row spacing (S_1= 20cm, S_2= 25cm, S_3= 30cm, S_4= 40cm) and three varieties (V_1= BARI Masur-8, V_2= BARI Masur-7, V_3= BARI Masur-6) were assigned in a factorial Randomize Complete Block Design with three replications. In this study skip the harmony of selection row spacing because of handling BARI strip tillage machine. Use row spacing 40 cm instead of 35 cm cause the limitation of furrow opener arrangement and maintain 35 cm row spacing. The furrow opener arrangement for different row spacing are shown in figure 2. The number of line for different row spacing like 20 cm, 25 cm, 30 cm, and 40 cm is 6, 5, 4 and 3 lines respectively. Seeding operation can be done by using inclined plate type seeding mechanism. Lentil are sown in continuous seeding system by this machine.

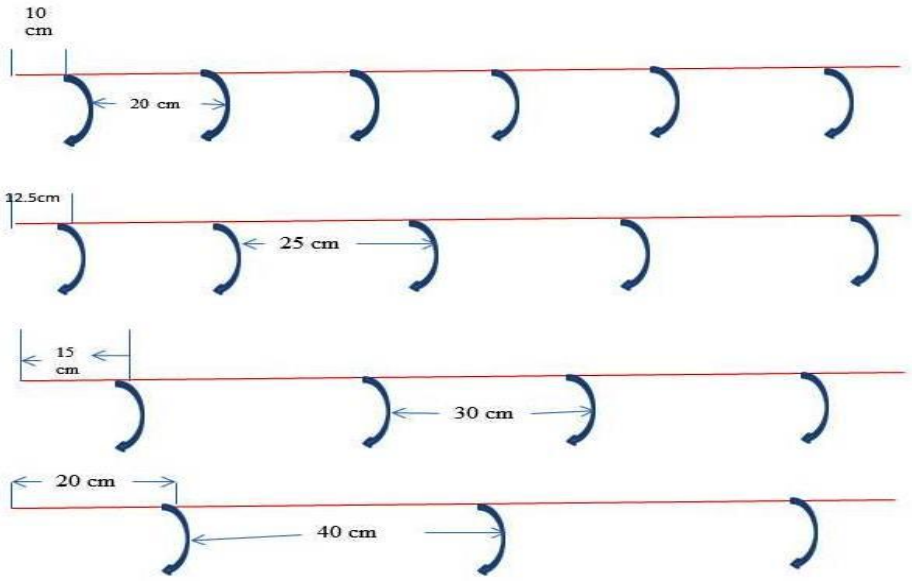

Fig. 2. Furrow opener arrangement for different row spacing

Fertilizer management

The crop was fertilized with 40-40-40-55-10 kg ha-1 as form of urea, murieate of potash, gypsum, boron, respectively. Only DAP (Di ammonium phosphate) was applied with machine and other fertilizer was broadcasted in land surface before seeding operation. Glyphosate @ 6ml per litter of water was sprayed before one day of seeding operation.

Cultural practices

Seed of different selected varieties of lentil were sown in the unit plot of size of 10 × 6 m by BARI developed strip tillage seeding machine. In strip tillage system maintained 20 cm, 25 cm, 30 cm and 40 cm distance between two rows. In strip tillage system, rotating blades were reduced where 4 blades in a face to face configuration remain in the gang at front position of seed furrow opener for tilling in strip 4 cm to 6 cm and creating tilt soil just in front of furrow openers. Between the two furrow openers the soil remained untilled. Strip tillage seeding system that utilizes residual soil moisture by tilling the soil just in front of furrow opener and place seed, and fertilizer in line at the appropriate depth in a single operation just after monsoon rice harvest. Monsoon rice residue was also used and maintain height 20–25 cm for lentil. At the sowing condition soil moisture was recorded 27.5% in first year and 29% in 2nd year. Lentil seeds were sown on 6th November and harvested on 4th March in both years. All the agronomic practices were carried out uniformly. The seed yield was recorded after harvest from unit plot size 5 × 6 m. Data was analyzed by using R software.

Results and Discussions

Machine performance on lentil

Total time requirement and fuel consumption of BARI strip tillage machine for lentil seed sowing are given in figure 3. These result was found 66% lower time with 68% of lower fuel than that of conventional tillage for lentil where using two wheeler. The conventional tillage performance data are collected from secondary sources of different research paper. In conventional tillage system, lentil cultivation was required time about 18.5 hr/ha and about 17.5 li/ha of fuel (Zaman et al., 2019). In strip tillage seeding, 57% lower fuel consumption were recorded than conventional tillage (Hossain et all,.2014).

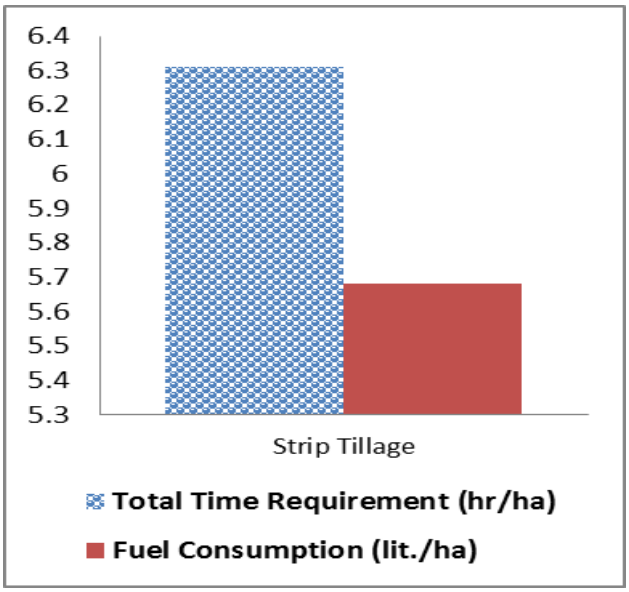

Fig. 3. Machine Performance on lentil

Performances of lentil varieties under strip tillage system

Effect of seed yield and plant population on different varieties were shown in figure 4. From the results, it was found that plant population was statically identical among the varieties but yield varied significantly. The highest seed yield was recorded from BARI Masur-8 which was significantly different from other variety and lowest from BARIMasur-6.

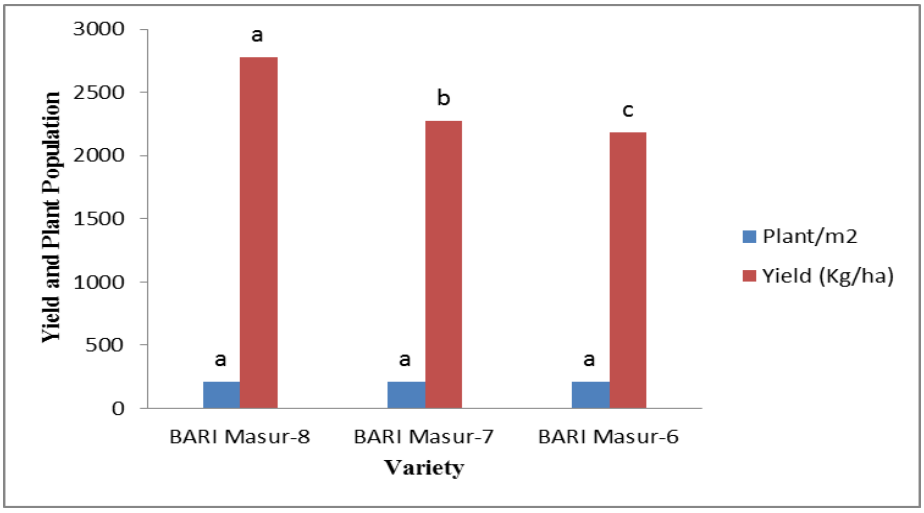

Fig. 4. Performance of different varieties on strip tillage

Relation between row spacing and seed yield

Row spacing and seed yield relations are shown in figure 5. The result was observed that plant population was decreased with increasing the row spacing for all variety. The plant population was observed about 220, 211, 200 and 194 at 20 cm, 25 cm, 30cm and 40cm respectively. Similar trend was observed in case of seed yield. Among the spacing 20 cm row spacing gave highest seed yield for all variety due to higher plant population.

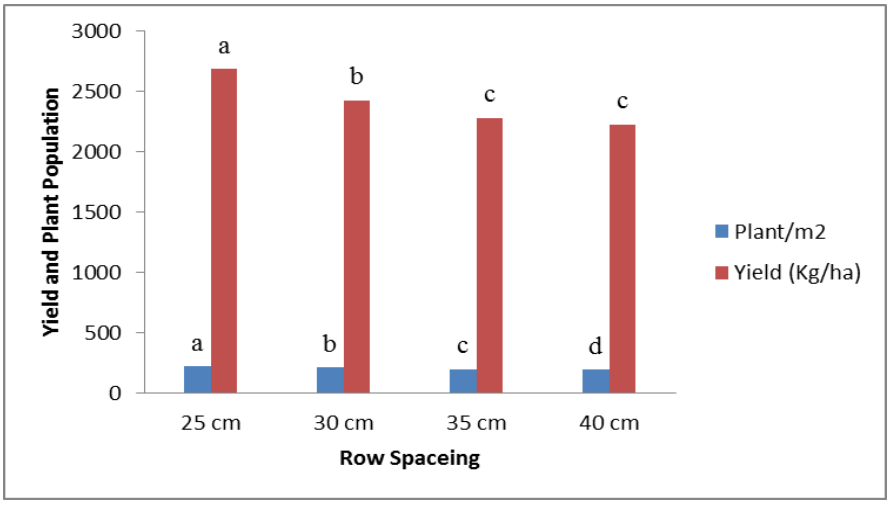

Fig. 5. Relation between row spacing and seed yield

Combined effect of spacing and varieties on strip tillage lentil

Combined effect of spacing and varieties are described in Table 1.

Plant population

The variation of plant per square meter was obtained S1 > S2 > S3 > S4. There was a trend to decrease plant population with the increase of row spacing in all the variety. Population did not influence any of the variety. Optimum row spacing have optimally utilized the growth resources, particularly solar radiation as compared to narrow row spacing where plants might have suffered due to mutual shading in case of adjoining rows and more plants within case of wider spacing. Optimum plant population density in lentil is an important factor for realize the potential yields as it directly affects plant growth and development (Turk *et al.*, 2003).

Pod per plant

Different row spacing significantly influenced number of pods /plant and seed yield of lentil. From this study, highest pod per plant was observed in highest row spacing treatment. Highest pod per plant was observed at BARI Masur-8 for all row spacing. The variety BARI Masur-6 and 7 showed similar trends in pods/plant but much lowers than former variety. Higher spacing can be related to intensify completion of plants and the decrease in over ground space for light interface.

Seed weight

Thousand seed weight of different varieties on different row spacing are given in Table 1. There were no significant variation was found. Seed weight was identically among the treatment.

Seed yield per hectare

Seed yield variation was obtained among the selected lentil varieties and different row spacing. The trend of seed yield was recorded as follows: BARI Masur-8 > BARI Masur-7 > BARI Masur-6. From the results, seed yield was decreased with increasing row spacing for all varieties. This could be clarified by the dominant effect of terminal bud lessens at lower densities and plants produce more auxiliary branches. So, they have better conditions for utilizing environmental conditions and produce more flowers. Consequently, increases pod number per plant. The increasing of row spacing is directly decreased plant population that leads to yield reduction.

From above results, it could be concluded that, BARI Masur-8 is found suitable than others lentil varieties due to steam blight tolerance and vigorous growth characters. There was no significant yield different between 20 cm and 25 cm row spacing for BARI Masur-8 except others combination. The result supports that 25 cm row spacing for BARI Masur-8; 20 cm for BARI Masur-6 and BARI Masur-7 are more suitable row to spacing at strip tillage seeding system. This results are consistent with the results of the of Idri's (2008) on faba been and Seyyed et al. (2014) on lentil that indicated increasing plant spacing increased number of pods per plant and consequently gave the highest seed yield.

Table 1. Combined effect of spacing and varieties on strip tillage lentil

(Pooled average of 2019-2020 and 2020-2021)Treatment	Plant per m^2	Pods/plant	1000 seed weight (gm)	Seed yield (kg/ha)
V1 XS1	221 a	115 abc	19.79	2930 a
V1 X S2	212 abc	134 ab	19.94	2943 a
V1 XS3	201 ef	135 a	20.38	2670 b
V1 X S4	193 f	136 a	20.11	2563 bc
V2X S1	221 a	110 c	20.89	2443 cd
V2X S2	212 bc	112 c	20.78	2286 de
V2XS3	199 ef	112 c	20.95	2190 ef
V2XS4	195 ef	112 bc	21.40	2187 ef
V3X S1	220 ab	109 c	19.79	2670 b
V3XS2	211 cd	111 c	20.89	2037 fg
V3XS3	202 de	110 c	21.12	1973 g
V3XS4	197 ef	112 c	21.50	1913 g
LSD (0.05)	8.83	22.09	2.05	160.41
CV%	4.88	11.12	NS	3.95

Spacing (S_1= 25cm, S_2= 30cm, S_3= 35cm, S_4= 40cm) and three varieties (V_1= BARI Masur-8, V_2= BARI Masur-7, V_3= BARI Masur-6)

Soil moisture profile

The Soil moisture profile of different experimental plot is shown in figure 6 (a-d). From the figure, it was found that there was no significant variation was found among the varieties as well as row spacing plot. Soil moisture was gradually decreased from sowing to harvest period for all variety at entire row spacing. Lentil faced permanent wilting point after 75 DAS.

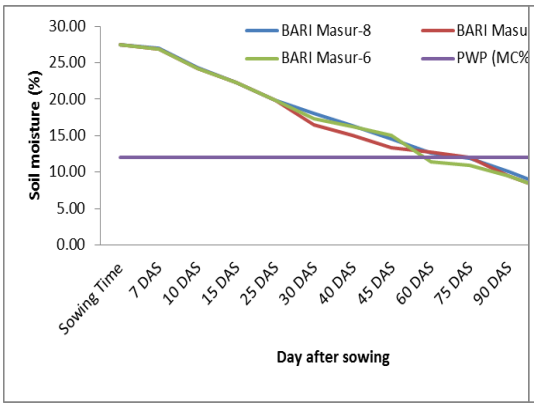

Fig. 6a. 20 cm row spacing plot

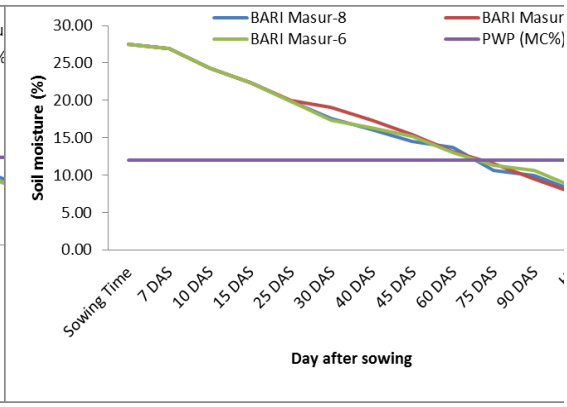

Fig. 6b. 25 cm row spacing plot

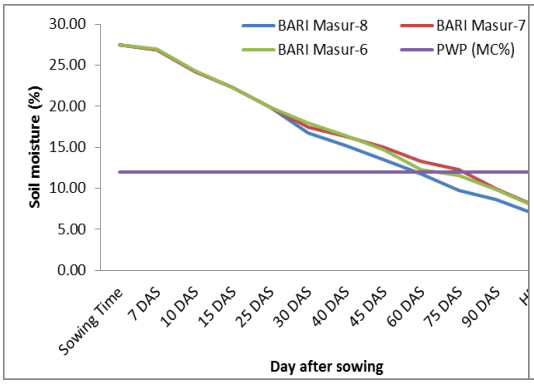

Fig. 6c. 30 cm row spacing plot

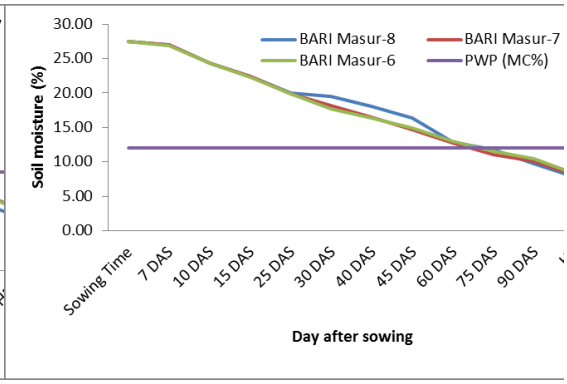

Fig. 6d. 40 cm row spacing plot

Fig. 6. Soil moisture profile of different experimental plot

Conclusion

From the study, the seed yield of lentil could be improved by seeding at optimum density. So, 25 cm row spacing for BARI Masur-8; 20 cm for BARI Masur-6 and BARI Masur-7 for lentil could be suitable row spacing at strip tillage seeding system. But lentil var. BARI Masur-8 could be cultivated under strip tillage seeding system for higher productivity in Ishurdi region.

Conflicts of Interest

The authors declare no conflicts of interest regarding publication of this paper**.**

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