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Mustard production with different tillage practices at Jamalpur

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ABSTRACT

Agricultural farming is a complex system that requires ongoing interactions throughout time between all of its various components. An investigation in the field was carried out in the Jamalpur region to expand the production area under the Charland ecosystem and evaluate the efficiency of various tillage techniques in mustard cultivation. On basis of seeding techniques three treatments were taken. The first one was minimum tillage with BARI seeder in single pass tillage and then sowing (T_1), the 2nd one was tillage by BARI seeder and then sowing manually in line (T_2) and the 3rd one was conventional tillage operation by two wheel tractor then broadcasting (T_3) and each of them was introduced with five replications. BARI Sarisha-14, a promising variety of mustard released by BARI (Bangladesh Agricultural Research Institute) was used as test crop. Tillage practices showed positive effects on yield parameter characteristics and mustard yields. The highest yield (1.5 tha^{-1}) of BARI Sarisha-14 was achieved under least tillage conditions using a BARI seeder in a single pass of tillage and seeding, based on the information collected. Minimum tillage technology in mustard production is acceptable to the farmer. So, this technology should be practiced on broader scale in mustard production in Jamalpur region.

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I. Introduction

Agriculture is the backbone of Bangladesh, supporting the livelihood of most of the population (MoA, 2021). About 13% of GDP and 40.6% of the workforce are employed in agriculture (Economic Survey, 2022). The acreage was used for mustard agriculture (66.21%), followed by soybeans (11.67%), groundnuts (8.06%), sesame (6.61%), coconut (6%), linseed (1.05%), and sunflower (0.42%) (BBS, 2022). Mustard has become the dominant oilseed crop in Bangladesh, about 80% of the total oilseed area and contributing to more than 60% of the total oilseed production (Monayem Miah and Afroz, 2015). It has been widely cultivated in this country and leads concerning area and production. In

emerging economies such as Bangladesh, the agriculture industry faces a critical problem in adapting to the consequences of climate change while satisfying food demand (Brouziyne et al., 2018; FAO, 2013). Many cropping patterns in Bangladesh allow for the cultivation of more oil crops without demanding significant modifications or the replacement of current ones, resulting in significant developments in both productivity and farmer profitability (Kamrozzaman et al., 2015). The cropping pattern in an area depends largely on agro-climatic, technical and institutional factors (Kakon et al., 2022). There is very little scope for increasing cultivable land. However, there are scopes of increasing cropping intensity from 190% to 250% by improving the present cropping pattern by incorporating short duration crops like mustard in the existing cropping pattern in different unfavourable ecosystems (Kakon et al., 2022). The area under mustard is shortening due to less time window before boro rice cultivation.

Mechanized tillage equipment became available in the nineteenth century during the Industrial Revolution, whereas the majority of tillage or cultivation equipment was operated by human labor or animal draft power during the primitive stage (Friedrich et al., 2012). Massive soil surface degradation from deep tillage gives rise to ideas such as using seeding machinery to sow seeds without tillage (Farooq et al., 2011; Friedrich et al., 2012). Timely sowing of rabi crops will be possible with BARI seeder (Roy et al., 2004; Hoque and Gathala, 2018). Thus, there is a growing trend of farmers adopting power tillers operated seeders, which can achieve land preparation and seeding in one pass. The BARI seeder is a single-pass shallow-tillage seed drill with an inclined plate seeding mechanism that is being commercially sold in Bangladesh. This is 120 cm wide, allowing four rows of mustard at 30 cm spacing having 0.14–0.20 ha/h field capacity (Hoque and Gathala, 2018). This seeder uses 48 rotary blades (bent C shape) accomplishes three operations in a single pass (Hoque et al., 2021b), including tillage (up to 5 cm), placement of seed in a T inverted furrow opener (Hoque et al., 2021a), and seed covering by a post-furrow opener roller bar (Islam et al., 2010; Hoque and Gathala, 2018). In conventional agriculture, land preparation takes about two weeks (Hoque and Gathala, 2018). The seeder also showed better performance for sowing seeds (Hoque et al., 2009; Hoque and Miah, 2015), which can be used for small to large seed sowing and planting (Hoque and Karim, 2016).

To succeed in the crops where field crops such as mustard are grown, a good seed bed should be determined by determining the most suitable soil tillage method for seed sowing (Sojib, 2021)). The alternative tillage methods for mustard cultivation are due to environmental concerns and cost involved many researchers and found better yield performance in reduced tillage than conventional tillage (Jain and Jha, 2012; Shilpa et al., 2022). Salahin et al. (2022) also found a better yield of mustard in strip tillage than conventional with BARI Sarisha 14. Soil cultivation methods are to be used according to soil structure, plant harvested before cultivation, plant to be cultivated and existing mechanization (Ioan and Gerard, 2009). Therefore, an experiment was conducted to determine the best tillage techniques for producing mustard in Jamalpur region.

II. Materials and Methods

The field experiment trial was executed in farmers' field of Joyrampur and Nauvangar char at Jamalpur sadar, also Manki and 5 no char at Melandha, Jamalpur, Bangladesh during rabi season cultivation years of 2023-24. The program was laid out in Agro-Ecological Zone 8 (Young Brahmaputra and Jamuna Flood Plain). This experiment comprised three treatments, namely, i) T_1 = Minimum tillage, single tillage and the sowing operation performed at once by power tiller operated inclined plate planter (PTOS); ii) T_2 = BARI seeder and then sowing manually in line; and iii) T_3 = Conventional tillage practice (farmers practice), usually three to four passes tillage of power tiller followed by 2-3 laddering. The design of the experiment was RCBD method having five replications. Labour-intensive and time-consuming conventional methods of cultivation take more time to prepare the land and sowing seeds, but mechanized cultivation with BARI seeder machines saves time because the rotary blade shaft of the seeder machine rotates at high speed.

Experimental location and climatic condition

The field experiments were conducted during the cultivation years 2023-24 in the farmer's field (Table 01) for the rabi season. The same design, management procedures, and preferences were used throughout the experiment. Sub-tropical, semi-arid monsoon weather with significant annual rainfall variations characterizes the overall climate (Figure 01).

Table 01. Summary of the characteristics of the study site

Characteristics	Details
Location	Joyrampur and Nauvangar char at Jamalpur sadar, also Manki and 5 no char at Melandha, Jamalpur, Mymensingh division
Texture class	Silt clay loam
Soil type	Calcareous clay flood plain
Location	24°56'11''N latitude and 89°55'54''E longitude and an altitude of 16.46m
	1049.45 mm, medium level.
Rainfall	Concentrated in monsoon season (June to September)
	236 mm (on average) (November to January, pick period)
Drainage	Moderate
Temperature	Maximum, 34.6°C and minimum, 11.9°C . Average 23.25° C
Humidity	78.48

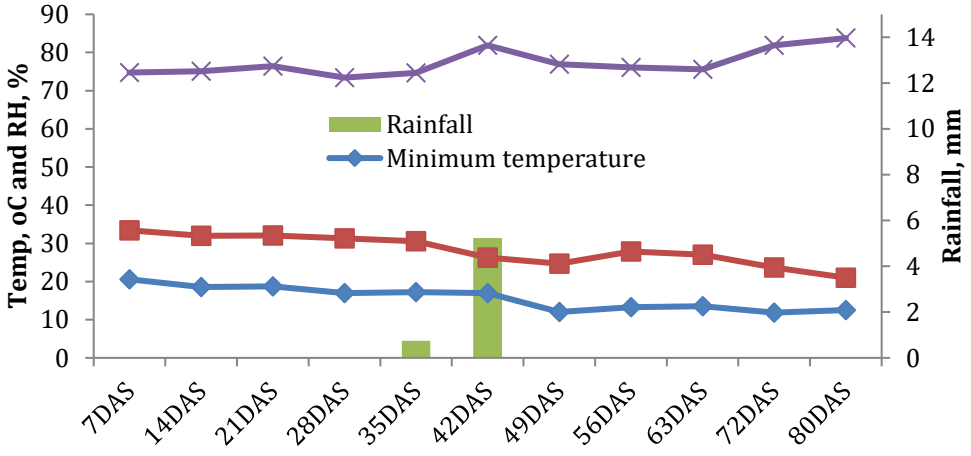

Figure 01. Weather data of Jamalpur during the crop duration

The initial soil and other characteristics details of the study site are given in Table 02. The same design, management procedures, and preferences were used throughout the experiment. Sub-tropical, semi-arid monsoon weather with significant annual rainfall variations characterizes the overall climate.

BARI Sarisha-14 was selected as an experimental crop variety. Design of experiment was factorial with five replications. For each replication, one farmer field (1 bigha) was selected. Fertilizer was applied @ 60-50-100-40-3-1.5 N-P-K-S-Zn-B, through Urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid, respectively (Based on FRG 2018). Half-N and full quantity of other fertilizers were applied as basal during final land preparation. Remaining fertilizers were top-dressed at flowering stage after irrigation. Data regarding yield attributes were collected from 10 randomly selected plants from each plot at maturity. Final yield data was recorded after harvest of crop on whole plot basis. Depending on the crop's maturity, harvesting dates varied. Data collected on yield and yield attributes were analyzed and mean separation was done at a 5% level of significance by HSD test.

Table 02. Soil characteristics of experimental four sites

Sample	pH	OM, %	OC %	K m_{eq} $100g^{-1}$	Total N %	P	S	B	Zn
						µg g^{-1}			
Nauvangar char	8	0.58	0.34	0.16	0.029	9.26	1.57	0.36	0.17
Joyrampur	7.9	0.59	0.34	0.19	0.03	7.42	12.42	0.3	0.19
Manki	7.9	0.53	0.31	0.18	0.027	18.14	34.13	0.33	1.11
5no Char	8	0.52	0.30	0.14	0.026	20.01	4.38	0.37	0.47
Critical level	-	-	-	0.12	-	10	10	0.2	0.6
Interpretation	Acidic	Low	V. low	High	V. low	Opt.	Opt.	Low	Low

III. Results and Discussion

Table 03 shows the effects of seeding treatments and locations on plant height, number of primary branches per plant, pod length, number of seeds per pod, and seed output per hectare. For both yield and yield contributing characteristics of BARI Sarisha-14, the interaction effect of location and seeding treatments was determined to be insignificant. At Jamalpur, there was no relationship between location and the yield-contributing characteristics of mustard. This might occur because all trial sites have comparable environments and soil textures. Oil seed crops can be grown on the silty clay loam soil found in the calcareous clay flood plain with one pass seeding technique that can be achieved with BARI seeder.

Table 03. Effect of locations and seeding treatments on yield and yield contributing characters of mustard.

Locations	Treatment	Plant height (cm)	Primary branch (No)	Siliqua/ plant (No)	Siliqua length (cm)	Seeds/ siliqua (no)	Yield, kg/ha
5 no Char		82.61	4.97	96.19	3.99	32.92	1428.40
5 no Char	T_1	81.42	5.14	101.06	3.96	34.18	1397.80
5 no Char	T_2	84.70	5.46	98.68	4.04	32.52	1459.00
5 no Char	T_3	81.70	4.32	88.84	3.96	32.06	1428.40
Joyrampur		84.12	4.97	98.41	4.03	35.15	1478.53
Joyrampur	T_1	85.06	5.36	113.82	4.00	38.72	1527.40
Joyrampur	T_2	85.20	5.30	96.34	4.12	36.58	1526.00
Joyrampur	T_3	82.10	4.24	85.08	3.98	30.16	1382.20
Manki		82.83	4.86	97.79	4.05	34.45	1482.20
Manki	T_1	84.58	5.58	108.14	4.14	38.52	1545.20
Manki	T_2	81.12	5.18	97.18	4.02	33.82	1466.20
Manki	T_3	82.78	3.82	88.04	4.00	31.02	1435.20
Nauvangar char		83.13	4.65	98.04	3.98	33.42	1457.60
Nauvangar char	T_1	85.26	4.76	108.62	4.00	37.10	1500.20
Nauvangar char	T_2	83.92	5.04	102.00	3.94	31.28	1447.40
Nauvangar char	T_3	80.20	4.16	83.50	4.00	31.88	1425.20
HSD		L=NS T= NS L*T=NS	L=NS T=0.60 L*T=NS	L=NS T=7.90 L*T=NS	L=NS T= NS L*T=NS	L=NS T=2.75 L*T=NS	L=NS T=52.60 L*T=NS
CV		5.67	16.16	10.55	5.25	10.56	4.69

Plant height and siliqua length were not statistically varied with seeding techniques of BARI Sarisha-14 (Figure 02). Number of primary branches was significantly varied with seeding techniques. The highest branch was found in T_1 which was statistically similar to that in T_2. The lowest primary branch was found in T_3. The siliqua per plant was highest in T_1 followed by T_2 and T_3. The highest seed per siliqua was found in T_1. The lower seeds per siliqua were found in T_2 and T_3. The highest seed yield of mustard was found in field sown by BARI seeder (T_1), which was statistically similar to that found in field sown manually tilling with BARI seeder (T_2). The lowest seed yield was found in farmers' practice (T_3). Lower mustard seed yield with conventional tillage practiced by the farmers was also found by Salahin *et al.* (2022), Shilpa *et al.* (2022), Tarwariya and Rajput (2019). To meet up the edible oil requirement of the country, mustard production should be increased, which is possible by proper tillage cum seeding practices as found in this research. BARI seeder accounted minimum time for seeding and also cost (Hoque and Miah, 2015). The most crucial task in agricultural crop production is soil tillage, which can greatly enhance soil aggregation, encourage crop root growth, and help reduce soil erosion (Jin et al., 2023 and Mosaddeghi et al., 2009). Farmers aim for uniform crop establishment, which can ultimately enhance yield (Håkansson et al., 2002). The process of germination depends on the direct contact of seeds with the moist soil aggregates surrounding them, which allows the seeds to absorb water. Larger aggregate-dominated seedbeds are inappropriate for most crop cultivation because of the restricted emergence capacity of the seedling and decreased establishment brought on by less seed-soil contact (Blunk et al., 2018). The BARI seeder often generates a suitable environment for crop establishment, with excellent seed planting and a fine tilth of soil except in extremely wet conditions (Hossain et al., 2009). Thus, government is giving a subsidy to BARI seeder to increase mustard production in a shorter

time between the two rice (Aman and Boro) ensuring a reduction in turnaround time and an increase in productivity.

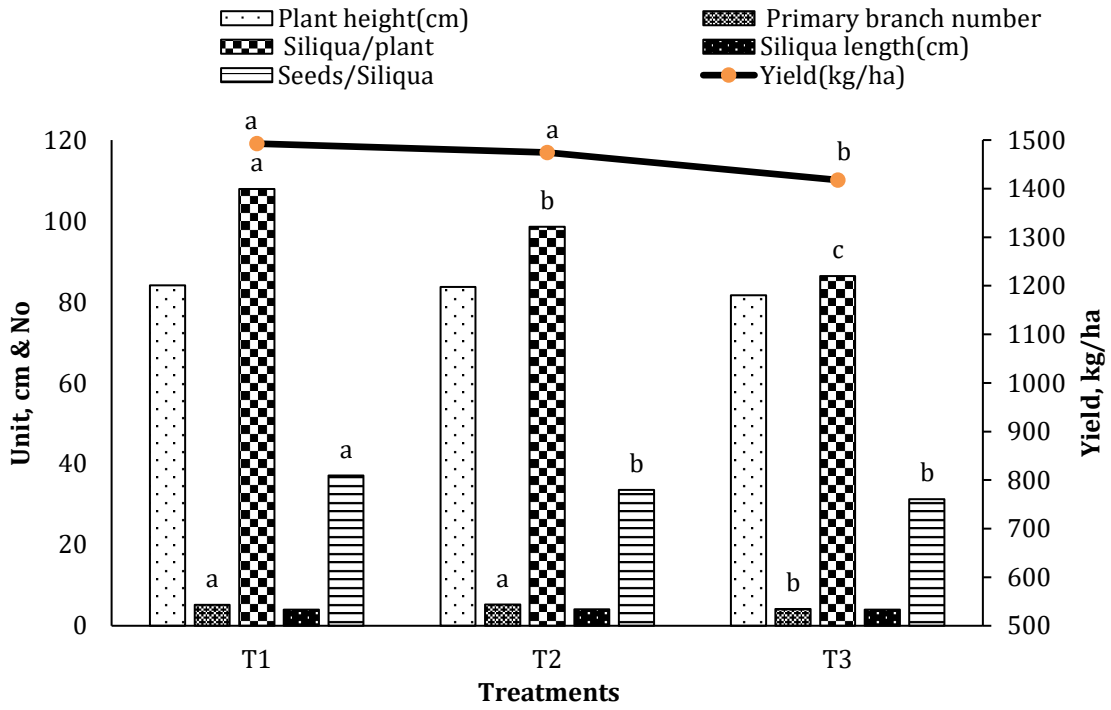

Figure 02. Individual effect of tillage and sowing treatments on yield and yield contributing characters of mustard.

IV. Conclusion

Future difficulties will include ensuring food safety for a large number of people and reducing the significant effects of climate change. In these circumstances, various tillage techniques help preserve smallholder farmers' natural resources and promote sustainable agricultural productivity by using the fewest inputs. The different seeding techniques showed that the highest seed yield and yield contributing characteristics in mustard could be found with BARI seeder. Therefore, minimum tillage practice was found to be most suitable tillage practice to get the highest yield of mustard. Future research should be conducted to see the long-term effect of using reduced tilled seeding techniques on soil fertility, biodiversity and sustainability. Performance of the machine will not be reflected at the mass level if intensive training of the operators cannot be provided. The policy's conclusion is that the government should establish a comprehensive strategy for these farming methods' wider distribution and field-level adoption. Enhancing farmers' knowledge and abilities through interactive training and technology shows with financial incentives should also be emphasized.

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