



# Assessment of High-yielding Rapeseed-mustard Varieties in Haor (Wetland) Ecosystem for Development of Mustard-Boro Rice-Fallow Pattern in Sylhet Region of Bangladesh

Subrato Debnath<sup>1</sup>, Mohammad Noor Hossain Miah<sup>2</sup>, Mrityunjoy Biswas<sup>3</sup>,  
Mozammel Hoque<sup>2</sup> and Rafat Al Foyal<sup>2\*</sup>

<sup>1</sup>Department of Agricultural Extension, Fenchuganj, Sylhet, Bangladesh.

<sup>2</sup>Department of Agronomy and Haor Agriculture, Sylhet Agricultural University, Sylhet- 3100, Bangladesh.

<sup>3</sup>Department of Agro Product Processing Technology, Jashore University of Science and Technology, Jashore-7408, Bangladesh.

## Authors' contributions

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** To assess the suitability of short duration high yielding rapeseed-mustard variety(s) cultivation in the haor (wetland) areas.

**Study Design:** Randomized complete block (RCB).

**Place and Duration of Study:** Farmers' field of Lalakhal, Jaintapur Upazila of Sylhet, Bangladesh during November 2014 to February 2015.

**Methodology:** The treatments included in the experiment were seven rapeseed-mustard varieties viz. i. Tori-7, ii. BARI sarisha-13, iii. BARI sarisha-14, iv. BARI sarisha-15, v. BARI sarisha-16, vi. advanced line Nap-205 and vii. BINA sarisha-4. Design of the experiment was randomized complete block (RCB) with three replications.

**Results:** The results revealed that BARI sarisha-16 produced the highest seed yield ( $1.99 \text{ t ha}^{-1}$ ), but it took the maximum days (92) to maturity. The variety BARI sarisha-15 produced the second highest seed yield ( $1.78 \text{ t ha}^{-1}$ ) closely followed by BINA sarisha-4 ( $1.75 \text{ t ha}^{-1}$ ) and BARI sarisha-13 ( $1.68 \text{ t ha}^{-1}$ ). The lowest seed yield ( $1.53 \text{ t ha}^{-1}$ ) was obtained from the variety Tori-7 which was statistically similar to that of BARI sarisha-14 ( $1.59 \text{ t ha}^{-1}$ ) and Nap-205 ( $1.68 \text{ t ha}^{-1}$ ). Tori-7 took the minimum days (74.7) to maturity while BARI sarisha-15 took 77.7 days.

**Conclusion:** Variety BARI sarisha-15 could be a good option for haor areas for cultivation in medium low land before Boro rice after recession of rainwater, as it took less duration to maturity (77.7 days) with good seed yield ( $1.78 \text{ t ha}^{-1}$ ).

*Keywords: Rapeseed-mustard; haor (wetland); yield.*

## 1. INTRODUCTION

Every year Bangladesh imports a huge amount of edible oils to meet-up the requirement. The country produces about 0.36 million tons of edible oil per year and total amount of oil requirement is 1.4 million tons [1]. The country has to spend a huge amount of foreign exchange on imports of edible oils and oilseeds to meet the increasing demand of its population. Bangladesh has to import about 2,539 metric ton of mustard worth Tk. 33 crore in 2014- 2015 [2]. The values of imported edible oils and oilseeds were USD1574 million and USD354 million in 2014-2015, respectively (Bangladesh Bank, 2016) [3]. To reduce the expenditure of foreign currency for importing edible oil, domestic production should be increased as far as possible.

Mustard covers 80% of the total area under oilseed crops in Bangladesh and attains first position among oilseed crops [4]. Per hectare total cost and net profit of mustard production are about Tk. 62,527 and Tk. 38,718, respectively [5]. The land use statistics of Sylhet region showed that about 260,000 acres land remain fallow in 2016-2017 [6]. In Sylhet region, Fallow-Boro rice-Fallow is the most dominant cropping pattern and covers 39.64% of net cropped areas [7]. A considerable area of land remains fallow during rabi season, thus, there is a large opportunity for accommodating short duration rapeseed-mustard varieties after recession of flood water, but before planting of boro rice in the haor niches. Since early flash flood causes severe crop loss (mainly rice) on most of the years, emphasis should be the plantation of early maturing (short duration) mustard variety to escape crop damage from early flash flood in the haor niches. Some farmer cultivates traditional Tori-7 variety repeatedly in this region and that's why its production rate is also decreasing day by day. This area has favorable production environments

which can boost oilseeds production in Bangladesh. Bangladesh Agricultural Research Institute (BARI) and Bangladesh Institute of Nuclear Agriculture (BINA) have developed a good number of improved rapeseed-mustard varieties. The adoption rate of these varieties at farm level is encouraging [8][9], created positive impact and saved foreign exchange [4]. Hence, there is a wider prospect of rapeseed-mustard cultivation in the present cropping patterns to improve the cropping intensity in this region.

Very limited research works have been conducted with regards to delineating the issues of mustard production in Sylhet region. Considering the fallow land and *haor* eco-system of Sylhet region this study have been designed to evaluate the performance of high yielding rapeseed-mustard varieties in the cropping pattern of Mustard-Boro rice-Fallow condition. Therefore, the study was conducted to identify suitable varieties of rapeseed-mustard that could be incorporated in the existing Fallow-Boro rice-Fallow cropping pattern in the haor niches of Sylhet.

## 2. MATERIALS AND METHODS

### 2.1 Location, Soil and Meteorology of Experimental Site

The experiment was conducted at the farmers' fields at Lalakhai (Afifa Nagar), Jaintapur, Sylhet districts during November 2014 to March 2015 to identify suitable short duration high yielding varieties of rapeseed-mustard that could be cultivated in the existing Fallow-Boro rice-Fallow cropping pattern in the haor niches. Soil samples were taken from surface layer (0-15 cm depth) from each plot of strip. Morphological and chemical characteristics of the soil were determined in the laboratory. Soil was deep brown sandy loam with pH 5.78 and organic matter of 0.125%. Total nitrogen (%) and

exchangeable K (mili mol 100g<sup>-1</sup> soil) were 2.16 and 0.15, respectively. Available P, S, B, Zn ( $\mu\text{g g}^{-1}$  soil) was 5.37, 18.38, 0.38, and 2.12, respectively. Meteorological data have been presented in the Table 1.

## 2.2 Treatment and Design

The treatments included in the experiment were seven rapeseed-mustard varieties viz. Tori-7 (*B. campestris*), BARI sarisha-13 (*B. napus*), BARI sarisha-14 (*B. campestris*), BARI sarisha-15 (*B. campestris*), BARI sarisha-16, advanced line Nap-259 and BINA sarisha-4 (*B. napus*). The experiment was conducted in randomized complete block design (RCBD) with three replications. Unit plot size was 4 m X 3 m.

## 2.3 Crop Husbandry

Three ploughing and cross ploughing were done followed by laddering to prepare the land. Unnecessary weeds, stubbles and plant residues were removed from the field. Fertilizers were applied at the rate of 120-36-90-27-6-3-0.8 kg ha<sup>-1</sup> of N-P-K-S-Mg-Zn and B, respectively as per Fertilizer Recommendation Guide-2012 of Bangladesh Agricultural Research Council (BARC, 2012). Half of the nitrogen and all other fertilizers were applied as basal and incorporated in soil during final land preparation. Seed was sown on 14 November, 2014 at the rate of 7-8 kg ha<sup>-1</sup> (depending on the variety) following broadcast method. Remaining half of the nitrogen was applied at the time of flower bud initiation at 25 days after sowing (DAS) as top dressing. Intercultural operations such as weeding, thinning, irrigation, spraying of insecticides were done uniformly in all plots. First weeding along with thinning was done at 23 DAS while 2nd weeding was done at 50 DAS. Thinning was done for maintaining an optimum plant population during first weeding operations. Two irrigation was applied at flowering stage at 25 DAS and pod filling stage at 55 DAS in plot wise that was followed by top dressing of nitrogen fertilizer. The insects were controlled effectively by spraying Sumithion 50 EC @ 1.0

Lha<sup>-1</sup>. Crop plants were harvested from each plot with sickle at full maturity (i.e. when 95% siliqua became yellowish). The harvested plants from each plot were tagged and bundled separately. The collected seeds were sun dried for five days to obtain seed moisture content of 10% to get optimum seed weight. The straw was also dried in the sun and seed and straw yields were recorded. The yield was converted in terms of t ha<sup>-1</sup> from the yield of harvesting area of 6 m<sup>2</sup>. The biological yield was calculated by summing the seed yield and straw yield.

## 2.4 Data Collection and Statistical Analysis

Data were recorded on days to flowering (50%), plant height (cm), plant population m<sup>-2</sup>, number of primary branches plant<sup>-1</sup>, number of siliqua plant<sup>-1</sup>, siliqua length (cm), number of seeds siliqua<sup>-1</sup>, 1000-seed weight (g), seed yield (t ha<sup>-1</sup>), straw yield (t ha<sup>-1</sup>), biological yield (t ha<sup>-1</sup>), harvest index (%) and days to maturity.

Biological yield and harvest index were calculated as follows.

Biological yield (t ha<sup>-1</sup>): The biological yield was calculated by the formula-  
Biological yield=Seed yield + straw yield

Harvest index (HI) (%): HI was calculated on the basis of grain and straw yield using the following formula [10].

$$\text{Harvest index \%} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Ten plants from each plot were collected to record data on yield attributes at harvest. Yield data was undertaken on individual plot-wise after threshing, drying and cleaning of seeds. Collected data were analysed statistically (except straw and biological yields where mean values were used) using R software and mean separation was done using Least Significant Difference (LSD) test at 5% level of significance wherever F was significant.

**Table 1. Meteorological data during the study period**

Months/Year	Average Temp. (°C)		Total rainfall (mm)
	Maximum	Minimum	
November 2014	31.2	18.9	Nil
December 2014	27.8	15.2	Nil
January 2015	27.2	14.8	16.1
February 2015	28.7	15.1	40.2
March 2015	33.1	18.7	28.6

### 3. RESULTS AND DISCUSSION

There were significant differences observed among the varieties in respect of all characters studied in the experiment except number of primary branches plant<sup>-1</sup> (Table 2). BINA sarisha-4 took maximum 34.0 days for 50% flowering which was statistically similar with the variety BARI sarisha-13 which took 33.0 days. BARI sarisha-14 took the minimum 30.3 days which was followed by the two varieties BARI sarisha-15 and NAP-205 both took 30.7 days (Table 2). The highest plant population (134.7 m<sup>-2</sup>) was found in the variety Tori-7 and BINA sarisha-4 produced the lowest number (59.0 m<sup>-2</sup>). Plant height showed significant variation among the varieties (Table 2). BARI sarisha-16 produced the tallest plant height (177.7 cm) followed by BARI sarisha-15 (117.9 cm) which was statistically similar with BARI sarisha-13 (115.9 cm) and Nap-205 (111.5 cm). BARI sarisha-14 produced the shortest plant height (105.7 cm). Jahan and Zakaria [11] and Mondal et al. [12] found similar result. They showed that variety had significant effect on plant height. Number of primary branches plant<sup>-1</sup> showed non-significant variation among the varieties (Table 2). The maximum number (6.0) of primary branches plant<sup>-1</sup> produced by BARI sarisha-15 which was followed by BARI sarisha-14 (5.7 plant<sup>-1</sup>) and lowest number (4.0 plant<sup>-1</sup>) was produced by NAP-205. BARI [13] observed that, rapeseed-mustard produced different number of primary branches plant<sup>-1</sup> in different management condition. Silique length (cm), number of silique plant<sup>-1</sup>, number of seeds silique<sup>-1</sup>, 1000-seed weight (g) and seed yield (t ha<sup>-1</sup>) were found significantly different among the varieties (Table 01). The longest silique was produced by Bina sarisha-4 (7.93 cm) which was followed by the varieties BARI sarisha-13 (7.57 cm), BARI sarisha-14 (6.27 cm) and NAP-205 (6.23 cm). The shortest silique (4.10 cm) was produced by BARI sarisha-16. Similar result was found by Hossain et al. [14] and they showed the longest silique (8.07 cm) in BLN-900 and the shortest (4.83 cm) in Hyola-401. The variety Tori-7 and BARI sarisha-14 was equally produced the highest number of silique plant<sup>-1</sup> (87.0) followed by both the varieties BARI sarisha-16 (78.3) and BARI sarisha-15 (74.7). The lowest number of silique plant<sup>-1</sup> (52.7) was produced by BARI sarisha-13. This result was partially similar with Mondal et al. [12] and Jahan and Zakaria [11]. They observed that the highest number of silique plant<sup>-1</sup> (130.9) in BLN-900 that was identical with that observed in Dhali (126.3) and Tori-7 had the lowest (46.3) number of silique plant<sup>-1</sup>. The number of seeds silique<sup>-1</sup>

significantly varied among the varieties (Table 3). The highest number of seeds silique<sup>-1</sup> (18.4) was produced by BARI sarisha-14 which was statistically identical with BINA sarisha-4 (17.5) and Tori-7 (17.4). The lowest number (11.9) of seeds silique<sup>-1</sup> produced by BARI sarisha-16 which was closely followed by BARI sarisha-15 (12.0). These results were closely similar with the result of Yadav et al. [15], Sharma [16] and Singh et al. [17]. They found cultivar Pusa Bold recorded higher number of seeds silique<sup>-1</sup> (14.02) as compared to cultivar local (11.15) in Jodhpur. Thousand-seed weight (g) significantly differed among the varieties (Table 3). The highest weight (3.90 g) of 1000-seed was found in NAP-205 which was closely followed by 3.70, 3.53 and 3.33 of BARI sarisha-13, BINA sarisha-4 and BARI sarisha-16, respectively. The lowest (2.73 g) of 1000-seed weight was found in Tori-7 and BARI sarisha-14. These results showed the partial similarity with the result of Karim et al. [18]. They found higher weight of 1000-seed in J-3018 (3.42) and J-4008 (3.50). BARI [19] concluded that there was significant variation in 1000-seed weight of mustard in different varieties. Seed yield differed significantly among the varieties (Table 3). BARI sarisha-16 produced the highest seed yield (1.99 t ha<sup>-1</sup>) which was closely followed by 1.78 t ha<sup>-1</sup> and 1.68 t ha<sup>-1</sup> produced by BARI sarisha-15 and BARI sarisha-13, respectively. The lowest seed yield (1.53 t ha<sup>-1</sup>) was produced by Tori-7 which was statistically similar with NAP-205 (1.56 t ha<sup>-1</sup>). Similar results were explained by Rahman [20] and stated that yield variation existed among varieties. The highest seed yield was observed in BARI sarisha-8 followed by BARI sarisha-11 (2.00-2.50 t ha<sup>-1</sup>) and the lowest yield was in the variety Improved Tori (0.95-1.10 t ha<sup>-1</sup>). Crop duration is an important trait in oilseed crop in Bangladesh and short duration varieties are more preferable to the farmers as these can be fitted in rice based cropping patterns. The crop duration (i.e. days to maturity) found significant variation among the varieties (Table 3). BARI sarisha-16 took maximum days (92.3) for maturity which was statistically similar with BINA sarisha-4 (87.0) and BARI sarisha-13 (86.3). Tori-7 took minimum maturity days (74.7) whereas BARI sarisha-14 and BARI sarisha-15 took 79.0 and 77.7 days, respectively. Maximum straw yield was obtained from BARI sarisha-16 (3.67 t ha<sup>-1</sup>) while Tori-7 gave the lowest straw yield (2.64 t ha<sup>-1</sup>). BARI [13] reported straw yield variation among the rapeseed-mustard varieties on the basis of management. In case of poor management,

**Table 2. Days to flower, some plant characters and yield attributes of rapeseed-mustard varieties in the haor ecosystem in Sylhet region**

Varieties	Days to flowering (50%)	Plant population m <sup>-2</sup>	Plant height (cm)	No. of primary branches plant <sup>-1</sup>	Length of siliqua (cm)	No. of siliqua plant <sup>-1</sup>
Tori-7	26.6d	134.7a	111.1b	4.3	5.90bc	87.0a
BARI sarisha-13	33.0ab	80.0c	115.9b	5.4	7.57a	52.7c
BARI sarisha-14	30.3c	83.7bc	105.7b	5.7	6.27b	87.0a
BARI sarisha-15	30.7c	102.0b	117.9b	6.0	5.20c	74.7b
BARI sarisha-16	31.0bc	73.3cd	177.7a	4.4	4.10d	78.3ab
Nap-205	30.7c	65.7cd	111.5b	4.0	6.23b	59.7c
BINA sarisha-4	34.0a	59.0d	109.5b	5.2	7.93a	58.0c
LSD <sub>0.05</sub>	2.07	19.78	13.95	NS	0.83	11.36
CV(%)	3.77	13.01	6.46	24.33	7.58	8.99

Note: NS = Not significant

**Table 3. Yield attributes, yield, maturity and harvest index of rapeseed-mustard varieties in the haor ecosystem in Sylhet region**

Varieties	No. of seed siliqua <sup>-1</sup>	1000-seed weight (g)	Seed yield (t ha <sup>-1</sup> )	Straw yield (t ha <sup>-1</sup> )	Biological yield (t ha <sup>-1</sup> )	Days to maturity	Harvest index (%)
Tori-7	17.4a	2.73d	1.53d	2.64	4.17	74.7e	36.75
BARI sarisha-13	15.0b	3.70ab	1.68b-d	3.02	4.36	86.3b	35.63
BARI sarisha-14	18.4a	2.73d	1.59cd	3.19	4.78	79.0cd	34.55
BARI sarisha-15	12.0c	3.03cd	1.78b	3.14	4.92	77.7d	36.14
BARI sarisha-16	11.9c	3.33bc	1.99a	3.67	5.66	92.3a	35.23
Nap-205	14.9b	3.90a	1.56d	2.87	4.43	80.7c	35.24
BINA sarisha-4	17.5a	3.53ab	1.75bc	3.44	5.19	87.0b	33.74
LSD <sub>0.05</sub>	2.36	0.45	0.18	MV	MV	2.37	NS
CV(%)	8.67	7.79	6.24	MV	MV	1.61	4.91

Note: NS = Not significant; MV = Mean values

Isd-local gave the highest straw yield (3.78 t ha<sup>-1</sup>) and the lowest yield (1.30 t ha<sup>-1</sup>) was found from Nap-248. In case of medium management, the highest weight (6.22 t ha<sup>-1</sup>) was in same variety and the lowest (3.70 t ha<sup>-1</sup>) from PT-303. The variety BARI sarisha-16 produced (5.66 t ha<sup>-1</sup>) the highest biological yield which was statistically identical with two varieties BARI sarisha-15 (4.92 t ha<sup>-1</sup>) and BINA sarisha-4 (5.20 t ha<sup>-1</sup>) in this experiment. The lowest biological yield was found in Tori-7 (4.17 t ha<sup>-1</sup>). There was no significant variation found in harvest index (%) among the varieties (Table 3). The highest harvest index was found in Tori-7 (36.75%) and the lowest was found in BINA sarisha-4 (33.74%).

#### 4. CONCLUSION

Among all varieties BARI sarisha-15 took less duration (77.7 days) for its maturity with satisfactory yield. The result obtained from the experiment suggests that after recession of

rainwater in the early November before planting of Boro rice in the haor niches, BARI sarisha-15 can be cultivated as it took less time to maturity as well as it gives good seed yield (1.78 t ha<sup>-1</sup>). BINA sarisha-4 had also potentiality of high yield (1.75 t ha<sup>-1</sup>) with duration 87 days which could be suggested for cultivation in this region. In haor ecosystem of Sylhet region the existing cropping pattern "Fallow-Boro rice-Fallow" can be developed as "Mustard-Boro rice-Fallow" cropping pattern which can help increasing the cropping intensity as well as production of oilseed.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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