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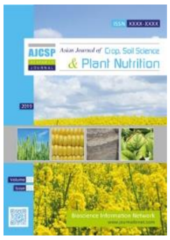

Comparative study of late maturity higher yielding mustard varieties in Satkhira

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ABSTRACT

The cultivation of oilseeds in Bangladesh is mainly dominated by rapeseed. The gap between the supply and demand of oilseeds may be closed by investigating both long- and short-duration rapeseed and mustard. This study's objective was to find suitable higher yielding late maturity rapeseed varieties in the Khulna region. The experiment was conducted at the farmer field of Nagarghat, Tala, Satkhira (AEZ-11) during the Rabi season in 2021-2022. There was a significant difference among all the studied characters for all tested varieties. BARI Sarisha-18 (100.67 days showed fewer days to maturity, whereas BARI Sarisha-11 (113.67 days) showed the maximum. The highest siliqua per plant was presented in Binasarisha-8 (308.89) and the lowest in BARI Sarisha-18 (212.22). SAUJR-001 exhibits the highest yield (2.12 tha^{-1}) and Binasarish-7 showed the lowest (1.64 tha^{-1}). SAUJR-001 followed by Binasarisha-8 may be selected for further cultivation for higher-yielding. The research's conclusions showed higher yielding late mature mustard varieties in Satkhira that cope with cropping patterns (Aman-Mustard-Jute/Sesame/Fallow).

Key Words: *Cropping pattern; Mustard; Late maturity; Varieties and Higher yield.*

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I. Introduction

Rapeseed and mustard belong to the Brassicaceae family and are significant edible oilseed crops in Bangladesh and the world's second-largest producers after soybeans (Rahman et al., 2022). Among the species, *Brassica napus* and *Brassica campestris* are regarded as ‘rapeseed’ while *Brassica juncea* is regarded as ‘mustard’. Bangladesh produces mustard and rapeseed, although both are sold and known as "mustard" in Bangladesh (USDA, 2022). The energy content of mustard seeds is considerable, with 28–45% oil and a comparatively high protein content (28–36%) by weight; nevertheless, these percentages might vary significantly throughout varieties, growing locations, and crop years (Sarker et al., 2021). Mustard oil is crucial for enhancing the taste of various dishes. Its oil is widely used as a flavoring and therapeutic element (Halim et al., 2023). Young leaves of plants are utilized as vegetables because they provide adequate minerals and Sulphur for a healthy diet.

Rapeseed and mustard account for around 11.7% of the world's total vegetable oil output (Statista, 2023). In Bangladesh, mustard is the most widely planted crop and is produced in the largest area throughout the winter months. The area planted with mustard has increased significantly in the last several years. Analyzing Bangladesh's existing domestic mustard production and future projections is essential to meet the growing demand. The current fiscal year of 2022–2023 presented Bangladesh generating 11.64 lakh tones of mustard oil seed, exceeding a goal of 11.12 tones because of an increase in area and higher yield (AIS, 2023). The oilseed mustard accounted for most of the cultivated area, more than 69.94% and provided 38.8% of Bangladesh's total oilseed output (BBS, 2019). Even with the increase in production rate relative to our needs, oil output remains unremarkable. Consequently, our nation imports significant oil and oil seeds every year. Increasing mustard output might be one way to lessen the disparity between the nation's supply and demand for edible oil (Tridge, 2023).

In Bangladesh, each consumes 10–12 grams of edible oil daily (Rahman et al., 2022). Over five years, Bangladesh's total dietary oil consumption grew by 36%, from 2.22 million tons in 2015 to 3.03 million tons in 2020 (Halim et al., 2023). According to (10 February 2023), the cost of importing mustard oil has increased significantly, going from BDT 2.42 million in 2006 to BDT 54.54 million in 2020. Indeed, 80% of the total area planted for oilseed crops is comprised of mustard alone (BBS, 2020). Thus, the importation of edible oils results in the yearly expenditure of a substantial amount of foreign currency. The primary causes of Bangladesh's poor mustard yield include a lack of high-yielding varieties, inadequate population density, and a lack of understanding of sowing techniques, planting time, and management practices (Mamun et al., 2014). The yield has been influenced by many environmental risk factors, such as drought, heavy metals, low or high temperatures, and salt stress (Rahman et al., 2022). If suitable high-yielding cultivars, soil topography, weather conditions, and enhanced management techniques are chosen, there is much potential to increase the production of mustard (Bhuiyan et al., 2011).

Fallow-Fallow-T. Aman is the predominant cropping pattern in the Khulna area of southwest coastal Bangladesh (Sarker et al., 2021). Following T. Aman's harvest, most of the land exists fallow due to excessive soil wetness, a shortage of fresh irrigation water, and a subsequent rise in soil salinity. As a short-duration crop, mustard may be added to the current cropping pattern in this area to improve fallow land use and crop intensity. Improved seed and biomass production in oilseed rape are mostly dependent on delayed maturity and duration of development (Diepenbrock, 2000). Oilseed rape that matures later yields more by generating more pods per square meter (Gomez and Miralles 2011). Late-maturing cultivars take more than 100 days to reach maturity, whereas early-maturing types need fewer than 80 days (Helal et al., 2016). So, this experiment was conducted to find higher yielding late mature mustard varieties in Satkhira that cope with cropping patterns (Aman-Mustard-Jute/Sesame/Fallow).

II. Materials and Methods

The experiment was conducted at the farmer field of Nagarghat, Tala, Satkhira (AEZ-11) during the Rabi season in 2021-2022. The experimental plot was medium-high and the soil was clay loam in texture. The location of the experimental site was at the High Ganges River Flood Plain (22.8875 N latitude and 89.5167 E longitude). Two BINA (Bangladesh Institute of Nuclear Agriculture) obtained from the BINA, Mymensingh and Two BARI (Bangladesh Agricultural Research Institute) received from the BARI, Joydepur, Gazipur mustard varieties, namely Binasarisha-7, Binasarisha-8, BARI Sarisha-11, and BARI Sarisha-18 with one promising line (SAUJR-001) were tested under natural growth conditions. An RCBD (randomized complete block design) with three replications was used to set up the experiment. The total number of plots was 18. The unit plot size was 3 m × 4 m. Seeds were sown in lines per treatment with 30 cm × 10 cm plant space. Mustard seeds were sown in rows on the 3rd of November. The plots received applications of Cowdung, Urea, Triple superphosphate, Muriate of potash, Gypsum and Boron at the rates of 10, 300, 300, 170, 100 and 150 kg ha^{-1} according to Fertilizer Recommended Guide (2018). During the last stages of land preparation, a basal dosage of Cowdung, Urea, Triple super phosphate, Muriate of potash, Gypsum, and Boron were all given. During the beginning of the flower initiation, the remaining urea was used. From 15 DAS till the final harvest, weeds were manually removed. To keep weeds out of the plots, weeding was done six times. For controlling aphids, Aktara (Thiamethoxam) 25 WG at 0.2 g L^{-1} was sprayed. Twenty-five days after planting, the first irrigation was carried out, and the second irrigation took place during the Pod formation stage. A random selection of ten mustard plants was made from each plot to gather data. Data collection did not include the plants in the outside rows or at the very end of the middle rows. Morphological and yield contributing parameters such as Days to maturity, Plant Height (cm), Primary Branches $plant^{-1}$, Secondary Branches $plant^{-1}$, Siliqua $Plant^{-1}$, Seed $Siliqua^{-1}$, Siliqua length (cm), 1000-seed weight (g), and Yield (tha^{-1}) were determined in the experiment. The fully grown crop from each plot was physically harvested and allowed to dry in the sun before being threshed by hand. Using the R version 4.2.1 program, the data were analyzed for variance analysis.

III. Results and Discussion

Days to Maturity

Regarding the days to maturity, there were significant variations among the varieties (Figure 01). Days to maturity play a vital role in higher yields. In this experiment, BARI Sarisha-11 showed the maximum days to maturity (113.67 days), followed by Binasarisha-7 (110.67 days), and the minimum days to maturity were shown by BARI Sarisha-18 (100.67 days), followed by SAUJR-001 (103.33 days) (Figure 01). A prolonged flowering time increases the potential yield (Oplinger, 1991). According to Jyoti et al. (2021), late varieties have longer reproductive phases, which results in more grain being produced per plant.

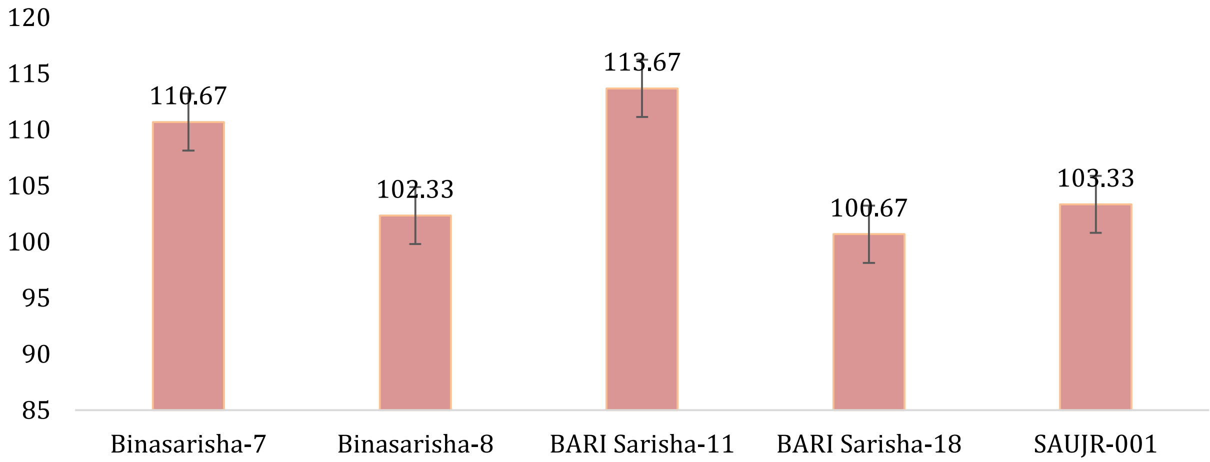

Figure 01. Days to maturity of five mustard varieties

Plant height

Plant height is a crucial morphological characteristic that is a reliable indicator of the proximity of growing resources. Throughout the growth season, the various cultivars significantly affected plant height (Table 01). In the case of plant height, SAUJR-001 showed the maximum (175.78 cm), followed by BARI Sarisha-11 (173.77 cm), and the minimum in Binasarisha-7 (151.56 cm). Numerous scientists have also documented similar variations in plant height between rapeseed/mustard types (Ahmed and Kashem, 2017; Roy, 2007; Zakaria and Jahan, 1997; Hossain et al., 1996). Yeasmin (2013) claimed that the varietal influence on plant height was not significant and disagreed with this conclusion.

Number of branches per plant

A significant correlation was found between the number of branches of $plant^{-1}$ and varieties of mustard (Table 01). The maximum number of primary branches per plant was shown by BARI Sarisha-18 (6.56), followed by Binasarisha-7 (6.44), whereas the lowest was in BARI Sarisha-11 (3.56). In the case of secondary branches per plant, Binasrisha-7 showed the maximum (20.67), followed by Binasarisha-8 (20.22), and the minimum was in SAUJR-001 (8.22). Laila (2014) reported a significant finding indicating that SAU SR-03 (5.20) had the maximum number of branch plants per variety, whereas BARI Sarisha-13 (2.92) had the lowest amount. There was a non-significant range, with BARI Sarisha-11 (5.00) being the highest branch and BADC-1 (4.73) showing the lowest branches per plant (Ahmed and Kashem, 2017).

Number of Siliqua per plant

Significant variations were observed in the number of siliqua plants per variety (Table 01). The highest siliqua per plant was shown in Binasarisha-8 (308.89) and the lowest was in BARI Sarisha-18 (221.22). Islam et al. (2015) also discovered a significant difference in the number of siliqua plant^{-1} across the varieties, with BARI Sarisha-16 (146) having the greatest number and BARI Sarisha-14 (44) having the lowest. According to Shamsuddin et al. (1987), there was a significant variation in the amount of siliquae plant^{-1} between rapeseed and mustard types, with mustard varieties exhibiting the largest number of siliquae. The greatest number of siliquae plant^{-1} (136) in variety J-5004 was discovered by Mondal et al. (1992); this number was the same for variety Tori-7. The cultivar SS-75 has the lowest number of siliquae plant^{-1} (45.9). The results of Mamun et al. (2014) are consistent with the observation that the varieties substantially impacted the number of siliqua plants^{-1} of mustard.

Number of seed per siliqua

The variation between varieties had a significant impact on the number of seeds per siliqua (Table 01). BARI Sarisha-18 showed the maximum number of seeds per siliqua (21.33), followed by SAUJR-001 (19.22) and the minimum was in Binasarisha-7 (12.67), followed by BARI Sarisha-11 (13.89). Significant variation was noted among 30 genotypes by Alam et al. (2014), with Nap-0538 having the maximum number of seed siliquae^{-1} (25.01) and BJDH-11 having the lowest (10.1); this result agrees with the present one. These conclusions correlate with Gurjar and Chauhan (1997) and Zakaria and Jahan (1997).

Length of siliqua

Significant variations were observed in the length of siliqua among the different varieties (Table 01). Siliqua's length was the longest in BARI Sarisha-18 (6.64 cm) and the shortest in BARI Sarisha-11 (3.80 cm). Hossain et al. (1996) documented that BARI sharisha-8 exhibited superior performance in terms of siliqua length. The BLN-900 siliqua measured the longest (8.07 cm), while the Hyola401 siliqua measured the shortest (4.83 cm). The siliqua length demonstrated considerable variation across the different varieties.

1000-seed weight

The correlation between seed weight and the extent of seed development is a significant factor influencing yield and greatly affects the realization of a crop's yield potential of Variety (Sana et al., 2003). The seed weight indicates seed development extent, which significantly impacts crop productivity and ultimately indicates yield potential (Mamun et al., 2014). The 1000-seed weight had a significant effect on variety (Table 01). The weight of the thousand seeds was the highest in BARI Sarisha-11 (3.88 g), followed by Binasarisha-8 (3.80 g) and the lowest was in BARI Sarisha-18 (2.07 g). According to Mondal and Wahab (2001), the yield is consistent with the 1000-seed weight, which differs among varieties. The weight of one thousand seeds differs between species and varieties (Karim et al., 2000; Roy, 2007).

Table 01. Yield and yield contributing characteristics of five mustard cultivars

Treatments	Plant height (cm)	Primary branches plant^{-1}	Secondary branches Plant^{-1}	Siliqua plant^{-1}	Seed siliqua^{-1}	Siliqua length (cm)	1000-seed weight (g)
Binasarisha-7	151.56b	6.44a	20.67a	288.56ab	12.67c	4.40bc	2.36b
Binasarisha-8	162.83ab	5.56ab	20.22a	308.89a	14.11bc	4.65b	3.80a
BARI Sarisha-11	173.77a	3.56c	9.00bc	251.89bc	13.89c	3.80c	3.88a
BARI Sarisha-18	166.17a	6.56a	11.78b	221.22c	21.33a	6.64a	2.07c
SAUJR-001	175.78a	4.67b	8.22c	265.56abc	19.22ab	4.11bc	2.24b
$Lsd_{0.05}$	13.70	1.09	3.34	47.62	5.31	0.70	0.14
CV (%)	4.38	10.84	12.70	9.46	17.36	7.87	2.50

Seed yield

A significant difference in seed yield was observed among the varieties, as determined by analysis of variance (Figure 02). SAUJR-001 showed the maximum yield (2.12 tha^{-1}) followed by Binasarisha-8 (2.08 tha^{-1}) and BARI Sarisha-11 (1.99 tha^{-1}), whereas the lowest yield was shown by Binasarisha-7 (1.64 tha^{-1}). The yield components have been correlated with greater seed yield. Rahman (2002), BARI (2001), Mondal et al. (1992) and Zaman et al. (1991) all reported that the seed yield of mustard and rape varied among different varieties. The findings of the present research correlated with these

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conclusions. A noteworthy variation in seed yield was also observed by Yeasmin (2013). These results compare with those of Uddin et al. (1987), Zaman et al. (1991) and Chakrabarty et al. (1991), which also found that yields varied between varieties. However, this finding contradicted the conclusions drawn by Roy (2007).

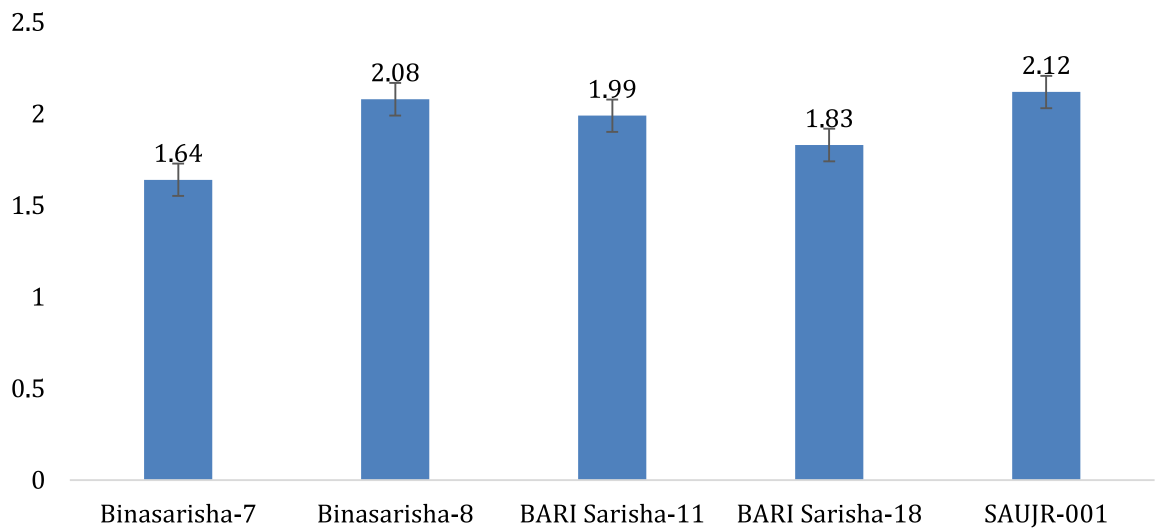

Figure 02. Yield of five mustard varieties

Correlation of yield and its contributing traits

Yield results from the environment's combined effect with several yield-influencing factors. Plant breeding benefited from understanding the interactions between different characteristics and their environment. In this experiment, we discovered that yield had a positive significant correlation with plant height (0.62) and the weight of thousands of seeds, siliqua plant^{-1} and seed siliqua^{-1} also positively correlated, but these were not statistically significant. Non-significant negative correlations were found in the other yield-contributing parameters (Figure 03).

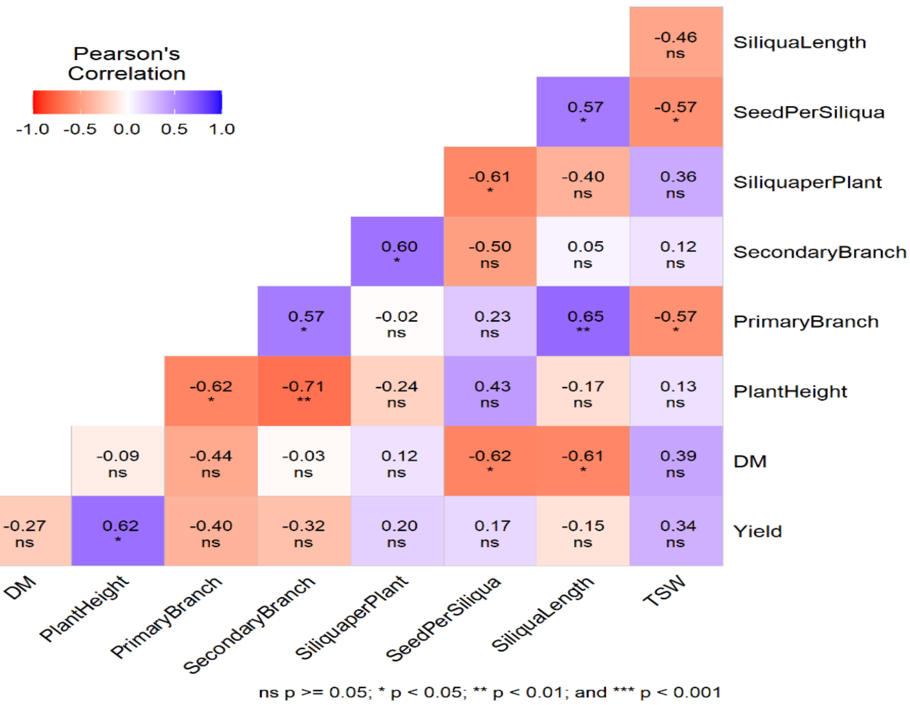

Figure 03. Correlation of yield and yield contributing characters among five mustard varieties

Plant height and grain yield per plant showed a significant and positive association (Ray et al., 2019). Along with these findings, the experiment also revealed a negative link between siliqua per plant and seeds per silique, positive correlation between siliqua plant^{-1} and major branches plant^{-1} and a negative correlation between siliqua length and seeds per siliqua. Plant height and primary branches plant^{-1} similarly had a negative correlation, although there was a positive correlation between siliqua length and primary branches plant^{-1}. siliqua length and number of seeds per siliqua were adversely linked with days to maturity. Principal branches plant^{-1} and seeds siliqua^{-1} showed a negative correlation with the weight of the thousand seeds. Besides these, all other combinations among yield and yield contributing characters were non-significant. Sur et al. (2023) found that siliqua per plant had a positive relationship with seed yield per plant, implying that improving this feature will result in a higher seed yield per plant. Rameeh (2016) found a substantial and positive link between the number of siliquae per plant and seed output.

IV. Conclusion

Reducing the massive import of edible oil from other nations requires improving the cultivars of mustard and rapeseed. We conducted an analysis that compared yield and yield attributing characters of late-maturing mustard genotypes. Among the tested varieties, SAUJR-001 produced a higher yield, and days to maturity were comparatively lower than others. Binasarisha-8 was also a promising higher-yielding variety that copes with (Aman-Mustard-Jute/Sesame/Fallow) cropping patterns. Due to their enormous yield potential, late maturing lines should be adopted at the farmer level to increase the nation's oilseeds output.

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