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Development of Salt Tolerant Mustard Varieties for the Coastal Region of Bangladesh

On the basis of the present consumption pattern (9.70 kg/year), the total requirement of edible oil is around 0.20 MT in Bangladesh. As per the Perspective Plan of Bangladesh (PPB), the estimated demand for edible oil is around 25 lakh tons whereas the domestic production of edible oil is only 2.19 lakh tons per annum on an average, necessitating the import of around 13 lakh tons yearly. Thus, PPB for for 2010-21 aimed at increasing the production of domestic oil seeds for providing the population with 40 g/person/day (14.6 kg/yr) of edible oil. Oilseed is cultivated on 8.71% of the total cultivated area in Bangladesh, and there is little scope of expanding the area under oilseeds on prime cultivated land of the country occupied by cereal, legume and fiber crops. One option is to use marginal lands like the coastal lands in southern Bangladesh. A vast area of land in the coastal belt remains either fallow or covered by some minor crops at marginal level of production after harvesting T. Aman rice. Twenty-eight Brassica varieties developed by different institutions are mostly suited to favorable environments in Bangladesh, but the coastal saline lands remaining idle or underutilized may be used to grow mustard to increase oilseed production in the country. However, for mustard cultivation in the coastal saline zone, salt tolerant varieties are required. Some tolerant genotypes are available at BAU and BARI which can be used to develop new varieties suitable for growing in the coastal area. This KGF sponsored project addressed the issues of development and adoption of salt tolerant rapeseed and mustard varieties in the coastal region of Bangladesh.

Methodology

The project had two general components: research and extension. In the first part of the project, experiments were conducted to develop high-yielding salt tolerant and short-duration rapeseed mustard varieties, and in the second part, demonstrations were conducted in farmers' fields of the coastal region. Twenty-five potential rapeseed mustard genotypes were collected from various sources were screened at BAU for salt tolerance, 5 genotypes (BD-6950, BD-7104, BD 10115, JUN-56, BJDH-12) were selected. They were evaluated for genetic divergence at the molecular level based on SSR marker. Yield performance of the 5 selected genotypes was studied in BAU field laboratories. Yield and yield contributing characters were recorded and analyzed. Pot culture experiments were conducted with the 5 selected genotypes to investigate the effect of different salinity levels (soil ECe 6, 8, 10 and 12 dS/m) on seed yield and yield contributing characters. Biochemical parameters such as, reactive oxygen species (ROS) and scavenging role of antioxidants against salt stress, H2O2 metabolizing enzymes such as catalases (CAT), ascorbic peroxidases (APX), peroxidase reductases (POD) were studied, and economic analysis was done. Seeds of these advanced lines were multiplied at the Genetics and Plant Breeding experimental farm of BAU and at the BARI research farm, Gazipur.

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Then field demonstrations were conducted in farmers' fields in 27 upazilas of 5 costal districts, viz. Khulna, Bagerhat, Satkhira, Patuakhali and Borguna in the southern coastal zone of Bangladesh. A total of 1620 beneficiary farmers were selected in these upazilas. Training camps were organized for the participating farmers of the project areas to train them on the aim of the project work, ways and means of better livelihood, effect of salinity on crop production and improved cultivation technologies for salt tolerant, high- yielding and short-duration mustard.

Results and Outputs

Development of salt tolerant rapeseed mustard varieties

Genetic divergence was found among the studied genotypes, molecular analysis revealed diversity among these genotypes in different locii related to salinity tolerance. The genotype BD-6950 gave the highest seed yield (2197.92 kg/ha) followed by BD-7104 (2190.42 kg/ha) and BD-10115 (2121.08 kg/ha), outyielding the check variety, BARI sarisha-14, by about 30%. Soil salinity affected yield components and yield of the rapeseed genotypes to various extents. In general, plant height, number of secondary branches, length of primary branches and leaf area, 1000 seed weight, 1000 seed weight and seed yield per plant were negatively affected by soil salinity. The genotypes BD-6950, BD-7104 and Jun-536 performed better than the other two genotypes; especially BD-7104 showed better interaction performance compared to others in terms of days to first flowering, days to maturity, chlorophyll content, 1000 seed weight, seed yield per plant.

Principal component analysis (PCA) revealed that days to first flowering and days to maturity had contrasting association with other variables for salinity stress tolerance in genotype BD-7104 and BD-10115 at higher salinity levels (8 dS/m and 10 dS/m). BD-6950, BD-7104, BD-10115 and Jun-536 were identified as salt tolerant genotypes.

Reactive oxygen species (ROS) and scavenging role of antioxidants against salt stress were assessed at the BAU laboratory. Plants are endowed with H_2O_2 metabolizing enzymes such as catalases (CAT), ascorbic peroxidases (APX), peroxidases reductases (POD). These enzymes have scavenging role on reactive oxygen species (ROS) like H_2O_2. In this study, activity of APX and CAT showed minor genotypic variations in rapeseed mustard advanced breeding lines under various salinity stresses. Interestingly, activity of POD showed striking variation among five advanced breeding lines of rapeseed mustard. Activities of POD (Fig. 1) markedly increased in BD-6950 and BD-7104 genotypes at both 30 and 60 min after the treatment at 6EC indicating that these two genotypes have innate capacity to manage the activity of reactive oxygen species (ROS).

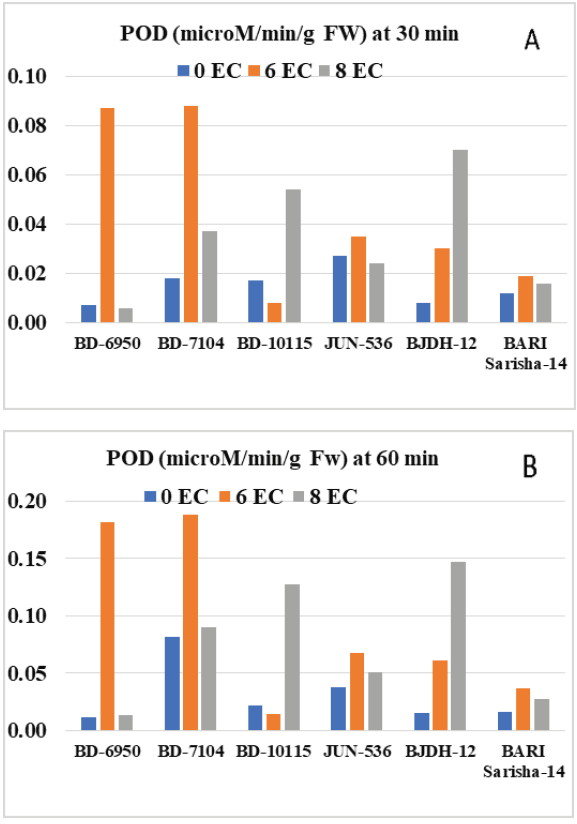

Fig. 1. POD activity in selected rapeseed mustard genotypes as influenced by salinity

Activities of POD also increased in BD-10115 and BJDH-12 at both 30 and 60 min after the treatment at the 8EC salinity level. In the saline susceptible variety BARI sarisha-14, the activity of POD did not differ between control and salinity stress.

In demonstration trials in 140 selected beneficiary farmers' fields of the project areas, the highest seed yield of 2355 kg/ha was obtained with genotype BD-6950. The 2nd and 3rd highest yields were 2335 and 2332 given by BD-7104 and BD- 10115, respectively. BD-6950 was also the earliest maturing genotype (86 days) followed closely by BD-7104 (88 days) and BD-10115 (91 days). All of these three lines may be considered early maturing. Overall, genotypes BD-6950, BD-7104 and BD-10115 were found to be salt tolerant (able to complete their life cycle in 6 to 12 dS/m), high-yielding (30% higher yield than check variety BARI sarisha-14), medium statured (plant height 105 cm), having a growth duration (81 to 91 days) similar as that for the popular varieties and stable across the natural saline environment.

Table 1. List of the selected five advanced promising genotypes

Promising genotype	Main feature
BD- 6950 (BAU Sarisha-1)	1. High yielding (30% higher than BARI sarisha-14) 2. Salt tolerance up to 12 dS/m 3. Seed to seed growth duration 85-95 days 4. Plant height 105 cm 5. Growth duration is similar to currently popular cultivars, i.e., 82-90 days but yield is about 400 kg/ha higher 6. Can be planted up to 1st week of December 7. Can be grown in low -lying salt affected coastal areas
BD- 7104 (BAU Sarisha-2)	
BD- 10115 (BAU Sarisha-3)	

These three newly developed genotypes can be grown in low-lying salt affected coastal areas and can be planted up to the 1st week of December. With these desirable attributes, these three genotypes were recommended for cultivation in the southern coastal saline region. The rapeseed genotypes, BD-6950, BD-7104 and BD-10115, were finally registered with the Seed Wing of the Ministry of Agriculture for release as new mustard varieties such as, BAU Sarisha-1, BAU Sarisha-2 and BAU Sarisha-3 (Table 1).

Table 2. Gross returns from T. Aman-mustard cropping pattern with improved mustard genotypes

Crop	Gross income (Tk/ha/yr)	Gross return (Tk/ha/yr)
T. Aman rice	90075	14773
Selected mustard genotypes	90541	37357
Total	**180616**	**52130**

Income generation and farmers' response

In the base line survey it was observed that the selected beneficiary farmers grew T. Aman rice and local conventional mustard varieties which fetched a total gross return of Tk. 44538/ha (Table 2). The adoption of newly developed salt-tolerant high-yielding rapeseed mustard genotypes replacing the traditional varieties increased the gross return to Tk. 52130/ha. Not only that, for lands where growing only a single crop (T. Aman rice) per year used to be the tradition, introduction of mustard as a second crop increased the cropping intensity to 200%. All participating farmers in the project areas as well as other farmers in general were satisfied with the performance of the newly introduced crop, mustard, following T. Aman rice opening up opportunities for increasing cropping intensity, land

productivity and incomes. They expressed their willingness to grow the newly developed salt-tolerant high-yielding rapeseed mustard varieties in the Rabi season after T. Aman rice harvest.

Expected Impact

- Availability of newly developed short-duration and salt tolerant high-yielding rapeseed mustard varieties along with improved production technologies to the local farmers will help increase cropping intensity in the coastal saline areas
- Employment opportunities for rural youth and women in the coastal areas and increased incomes for rural households will be increased
- The coastal region will contribute more than before to increasing the overall production of oilseeds in the country.

Recommendations

- Initiatives should be taken to popularize the newly developed short-duration, salt tolerant, higfh-yielding rapeseed mustard varieties among the farmers and growers in the coastal region, they should have adequate access to seeds
- Intensive programs should be initiated to increase oilseed crop productivity in the country involving research organizations like BAU, BARI, BINA, etc
- Seed multiplication should be expedited by BADC, and DAE and NGOs need to begin demonstration trials and seed distribution.

This Technical Bulletin has been prepared on the basis of technical information available from a completed BKGET-KGF Funded CGP Project, the details of which are given below:

Project Code and Title: TF 56-C/17. Collection Characterization of Potential Germplasm of Rape Seed-mustard and Participatory Salt Tolerant Short Duration Variety Development for Increasing Cropping Intensity in Southern Coastal Bangladesh

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