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Introducing high-yielding elite mustard cultivars for cultivation in semi-saline soils of South 24-Parganas, West Bengal

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Abstract

A field experiment was conducted during the rabi season of 2024 at the University Instructional Farm, The Neotia University, South 24 Parganas, West Bengal, to evaluate ten genetically diverse mustard (*Brassica juncea* L.) cultivars under semi-saline soil conditions. The trial was laid out in a randomized block design with three replications to assess growth, yield, and oil-related traits. Significant variability was observed among cultivars for plant height, branches per plant, pods per plant, seeds per pod, test weight, seed yield, oil content, and oil yield. NRCHB101 (1066.59 kg/ha) and Sita (1062.19 kg/ha) recorded the highest seed yield, while Anuska exhibited the highest oil content (44.13%) and oil yield (429.15 kg/ha). Results indicate that balanced expression of yield components rather than single traits determines productivity under semi-saline conditions. The study highlights the potential of salt-tolerant cultivars, particularly Anuska, NRCHB101, and Sita, for enhancing mustard productivity and oil yield in coastal regions of West Bengal.

Keywords: *Brassica juncea* L., mustard cultivars, semi-saline soil, rabi season

Introduction

Mustard (*Brassica* spp.) is one of India's most important oilseed crops, playing a crucial role in the nation's edible oil economy. Among various oilseed crops, Indian mustard (*Brassica juncea* L.) ranks second only to soybean in terms of acreage and production. Its oil is highly valued not only as a dietary staple, rich in essential fatty acids like omega-3 and omega-6, but also for its applications in sustainable agriculture. Mustard oil contains natural bioactive compounds such as allyl isothiocyanate, which possess pesticidal properties effective against a range of soil-borne pests and pathogens. Furthermore, mustard oil cake a nutrient-rich by-product from oil extraction is widely used as an organic fertilizer and soil conditioner. It enhances soil fertility, improves structure, and stimulates microbial activity, thereby promoting eco-friendly and sustainable farming practices (Baltrukoniene *et al.*, 2015) ^[1].

During the winter (rabi) season, mustard becomes the dominant crop in many Indian states due to its adaptability to cooler temperatures and relatively low water requirements. In this context, West Bengal holds significant potential for mustard cultivation. The state contributes 5.57% of India's total mustard acreage and 5.10% of its production, with an average productivity of 911 kg ha⁻¹. However, despite its potential, mustard cultivation in the state is constrained by challenging soil and water conditions in many areas, particularly in the southern and coastal regions.

Notably, districts like South 24-Parganas and East Midnapore possess large tracts of semi-saline soils resulting from tidal ingress, poor drainage, and saline groundwater. While such conditions are often detrimental to traditional crops, mustard, being moderately tolerant to salinity, emerges as a promising alternative. The crop's inherent resilience to abiotic stress, combined with its low input requirements, makes it particularly well-suited for cultivation in these marginal lands where fresh water is limited. Mustard, particularly *Brassica juncea* (Indian mustard), exhibits a moderate degree of salt tolerance, making it a suitable crop for cultivation in semi-saline and marginal soils. This salt tolerance is attributed to several physiological and biochemical

mechanisms that allow the plant to adapt and perform under saline stress. One of the key characteristics is its ability to maintain osmotic balance through the accumulation of compatible solutes such as proline and glycine betaine, which help stabilize cellular functions and protect membranes from salt-induced damage. Mustard plants also possess efficient ion regulation mechanisms that restrict the uptake and translocation of toxic sodium (Na^+) and chloride (Cl^-) ions while maintaining adequate levels of essential nutrients like potassium (K^+) and calcium (Ca^{2+}). In addition, the presence of a deep and well-branched root system aids in water and nutrient absorption from lower soil profiles, where salinity may be relatively less concentrated. Salt-tolerant mustard genotypes have also demonstrated higher antioxidant enzyme activities, which help in mitigating oxidative stress caused by high salt concentrations. Furthermore, research indicates that certain mustard varieties show stable flowering and seed-setting capacity even under saline irrigation or soil conditions. These traits not only enable mustard to survive but also to yield reasonably well under moderate salinity, making it an important crop option for regions facing increasing soil salinization due to climate change, sea water intrusion, or poor irrigation practices. The development and use of salt-tolerant cultivars are therefore critical in expanding mustard cultivation into salt-affected areas, contributing to sustainable agriculture and food security. Recognizing these opportunities, the state of West Bengal can significantly boost its mustard productivity through the adoption of improved cultivars and modern agronomic practices. The introduction and dissemination of elite mustard cultivars specifically bred for salinity tolerance offer a sustainable solution. These advanced lines not only withstand adverse soil conditions but also demonstrate superior yield potential and robust agronomic traits. With appropriate irrigation management, farmer training, and extension support, these cultivars can revolutionize mustard farming in semi-saline regions.

In particular, South 24-Parganas has emerged as a focal point for evaluating and promoting salt-tolerant mustard varieties. Given the region's unique agro-climatic conditions and rising market demand for mustard oil and related products, promoting climate-resilient, high-yielding mustard cultivars becomes a strategic imperative. Such interventions not only enhance agricultural productivity but also improve rural livelihoods, ensure better utilization of salt-affected lands, and contribute to the broader goals of sustainable and climate-resilient agriculture.

This article aims to explore the evaluation, performance, and adaptability of elite mustard cultivars under semi-saline soil conditions in South 24-Parganas, thereby offering practical insights for oilseed development in coastal and marginal environments.

Materials and Methods

The experiment was carried out at University Instructional Farm, School of Agriculture & Allied Sciences, The Neotia University, South 24 Parganas, West Bengal, India during winter season of 2024 with ten genetically diversified mustard variety genotypes collected from West Bengal and all over India in randomized block design with three replications and spacing of 60 cm x 30cm. The recommended agronomic practices were carried out to raise the crop in the field. Observations were recorded from five randomly selected plants (excluding the border plants) per replication on the following ten characters: plant height (cm), No. of Branch/plant, No. of pods/plant, Pod length (cm), No. of seeds/pod, Days to Maturity, Test weight ('000 seed in g), Seed

yield (kg/ha), Oil percentage (%), Oil yield (kg/ha). The data generated in the experiments were subjected to the following statistical analysis to draw valid conclusion from the experimental results: analysis of variance (Panse and Sukhatme, 1978), to determine which specific pairs of means are significantly different after an ANOVA, a Duncan Multiple Range Test (DMRT) was conducted using Excell stat and SPSS.

Results and Discussion

The present investigation revealed significant variability among the evaluated cultivars for growth, yield, and oil-related traits, indicating substantial genetic diversity and scope for selection in Indian mustard (*Brassica juncea* L.). The significant differences observed for plant height, number of branches per plant, pods per plant, pod length, seeds per pod, test weight, seed yield, oil content, and oil yield suggest strong genotypic influence on these characters, which is consistent with earlier findings in mustard (Rai *et al.*, 2016; Singh *et al.*, 2018) ^[3, 6].

Growth parameters

Plant height varied significantly among cultivars, with Bhagirathi (131.10 cm) recording the tallest plants, while B-9 (74.07 cm) was the shortest. Plant height is an important architectural trait influencing light interception and biomass accumulation; however, excessive height may predispose plants to lodging (Shekhawat *et al.*, 2012) ^[4]. Moderate plant height coupled with higher branching, as observed in Sanjukta and Sita, may contribute positively to yield formation. The number of branches per plant was highest in Sanjukta (4.23) and Sita (4.07), which could enhance sink capacity through increased silique formation, corroborating earlier reports that branching is positively correlated with yield in mustard (Singh *et al.*, 2017) ^[5].

Yield contributing traits

The number of pods per plant ranged from 196.53 (Agroni) to 221.87 (Varuna). Pods per plant is a primary yield component and directly contributes to final seed yield (Rai *et al.*, 2016) ^[3]. Similarly, pod length showed significant variation, with Sita (6.00 cm) and Sanchita (5.97 cm) producing longer pods. Longer pods generally accommodate more seeds, as reflected in Sanchita (15.93 seeds per pod), which recorded the highest seeds per pod. Seed number per pod is considered a major determinant of yield potential in *Brassica* crops (Kumar *et al.*, 2015) ^[2].

Test weight (1000-seed weight) was highest in Anuska (4.08 g), indicating bold seeds, which is often associated with improved market preference and yield stability (Singh *et al.*, 2018) ^[6]. However, higher test weight alone did not always correspond to maximum seed yield, suggesting that yield is a complex trait governed by multiple interacting components.

Seed yield performance

Among the cultivars, NRCHB101 (1066.59 kg/ha) and SITA (1062.19 kg/ha) recorded the highest seed yields, followed by Anuska (980.82 kg/ha) and Sanchita (923.43 kg/ha). The superior performance of NRCHB101 and Sita may be attributed to a favorable combination of pods per plant, seeds per pod, and adequate test weight. These findings align with previous studies indicating that seed yield in mustard is positively associated with pods per plant, seeds per pod, and branching (Rai *et al.*, 2016; Shekhawat *et al.*, 2012) ^[3, 4].

Despite Bhagirathi exhibiting the maximum plant height, it recorded relatively lower seed yield (625.10 kg/ha), suggesting that vegetative vigor alone does not ensure higher productivity.

Similarly, Sanjukta, though superior in branching, recorded moderate yield, indicating that yield is influenced by balanced expression of multiple traits rather than a single attribute.

Oil content and oil yield

Oil percentage varied significantly, with Anuska (44.13%) and Sanchita (41.57%) recording the highest oil content. Oil content is largely genotype-dependent but may also be influenced by environmental conditions (Kumar *et al.*, 2015) [2]. Although NRCHB101 and SITA recorded higher seed yield, their oil content was moderate (33.33% and 30.63%, respectively), demonstrating the common trade-off between seed yield and oil percentage reported in *Brassica* species.

Oil yield, being a function of both seed yield and oil percentage,

was highest in ANUSKA (429.15 kg/ha), followed by Sanchita (388.00 kg/ha) and NRCHB101 (343.51 kg/ha). This indicates that Anuska, despite not being the highest seed yielder, achieved superior oil productivity due to its significantly higher oil concentration. Similar observations have been reported by Rai *et al.* (2016) [3], emphasizing that oil yield should be considered a key selection criterion in breeding programs.

Variability and experimental precision

The relatively low coefficient of variation (CV%) values for most traits (ranging from 0.73% to 10.69%) indicates good experimental precision and reliability of results. Significant CD values further confirm the presence of meaningful genetic differences among cultivars.

Table 1: Performance of ten mustard (*Brassica juncea* L.) cultivars for growth, yield, and oil-related traits under semi-saline soil conditions of South 24-Parganas, West Bengal (Rabi 2024).

Sl. no	Cultivars	Plant height (cm)	No. of Branch/plant	No. of pods/plant	Pod length (cm)	No. of seed/pod	Days to Maturity	Test weight ('000 seed in g)	Seed yield (kg/ha)	Oil percentage (%)	Oil yield (kg/ha)
1.	B-9	74.07ab	3.23c	214.23c	3.43a	12.07b	99.20	2.46a	834.01d	34.70c	301.30d
2.	VARUNA	103.40c	3.07c	221.87d	4.37b	12.13b	102.07	3.53b	902.98e	30.37b	268.91c
3.	ANUSKA	95.60b	3.77d	208.63b	5.10c	9.70a	102.73	4.08c	980.82e	44.13d	429.15f
4.	SAROMA	95.60b	3.90d	206.27b	4.80b	7.30a	121.27	2.27a	772.61d	35.90c	279.20c
5.	BHAGIRATHI	131.10e	2.13a	206.77b	5.17c	10.03a	121.30	3.44b	625.10c	30.17b	192.21b
6.	SANJUKTA	114.77d	4.23e	219.93c	4.20b	11.60b	123.87	3.57b	589.13b	27.27a	166.73a
7.	NRCHB101	113.17d	2.90b	216.53c	4.03b	11.33b	120.50	2.75a	1066.59f	33.33c	343.51e
8.	SITA	102.83c	4.07e	206.93b	6.00d	13.13bb	121.30	2.91a	1062.19f	30.63b	320.60d
9.	SANCHITA	95.87b	3.17c	198.40a	5.97c	15.93c	98.43	3.46b	923.43e	41.57d	388.00e
10.	AGRONI	111.30d	2.80b	196.53a	5.90c	10.43	120.97	2.92a	514.09a	30.43b	184.40b
	SE	6.00	0.14	1.25	0.23	0.25	1.35	0.19	0.48	0.58	0.99
	CD	17.37	0.40	2.55	0.46	4.73	3.90	5.06	5.38	6.67	7.87
	CV (%)	10.02	7.15	0.73	5.66	3.87	2.06	10.69	1.10	2.95	3.60

Conclusion

The study demonstrated considerable genetic variability among mustard cultivars for yield and oil-related traits. NRCHB101 and Sita were superior in seed yield, whereas Anuska was outstanding in oil content and oil yield. Therefore, Anuska may be recommended for oil productivity, while NRCHB101 and Sita may be suitable for higher seed yield under similar agro-climatic conditions. These cultivars could also serve as valuable genetic resources for future breeding programs aimed at improving both yield and oil content.

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