



Evaluation of Some Rapeseed Mutants Based on Morpho-Physiological, Biochemical and Yield Attributes

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Abstract

An experiment was conducted at the field laboratory of Bangladesh Institute of Nuclear Agriculture, Mymensingh, to investigate morpho-physiological characters, yield attributes and seed yield in seven advanced mustard mutants *viz.*, RM 01, RM 02, RM 03, RM 04, RM 05, RM 10 and RM 11 along with a cultivar BINAsarisa-4. The experiment was laid out in a Randomized Complete Block Design with three replications. High yielding genotypes showed superiority in leaf chlorophyll content, photosynthesis, total sugar content and nitrate reductase activity. RM 05 produced higher number of siliqua plant⁻¹ resulting higher seed yield. In contrast, the mutants RM 01 and RM 10 produced the lower number of siliqua plant⁻¹ and also showed the lower seed yield with being the lowest in RM01. Among the mutants/cultivars, RM 05 produced the highest seed yield due to morpho-physiological superiority than the others.

Key words: Attributes, Biochemical, Evaluation, Mustard, Mutants

Introduction

Mustard (*Brassica sp.*) is one of the most important oil crops of the world. Oils of plant origin constitute important component of human diet, ranking third after cereals and animal products and are nutritionally superior to animal oil (Singh, 2000). In Bangladesh, about ten oil seed crops are grown in the country. Among them, *Brassica* oil crop is the most important that supplies major edible oil in Bangladesh. It covers about 80% of the total oilseed acreage and about 71% of the total production (BBS, 2009). However, Bangladesh is facing acute shortage in edible oil. In Bangladesh, the seed yield of mustard/rapeseed is about 760 kg ha⁻¹ which is very low in comparison to other developed countries (2400 kg ha⁻¹) (FAO, 2007). The low yield is due to lack of high yielding varieties and improper agronomic practices. That is why, improvement of existing oilseed crops and introduction of a new oilseed crop species as well as proper cultural management practices need urgent attention to meet increasing demand of edible oils for the fast growing population of Bangladesh. An understanding of some morpho-physiological characters in mustard is necessary to make progress in genotypic improvement and for the management of the crop either to increase yield and quality or to reduce the cost of production (Mendham and Salisbury, 1985). The capability of efficient partitioning between the vegetative and reproductive parts may produce high economic yield (Maola, 2005). For optimum yield in mustard, the LAI should be ranged from 3.5 to 4.5 (Bhat *et al.*, 2006). In Bangladesh, several research Institutes like BARI, BINA and BAU have developed a couple of varieties of mustard which are high yielding compared to local landrace. But the farmers are reluctant to mustard

cultivation for poor economic return compared to cereals and vegetable crops. Recently, BINA has developed several promising mustard genotypes of high yield potentials. These genotypes need to be assessed for their physiological growth and morphological maneuvering that takes place compared to the existing mustard cultivars. The present research work has been designed to study different growth parameters and other morpho-physiological characteristics responsible for higher biological yield as well as their interrelation to the grain yield.

Materials and Methods

The experiment was carried out at the Field laboratory, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. The experimental field was medium high land belonging to the Sonatola Soil Series of Grey Floodplain soil under the agro-ecological zone of Old Bahmaputra Flood plain (AEZ-9). The soil was silty loam.

Treatment

Seven advanced mutant lines along with one mustard variety (BINAsarisa-4) were collected from plant Breeding Division, BINA, Mymensingh and used as treatment in the present study. The characters of advanced mutant lines are still unknown. The average yield potential of BINAsarisa-4 is about 2.0 t ha⁻¹. The land of the experimental site was first opened with power tiller. After ploughing and laddering all the stubbles and uprooted weeds were removed and the land was made ready.

Experimental design and lay-out

The experiment was laid out in a Randomized Complete Block Design with 3 replications. The size of the unit plot was 4.0×2.5m. Distance between block to block and plot to plot were 1.0 and 0.5 meter, respectively. Plant to plant and row to row distances were maintained as 5-8 cm and 30 cm, respectively. Urea, TSP, MP, gypsum and borax were used. Weeding was done once at 20 DAS only. Two irrigations were applied. At flowering, few plants were affected by aphid. To control aphid, Malathion 57 EC was sprayed @ 25 L ha⁻¹ in the afternoon by using a sprayer.

Crop sampling and data collection

The date of harvest was determined when 85-90% of the siliqua became brown colour. The maturity dates were different among the varieties. The plots were harvested separately and tagged and brought to the threshing floor and dried in the sun. The seed were threshed by mild pounding with stick.

Data Collection

The following data were collected by using the standard methods. 1. Days to maturity 2. Branches/plant(no) 3. Chlorophyll 4. Photosynthesis 5. Nitrate Reductase 6. Total sugar.

The collected data were analyzed statistically following the analysis of variance (ANOVA) technique and the mean differences were adjusted with Duncan's Multiple Range Test (DMRT) using the statistical computer package program, MSTAT-C (Russell, 1986).

Results and Discussion

The results of the study on the mutants/variety effect on growth, yield and yield contributing characters of mustard have been presented and possible interpretations have been made in this chapter.

Some morpho-physiological parameters

Days to maturity: Days required to maturity had a range of non-significant variation amongst the mutants/variety studied (Table 1). Days to maturity varied between 94 and 98 days. However, three mutants, RM01, RM02 and RM05 matured earliest, took 94 days only whereas RM04 and RM10 required maximum days to maturity, 98 days. The above results are in full agreement with Khaton (2004) who reported that maturity start between 74-102 days after sowing in mustard/rapeseed.

Table 1. Some morphological and biochemical attributes in eight mustard genotypes

Mutants/ variety	Days to maturity	Branches/ Plant(no)	Chlorophyll (mg/gfw)	Photosynthesis (µmolCO ₂ /dms)	Nitrate redu. (µmolNO ₂ /gfw)	Total sug. (mg/gfw)
RM 01	94	1.67 c	1.89 b	17.6 b	5.80 d	68.3 b
RM 02	94	2.00 b	2.06 ab	20.2 a	7.00 c	70.7 ab
RM 03	96	2.50 a	2.22 ab	22.8 a	7.69 ab	74.2 ab
RM 04	98	2.00 b	1.99 ab	20.9 a	7.00 c	72.33 ab
RM 05	94	2.67 a	2.30 a	23.3 a	8.22 a	75.6 a
RM 10	98	1.68 c	2.11 ab	20.9 a	6.66 c	69.9 ab
RM 11	96	2.10 b	2.28 ab	21.9 a	6.90 c	73.1 ab
Bina sarisa-4	96	1.87 bc	2.00 ab	21.5 a	7.10 bc	72.8 ab
F-test	NS	**	*	*	**	*
LSD(0.05)	4.53	0.28	0.36	2.59	0.62	5.91
CV(%)	2.70	7.62	7.87	7.03	4.99	4.68

In a column, means followed by same letter(s) do not differ significantly at 5% level by DMRT; NS=Not significant; *, ** indicate significant at 5% and 1% levels of probability, respectively

Number of branches plant⁻¹

Number of branches plant⁻¹ amongst the studied mustard mutants/variety was statistically significant (Table 1). The highest number of branches plant⁻¹ was recorded in RM05 (2.67) followed by RM03 (2.50) with same statistical rank. On the other hand, the lowest branches plant⁻¹ was observed in RM01 (1.67) which was statistically similar to RM10 (1.68). Results further indicated that high yielding genotypes had higher number of branches

plant⁻¹ than low yielding ones. This result is agreed with the result of BINA (2007) in mustard who stated that high yielding genotypes had higher number of pod bearing nodes plant⁻¹ than low yielding ones.

Chlorophyll content in leaves

The variation in chlorophyll content during flowering and fruiting stages was significant among the mutants/variety (Table 1). The highest chlorophyll was recorded in RM05 (2.30 mg/gfw) and the lowest was

recorded in RM01(1.89mg/gfw). Genotypic variability in chlorophyll content in leaf was also observed by Akbar *et al.*(2003) in mustard that agreed the present experimental result.

Photosynthesis

The variation in leaf photosynthesis during flowering fruiting stage was significant among the mutants (Table1). The highest leaf photosynthesis was recorded in RM05(23.3 μ mol CO dm⁻² s⁻¹).

Total sugar content in leaves

Significant variation on total sugar content in leaf of mustard was observed (Table1). Seven mutants/variety out of eight was recorded greater amount of total sugar content in leaf (range 69.90-75.60 mg g⁻¹fw) than in the mutant, RM01 (68.30 mg g⁻¹fw). The highest amount of total sugar content in leaf was observed in RM05(75.60mg g⁻¹fw), which was statistically similar to other six mutants. In contrast, RM 01 recorded the lowest amount of sugar content in leaf (68.30 mg g⁻¹fw) that also showed inferiority in seed yield. Result further revealed that the genotypes which had higher total sugar content in leaf, in general, also showed high yield performance which indicated that yield was positively associated with sugar content in leaf. This result was consistent with result of BINA (2004) in mustard who reported that high yielding mustard genotypes had greater sugar content in leaf than the low yielding ones.

Nitrate reductase activity

Nitrate reductase (NR) activity in leaf during flowering and fruiting stage varied significantly among the studied variety (Table 1). The highest NR activity was recorded in RM 05(8.22 μ molg⁻¹fw) followed by RM03 (7.69 μ molg⁻¹fw). Result revealed that high yielding mutants had greater NR activity in leaves than low yielding ones. It means NR activity is positively correlated with yield. BINA (2004) reported significant variability in NR activity among the genotypes in mustard.

Yield contributing characters

Reproductive efficiency (RE): The effect of mutants on percent siliqua to total reproductive unit was significant (Table2). The RE varied between 53.4 and 67.5%. Among the variety, RM 02 had the highest RE value (67.5%) that was statistically similar to RM03, RM04, RM05, RM11 and BINAsarisa-4 and the lowest was in RM10 (53.4%). Genotypic variation in RE was also observed by Islam (2006) in mustard that supported the present experimental result.

Number of siliqua plant⁻¹

Siliqua number, the most important yield attribute, was significantly different among the mutants (Table 2). RM05 produced the highest number of siliqua plant⁻¹(55.4). RM 01 produced the lowest number of siliqua plant⁻¹ (40.1). Result also revealed that high yielding mutants also had higher number of siliqua plant⁻¹. Khatun(2004) conducted an experiment with 20 mustard/rapeseed cultivars and observed a wide range of variability in siliqua number plant⁻¹ ranging from 75 to 198.

Siliqua length

Siliqua length had significant difference among the mutants studied (Table 2). The highest siliqua length was recorded in RM 05 (7.00 cm) and lowest was recorded in RM 01 (6.20 cm) (Table 2). Results further revealed that high yielding mutants produced longer siliqua than low yielding ones. The result indicates that longer siliqua is desirable for getting higher seed yield. This result is consistent with the result of Mondal *et al.*(2003) who studied 15 mustard genotypes and observed wide range of variability in siliqua lengths.

Number of seeds siliqua⁻¹

The effect of mutants on seed number siliqua⁻¹ was significant (Table 2). The number of seeds siliqua⁻¹ varied between 21.8 and 24.6. The highest seed siliqua⁻¹ was recorded in RM 05(24.6) and the lowest in RM 03 due to longer siliqua. Genotypic variability in seeds siliqua⁻¹ was also observed by many workers.

Thousand-seed weight

Thousand seed weight, the 3rd important yield attribute had also shown significant variation among the mutants (Table 2). The mutants RM 01 showed the highest 1000-seed weight (4.08 g) followed by RM 03(4.00 g). On the other hand, RM 11 showed the lowest 1000-seed weight(3.73 g) whilst showing indifference with RM 10(3.78 g). Genotypic variability in 1000-seed weight was also observed by many workers in mustard. (Rahman, 2007).

Seed yield

There was a remarkable difference in respect of seed yield plant⁻¹ and unit area basis (Table 2). The mutant RM 05 produced the highest seed yield plant⁻¹(3.09 g) followed by RM 03 (2.96 g) and RM 02 (2.88 g) with same statistical rank. The yield was higher in those mutants because of producing higher number of siliqua plant⁻¹. In contrast, RM 01 produced the lowest seed yield plant⁻¹ (2.28 g) due to production of lower number of siliqua plant⁻¹. However, in case of unit area basis, result revealed that seed yield ha⁻¹ was rationale to seed yield plant⁻¹. This result is consistent with the result of Rahman (2007).

Table 2. Reproductive efficiency, yield attributes and seed yield in eight mustard genotypes

Genotypes/ Varieties	Rep. eff. (%)	Siliqua/ Plant(no.)	Siliqua Len.(cm)	Seed/ Sili.no.	1000 S Wei.(g).	Seed wei./p(g)	Seed yield(t/ha)	Harvest Index(%)
RM 01	57.1 bc	40.1 c	6.20 c	22.3b	4.08 a	2.28 d	1505 d	24.9 ab
RM 02	67.5 a	47.4 b	6.60 abc	23.3a	3.87abc	2.88 ab	1890 ab	25.9 a
RM 03	63.7 ab	48.4 b	6.80 ab	24.1a	4.00 ab	2.96 ab	1944 ab	23.7 abc
RM 04	67.4 a	42.6 bc	6.40 bc	23.7a	3.96abc	2.69 bc	1775 bc	22.4 c
RM 05	66.0 a	55.4 a	7.00 a	24.6a	3.93abc	3.09 a	2039 a	22.2 c
RM10	53.4 c	42.2 bc	6.60 abc	22.0b	3.78 bc	2.45 cd	1617 cd	23.2 bc
RM 11	63.4 ab	45.2 bc	6.51 abc	21.8b	3.73 c	2.68 bc	1769 bc	24.2 abc
Bina Sarisa-4	65.8 a	43.7 bc	6.72 abc	24.2a	3.88abc	2.57 c	1696 c	22.2 c
sF-test	**	**	*	*	*	**	**	*
LSD(0.05)	6.34	6.24	0.51	1.64	0.21	0.26	173.0	2.17
CV(%)	5.75	7.81	4.43	4.49	3.05	5.46	5.55	5.24

In a column, means followed by same letter(s) do not differ significantly at 5% level by DMRT;*,** indicate significant at 5% and 1% levels of probability, respectively

Harvest index

Among the studied mutants, there was a significant variation in case of harvest index(HI)(Table 02).The highest HI was recorded in RM 02 (25.9%) followed by RM 01(24.9%). In constant, RM 05 and BINAsarisa-4 had the lowest HI(22.2%). According to Poehlman (1991), high yield is determined by physiological process leading to a high net accumulation of photosynthates and its partitioning into plant and seed. This opinion has been reflected in the present study. In the experiment, result revealed that high yielding genotypes produced larger TDM but showed lower HI.

Conclusion

High yielding mutants produced higher number of branches plant⁻¹, higher chlorophyll, photosynthates, total sugar content in leaf, nitrate reductase activity than low yielding ones. Days to maturity was not significantly different among the mutants. Reproductive efficiency (RE) had positive effect with yield. The high yielding mutants showed higher RE (average 66.1%) than low yielding ones (average 55.25). Siliqua number, the most important yield attribute, showed significant differences among the variety. Results revealed that high yielding mutants produced higher numbers of pods plant⁻¹. RM 05 produced the highest number of pods plant⁻¹(55.4) whilst RM 01 produced the lowest (40.1). High yielding mutants also produced longer siliqua and greater number of seed siliqua⁻¹ but there had no relation of 1000-seed weight with the yield.

References

- Akber, M.; Mehmood, T.; Yaqub, M.; Ali, M.A. and Iqbal, N. 2003. Variability, correlation and path coefficient studies in summer mustard. *Asian J. plant Sci.*, 696-698.
- Akbar, M.; Saleem, U.; Yaqub, M. and Iqbal, N. 2007. Utilization of genetic variability, correlation and path analysis for seed yield improvement in mustard. *J. Agric. Res.*, 45(1):25-30.
- BBS (Bangladesh Bureau of Statistics). 2009. Monthly Statistical Book of Bangladesh. October
2009. Ministry of Planning, Govt. Peoples Rep. Bangladesh. p.14.
- Bhat, S. A.; Khan, F. A. and Khan, M. I. 2006. Effect of nitrogen and phosphorus on growth, nutrient content, seed yield and quality of mustard. *Indian J. Plant Physiol.*, 11(3):281-286.
- BINA. 2004. Advanced yield trials of 30 mustard mutants. Annual Report of 2003-
- 2004, Bangladesh Institute of Nuclear Agriculture (BINA). p.27.
- BINA. 2007. Comparative performance study of 30 mustard mutants. Annual Report of 2006-07.

- Bangladesh Inst. Nuclear Agric. (BINA), Mymensing.P.25.
- FAO (Food and Agricultural Organization). 2007. FAO Production Year Book. Rome, Italy.Vol.61.p.64.
- Islam, A. 2006. Study of some morphological characters and reproductive efficiency in mustard. M.S. Thesis. Dept. Crop Bot., Bangladesh Agric. Univ., Mymensingh.
- Khaton, M. 2004. Study of canopy structure and flower production in mustard. M.S. Thesis. Dept. Crop Bot., Bangladesh Agric. Univ., Mymensingh.
- Mondal, M. M. A.; Das, M. L.; Malek, M. A. and Khalil, M. I. 2003. Performance of advanced generation rapeseed mutants under high and low input conditions. *Bangladesh J.agric.Sci.*, 30:115-118.
- Rahman, M. A. 2007.Evaluation of mustard genotypes in respect to their morphological, reproductive and yield. M.S. Thesis, Dept. Crop Bot., BAU, Mymensing.
- Russell, D. F. 1986. MSTAT-C pakage Programme. Crop and Soil Science Department, Michigan University, USA.
- Shil, R. K. 2005. A study of growth, dry matter production and yield in fifteen mustard genotypes. M.S. Thesis. Dept. Crop Bot., Bangladesh Agric. Univ., Mymensingh.
- Singh, B. D. 2000. Plant Breeding. Klyani Publications, New Delhi.p.574-597.
- Stewart, G, R. and Orebamjo,T. O. 1979. Some unusual characteristics of nitrate reduction in *Erythraea senegalensis*. *New Physiol.*, 83:311-319.
- Verma, S. K. and Sachan, J. N.2000. Genetic divergence in Indian mustard. *Crop Res.Hisar*, 9(2):271-276.
- Yoshida, S., Forno, D. A.; Cock, J. A. and Gomes, K. A. 1976. Laboratory manual for physiological studies of rice.3rd ed., IRRI, Los B