Selection of promising rapeseed mutants on the basis of morphology and yield attributes

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DOI: https://doi.org/10.22271/chemi.2020.v8.i3ae.9528

Abstract

The experiment was conducted to find out the best rapeseed mutants by observing their morphology and yield attributes. Seven mutant lines (RL-11, RL-12, RL-13, RL-14, RL-15, RL-16 and RL-17) with two checks (Binasarisha-9 and BARI Sharisha-14) were evaluated in this experiment. The experiment was conducted in RCBD design with three replications. High level of genetic diversity was observed among the mutant lines and the check varieties. Among the mutants RL-12, RL-14 and RL-17 proved their performance better in terms of morphology and yield attributes. These three mutant lines showed the highest yield and other yield attributes performance over the two check varieties. From this study it was revealed that these three mutants can be further used in genetic improvement of rapeseed.

Keywords: Rapeseed, mutant, genetic diversity, siliqua, significant

Introduction

Rapeseed (Brassica napus) is one of the most important oilseed crops in the world. It is the second most important edible oil crop in the world. Brassica oil crop is the most important group that supplies major edible oil in Bangladesh. Its national average seed yield is 1.14 ton ha⁻¹ only (BBS, 2018) [2]. Domestic oilseed production can hardly meet 15% demand but its contribution to industrial, agricultural and medicinal sectors is significantly increasing. In Bangladesh, there is little scope of horizontal expansion of the rapeseed cultivation, in this regard, attempt should be made to increase the yield per unit area within the shortest possible time. Seed yield itself is a product of interaction of many component traits which influence yield directly or indirectly. By creating genetic variability we can achieve higher seed yield with desired agronomic traits. Induced mutations have generated a vast amount of genetic variability and are now widely used for the development of genes controlling important traits and understanding the functions and mechanisms of actions of these genes in plants (Liang, 2009) [8]. Using mutation breeding, genetic improvement of any yield attributes either qualitative or quantitative trait, has been successfully achieved in rapeseed-mustard (Seyis et al., 2006; Spasibione, 2006; Zhao et al., 2009; Malek et al., 2012) [18, 18, 20, 10]. Furthermore, mutation breeding requires less time to develop crop cultivars as compared to the conventional breeding (Manjaya, 2009) [11]. Availability of genetic diversity and genetic variation is the heart of any breeding program which plays a critical role in developing well-adapted and improved crop varieties. Induced mutagenesis has played a vital role in germplasm strengthening and the development of high yielding varieties (Choudhary et al., 2016) [9]. Kharkwal et al. (2004) [7] reported that among the mutant varieties, 89% have been developed worldwide using physical mutagens like X-rays, gamma rays, thermal and fast neutrons and with gamma rays alone accounting for the development of 60% of the mutant varieties. For an effective breeding program for crop variety development through hybridization, the analysis of genetic diversity is one of the useful tools and plays a fundamental role in identification of parents (Mazid et al., 2013) [12]. This study investigated the morphology, seed yield and yield components variability among 7 rapeseed mutants along with two check varieties (Binasarisha-9 and BARI sarisha-14).
Materials and Methods

Experiment material

Seven mutant lines (RL-11, RL-12, RL-13, RL-14, RL-15, RL-16 and RL-17) and two checks (Binasarisha-9 and BARI Sharisha-14) were used as plant material for evaluation in this experiment. To create genetic variations, seeds of popular variety Binasarisha-9 were irradiated at Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh.

Design of experiment

The experiment was conducted in randomized complete block design with three replications at farm of BINA sub-station, Gopalganj during 2019-2020. Seeds were sown on 25 November in BINA sub-station, Gopalganj. Unit plot size was 5.4 m² (3×1.8 m) with 25 cm row to row spacing and 6-8 cm from plant to plant within rows.

Experimental management

Recommended production packages i.e., application of fertilizers, weeding, thinning, irrigation, application of pesticide etc. were followed to ensure normal plant growth and development of the plants in each plot.

Data collection parameters

Data were taken on morphological yield contributing characters such as plant height (avg. of 10 randomly selected representative plants), branches/plant (avg. of 10 randomly selected representative plants) and yield attributes like siliqua/plant and number of seeds per siliqua that leads to higher yield of rapeseed (Javed et al., 2003) [6]. Seys et al. (2006) [6] showed that induced mutation through gamma rays played a significant role in the alteration of plant architecture in rapeseed-mustard. Number of branches per plant is the important morphological parameters contributing to yield. A significant variation was found on the number of branches per plant among the mutant lines (Table 1). Mutant RL-15 produced the highest number of branches (7.93) followed by RL-11 (7.40) and RL-12 (7.27) while Binarasha-4 produced the lowest number (3.40). Genotypes with more branches and siliqua/plant have also been reported in oilseed Brassica (Chauhan and Kumar 1986, Naz and Islam 1979, Shah et al. 1999, Javed et al. 2003, Malek and Monshi 2009) [3, 14, 17, 9, 6, 16] as a consequence of mutagenesis. Binasarisha-9 produced the highest siliqua length (7.33 cm) and BARI Sarisha-14 produced the lowest (4.11 cm). Among the mutants RL-11 produced the highest siliqua length (5.63 cm) followed by RL-15 (5.11 cm) and RL-12 (5.05 cm). RL-17 produced the highest no. of siliqua/plant (112.73) followed by RL-12 (100.33) and the lowest no. of siliqua/plant produced by BARI Sarisha-14 (31.87). There is significant difference among the mutant lines than the mother Binasarisha-9 in producing no. of siliqua/plant. Binarasha-9 produced the highest no. of seeds/siliqua (25.80) followed by BARI Sarisha-14 (23.47). Among the mutant lines the highest no. of seeds/siliqua produced by RL-16 (18.73) and the lowest one produced by RL-11 (14.00). Spasibionek (2006) [18] reported similar type of results and found positive and significant correlation in number of seeds per siliqua. Binarasha-9 produced the highest 1000 seed weight (2.90 gm.) followed by RL-16 (2.86 gm.) and lowest one produced by RL-14 (2.12 gm.) (Table 1). Javed et al. (2003) [6] demonstrated that number of seeds per siliqua and 1000 seed weight directly influenced the seed yield in rapeseed and mustard. Improvement in seed size i.e., obtaining bold-seeded mutants has also been achieved earlier through induced mutations in oilseed Brassica by Malek et al. (2012) [12] which confirm the present results.

Results and Discussion

A significant variation was observed on the plant height among the mutants and check varieties. Among the mutants, RL-14 produced the tallest plant (87.33 cm). It is statistically similar with Binasarisha-9 (84.40 cm) but shows significant difference with BARI Sarisha-14 (56.33 cm) (Table 1). On the other hand, RL-16 (68.13 cm) produced the shortest plant (Table 1). Plant height may vary due to the genetic effects present among the genotypes and as well as the proper agronomic management. Medium size plants are more likely to produce greater number of branches, number of siliqua per plant and number of seeds per siliqua that leads to higher yield of rapeseed (Javed et al., 2003) [6]. Seys et al. (2006) [6] showed that induced mutation through gamma rays played a significant role in the alteration of plant architecture in rapeseed-mustard. Number of branches per plant is the important morphological parameters contributing to yield. A significant variation was found on the number of branches per plant among the mutant lines (Table 1). Mutant RL-15 produced the highest number of branches (7.93) followed by RL-11 (7.40) and RL-12 (7.27) while Binarasha-4 produced the lowest number (3.40). Genotypes with more branches and siliqua/plant have also been reported in oilseed Brassica (Chauhan and Kumar 1986, Naz and Islam 1979, Shah et al. 1999, Javed et al. 2003, Malek and Monshi 2009) [3, 14, 17, 9, 6, 16] as a consequence of mutagenesis. Binarasha-9 produced the highest siliqua length (7.33 cm) and BARI Sarisha-14 produced the lowest (4.11 cm). Among the mutants RL-11 produced the highest siliqua length (5.63 cm) followed by RL-15 (5.11 cm) and RL-12 (5.05 cm). RL-17 produced the highest no. of siliqua/plant (112.73) followed by RL-12 (100.33) and the lowest no. of siliqua/plant produced by BARI Sarisha-14 (31.87). There is significant difference among the mutant lines than the mother Binasarisha-9 in producing no. of siliqua/plant. Binarasha-9 produced the highest no. of seeds/siliqua (25.80) followed by BARI Sarisha-14 (23.47). Among the mutant lines the highest no. of seeds/siliqua produced by RL-16 (18.73) and the lowest one produced by RL-11 (14.00). Spasibionek (2006) [18] reported similar type of results and found positive and significant correlation in number of seeds per siliqua. Binarasha-9 produced the highest 1000 seed weight (2.90 gm.) followed by RL-16 (2.86 gm.) and lowest one produced by RL-14 (2.12 gm.) (Table 1). Javed et al. (2003) [6] demonstrated that number of seeds per siliqua and 1000 seed weight directly influenced the seed yield in rapeseed and mustard. Improvement in seed size i.e., obtaining bold-seeded mutants has also been achieved earlier through induced mutations in oilseed Brassica by Malek et al. (2012) [12] which confirm the present results.

Table 1: Different yield contributing characters of rapeseed mutants with check varieties

| Mutants/Varities | Plant height (cm) | Branches/plant (no.) | Siliqua length (cm) | Siliqua/plant (no.) | Seeds/siliqua (no.) | 1000 seed weight (gm.) |
|------------------|------------------|----------------------|---------------------|---------------------|---------------------|-----------------------|
| RL-11            | 74.27abc         | 7.40ab               | 5.63b               | 71.93abc            | 14.00c              | 2.79a                 |
| RL-12            | 78.27abc         | 7.27abc              | 5.05bc              | 100.33ab            | 15.53bc             | 2.73a                 |
| RL-13            | 73.40bc          | 5.87c                | 4.34d               | 74.27abc            | 17.13bc             | 2.38bc                |
| RL-14            | 87.33a           | 6.93abc              | 4.74cde             | 77.53ab             | 14.67bc             | 2.12c                 |
| RL-15            | 68.93cd          | 7.93a                | 5.11bc              | 83.40ab             | 15.33bc             | 2.61ab                |
| RL-16            | 68.13cda         | 6.00bc               | 4.92cd              | 72.53abc            | 18.73b              | 2.86ab                |
| RL-17            | 71.27c           | 6.87abc              | 4.53cde             | 112.73a             | 14.47bc             | 2.75ab                |
| Binarasha-9      | 84.40ab          | 3.40d                | 7.33a               | 61.20bc             | 25.80a              | 2.90a                 |
| BARI Sarisha-14  | 56.33d           | 3.80d                | 4.11e               | 31.87c              | 23.47a              | 2.64ab                |
| CV (%)           | 10.27            | 13.15                | 7.32                | 32.27               | 15.12               | 8.74                  |

Plant height showed significant correlation with no. of siliqua/plant and yield. Both no. of siliqua/plant and yield were significant at 5% level. Other yield contributing characters had non-significant correlation with plant height.
Plant height had negative non-significant correlation with no. of seeds/siliqua and 1000 seeds weight that means plant height had no positive influence on those parameters (Table 2). No. of branches/plant showed significant correlation with no. of siliqua/plant and no. of seeds/siliqua at 1% level. No. of branches/plant had negative significant correlation with no. of seeds/siliqua and with other yield contributing characters it had non-significant correlation. Siliqua length showed non-significant correlation with all the yield contributing characters. No. of siliqua/plant showed significant correlation with yield at 1% level and showed negative non-significant correlation with no. of seeds/siliqua and 1000 seeds weight. No. of seed/siliqua showed non-significant correlation with 1000 seeds weight and negative non-significant correlation with yield. 1000 seeds weight showed non-significant correlation with yield (Table 2). Seed yield was significantly and positively correlated with number of siliqua/plant, 1000 seed weight, straw yield, plant height, biological yield and harvest index which implies that seed yield would increase with the increase of these yield attributes. It was also reported by Zehra et al. (2009) [19].

Among the mutant lines, RL-12 produced the highest seed yield (0.88 ton/ha) followed by RL-14 (0.66 ton/ha) and RL-17 (0.64 ton/ha). The lowest seed yield produced by BARI sarisha-14 (0.41 ton/ha) (Fig. 1). The results are supported with the findings of Javed et al. (2003) [6], Seysis et al. (2006) [16] and Zhao et al. (2009) [20] who obtained considerable genotypic variability for seed yield. Mostofa et al. (2016) [13] reported that production of higher yield by different varieties might be due to the contribution of cumulative favorable effects of the crop characteristics viz., number of branches/plant, siliqua/plant and seeds/siliqua.

**Table 2**: Correlation between different yield contributing characters and yield of rapeseed mutants and check verities

| P.H. | Br./P | Siliqua L. | Siliqua/P. | Seeds/S. | 1000S.w. | Yield |
|------|-------|------------|------------|----------|----------|-------|
| P.H. | 1.0000|            |            |          |          |       |
| Br./P| 0.1433*| 1.0000     |            |          |          |       |
| Siliqua L. | 0.4179*| -0.3017NS | 1.0000     |          |          |       |
| Siliqua/P. | 0.5046*| 0.5858* | -0.0967NS | 1.0000   |          |       |
| Seeds/S. | -0.0703NS | -0.7434** | 0.3407NS  | -0.3741NS| 1.0000   |       |
| 1000S.w. | -0.2811NS | -0.1873NS | 0.4242NS  | -0.1027NS| 0.1383NS | 1.0000 |
| Yield | 0.5239* | 0.2702NS  | 0.1957NS  | 0.6263** | -0.1844NS| 0.0795NS| 1.0000 |

NS-Non Significant; *-Significant at 5% level; **- Significant at 1% level
P.H.-Plant height; Br./P-Branches/Plant; Siliqua L.-Siliqua Length; Siliqua/P-Siliqua/Plant; Seeds/S-Seeds/Siliqua; 1000S.w.-1000 Seeds Weight.

Fig 1: Seed yield (ton/ha) of rapeseed mutants with check variety.

Yield is a complex quantitative character governed by large number of genes and is greatly affected by environmental fluctuations. Seed yield is the most important character for considering as a promising variety of a particular crop. Among the mutant lines, the yield of RL-12, RL-14 and RL-17 increased over the check variety Binasarisha-9 and others are decreased. RL-12 showed the highest yield increase (51.72%) over Binasarisha-9 (Fig. 2). RL-13 showed the highest decrease of yield (-12.06%) from Binasarisha-9. Mutants having higher seed yield over mother variety were also reported earlier in rapeseed-mustard (Radoev et al., 2008; Barve et al., 2009; Malek et al., 2012) [15, 1, 12].

All the mutant lines showed the positive yield increase over the check variety BARI sarisha-14 (Fig. 3). Here RL-12 shows the highest % yield increase (114.63%). RL-14 showed the lowest increase (13.79%) of yield over the check variety BARI sarisha-14 among the mutant lines. All the mutant lines showed their yield potentiality over BARI sarisha-14 (Fig. 3).
Conclusion
The mutants showed variation of different morphological and yield contributing characters among them from their mother plant Binasarisha-9. Among the mutants RL-12, RL-14 and RL-17 showed better performance for seed yield and yield contributing character like no. of siliqua/plant and proved as promising lines to be mutant varieties. These three lines showed significant correlation with all the yield contributing characters. This suggests that gamma rays irradiation can be fruitfully applied to develop mutants with higher seed yield and other improved agronomic traits in oleiferous Brassica. RL-12, RL-14 and RL-17 also showed yield increase over Binasarisha-9 and BARI sarisha-14. This study indicated that these lines showed presence of high level of genetic diversity and can be recommended as variety or used in further genetic improvement of rapeseed.

Acknowledgement
The authors gratefully acknowledge for providing various facilities to the research farm of BINA Sub-station, Gopinathpur, Gopalganj.

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