selecting for biological yield and/or economic yield.

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# MUTAGEN INDUCED STRESS RESPONSE AND ITS IMPLICATION IN IMPROVEMENT OF RAPESEED AND MUSTARD

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**ABSTRACT**

An experiment with $M_1$ and $M_2$ generation following treatment of one variety each of mustard *(Brassica juncea)* and rapeseed *(Brassica campestris* var. *toria)* with three different doses of Ethyl methane sulphonate (EMS) and Diethyl sulphate (DES) revealed that the mustard variety is less sensitive than rapeseed variety for EMS whereas the reverse trend was noticed for DES in respect of mutagen induced stress response. The EMS and DES mutagenesis may be recommended for improvement of the rapeseed and mustard varieties respectively. The analysis of stress response is considered helpful in predicting changes in mean and variability of some traits like siliqua per plant and plant height in favourable direction.

KEY WORDS : Rapeseed, Mustard, Chemical Mutagen, Mutation Effects, Stress Response Index.

Physiological damage of primary injury exerted by mutagens is of special interest in genetics and plant breeding (Gaul, 1977). It is generally restricted to $M_1$ generation and sets the practical limit to increasing dose. This can be manifested in terms of changes in germination, survival, growth and developmental traits, Since some of the $M_1$ parameters are correlated with $M_2$ mutation frequency (Gaul, 1977), studies of physiological injury in $M_1$ are often a routine procedure in mutation breeding experiment. In the present investigation, an attempt was made to differentiate the response of rapeseed and mustard in terms of mutagen induced stress in $M_1$ and its relationship with $M_2$ mean and variability of different quantitative traits.

## MATERIALS AND METHODS

The experimental material comprised of $M_1$ and $M_2$ generations following treatment of one variety each of mustard *(Brassica juncea)* and rapeseed *(B.campestris* var. *toria) viz.*, BM 35-9- 9 ·

Table 1. Effect of mutagens: germination, survival, growth and development of $M_1$ plants in TS-29

| Characters | Treatments | | | | | |
|---|---|---|---|---|---|---|
| | Control | 0.25% EMS | 0.50% EMS | 0.05% DES | 0.10% DES | 0.15% DES |
| Germination (%) | 68.5 | 21.50 | 0.03 | 58.17 | 40.50 | 13.83 |
| Survival (% on control) | 100.0 | 32.82 | 4.58 | 85.75 | 55.72 | 19.34 |
| Days to 1st flowering | 19 | 22 | 26 | 20 | 21 | 23 |
| Days to 50% flowering | 25 | 26 | 28 | 25 | 25 | 27 |
| Plant height : | | | | | | |
| Mean (cm) | 66.0 | 59.8 | 76.1 | 68.1 | 66.8 | 73.2 |
| c.v. (%) | 10.3 | 13.1 | 15.2 | 16.1 | 13.3 | 15.1 |
| Primary branches : | | | | | | |
| Mean (No) | 4.0 | 3.7 | 5.5 | 3.6 | 4.1 | 4.1 |
| c.v. (%) | 22.2 | 21.0 | 35.8 | 19.8 | 17.7 | 34.7 |
| No. of silliqua/plant : | | | | | | |
| Mean (No) | 97.7 | 97.6 | 302.7 | 104.8 | 111.1 | 155.1 |
| c.v. (%) | 21.8 | 25.5 | 55.7 | 46.0 | 34.9 | 39.1 |
| Siliqua length : | | | | | | |
| Mean (No) | 4.4 | 4.3 | 3.8 | 4.6 | 4.2 | 4.8 |
| c.v. (%) | 8.7 | 8.3 | 23.4 | 14.7 | 12.3 | 10.4 |
| Seeds/siliqua : | | | | | | |
| Mean (No) | 12.5 | 13.2 | 9.5 | 14.6 | 12.2 | 14.6 |
| c.v. (%) | 13.6 | 9.9 | 26.4 | 23.4 | 14.2 | 12.6 |
| Seed yield/plant : | | | | | | |
| Mean (g) | 2.7 | 3.9 | 4.6 | 2.3 | 2.5 | 4.1 |
| c.v. (%) | 58.0 | 59.6 | 93.1 | 60.7 | 60.9 | 44.7 |

and TS-29 respectively with two chemical mutagens of alkylating group along with appropriate control. The doses of chemical mutagens were 0.25, 0.50 and 0.75 per cent for EMS (Ethyl methane sulphonate) and 0.05, 0.10, 0.15 per cent for DES (Diethyl sulphate). Healthy seeds (600) were soaked in distilled water for 6 h and then treated with freshly prepared mutagen solution for 6 h at room temperature (21.5$^0$C). After treatment, seeds were thoroughly washed in running tap water and were then space planted in field under normal cultural condition during 1991-92 winter. $M_2$ generation was grown during 1992-93 winter with four replications in randomised block design, taking equal quantity of bulked seeds from mutagen treated and control population in $M_1$ generation. The EMS treatment (0.75%) was discarded dut to high lethality.

Observations were taken in $M_1$ generation in respect of germination, survival, flowering and growth traits such as plant height, primary branches, siliqua/plant, siliqua length, seeds/siliqua and seed yield/plant. Data on above traits (Table 1) were utilised to calculate stress response index for different treatments, which is rough measure of stress imposed by chemical mutagen. In $M_2$ generation, means and coefficient of variation (cv) were calculated from observations taken on 20 randomly sampled plants in each replication. These were utilised for estimating correlation with stress response indices of $M_1$ generation.

## RESULTS AND DISCUSSION

As expected, in both the varieties (Tables 1, 2), the germination and survival reduced progressively with increase in dose. The EMS was found to be more damaging than DES. Germination and survival was comparatively low in TS-29 than BM 35-9-9. This discrepancy could be due to differential sensitivity to mutagen treatments because of geneotypic and ploidy differences. Since the oilseeds are usually resistant to mutagens

**Table 2. Effect of mutagens : germination, survival, growth and development of $M_1$ plants in BM 35-9-9**

| Characters | Treatments | | | | | |
|---|---|---|---|---|---|---|
| | Control | 0.25% EMS | 0.50% EMS | 0.05% DES | 0.10% DES | 0.15% DES |
| Germination (%) | 67.67 | 44.50 | 9.16 | 64.17 | 52.17 | 23.17 |
| Survival (% on control) | 100.00 | 63.79 | 12.81 | 94.83 | 73.64 | 34.24 |
| Days to 1st flowering | 35 | 34 | 39 | 34 | 35 | 40 |
| Days to 50% flowering | 42 | 43 | 46 | 41 | 41 | 45 |
| Plant height : | | | | | | |
| Mean (No) | 147.6 | 140.6 | 128.6 | 136.1 | 134.5 | 135.9 |
| c.v. (%) | 9.4 | 11.6 | 14.2 | 10.2 | 13.4 | 12.5 |
| Primary branches : | | | | | | |
| Mean (No) | 3.5 | 3.2 | 3.8 | 2.7 | 3.2 | 3.1 |
| c.v. (%) | 32.5 | 25.0 | 39.2 | 33.1 | 30.0 | 29.6 |
| Silliqua/plant : | | | | | | |
| Mean (No.) | 121.4 | 109.7 | 135.3 | 79.9 | 84.2 | 89.2 |
| c.v. (%) | 58.0 | 49.8 | 62.2 | 53.2 | 49.2 | 74.9 |
| Siliqua length : | | | | | | |
| Mean (No.) | 3.9 | 3.8 | 3.9 | 3.9 | 4.1 | 4.0 |
| c.v. (%) | 15.6 | 13.4 | 14.7 | 8.7 | 11.1 | 14.4 |
| Seeds/siliqua : | | | | | | |
| Mean (No) | 9.0 | 10.0 | 10.0 | 8.8 | 9.2 | 9.7 |
| c.v. (%) | 31.7 | 18.8 | 28.5 | 24.3 | 30.3 | 37.8 |
| Seed yield/plant : | | | | | | |
| Mean (g) | 3.3 | 2.9 | 4.2 | 2.2 | 2.1 | 2.5 |
| c.v. (%) | 99.7 | 57.5 | 69.1 | 62.1 | 53.8 | 102.5 |

**Table 3. Stress Response Indices for different treatments of $M_1$ generation in TS-29 and BM 35-9-9**

| Treatments | TS-29 | BM 35-9-9 |
|---|---|---|
| 0.25 % EMS | 0.60 | 0.55 |
| 0.5 % EMS | 0.80 | 0.60 |
| 0.05 % DES | 0.45 | 0.30 |
| 0.10 % DES | 0.55 | 0.35 |
| 0.15 % DES | 0.55 | 0.80 |

and germination was even lower in control, suitable manipulation of presoaking and treatment duration is required to realise the effects of induced mutations in higher doses.

Usually two distinct effects in quantitative traits were encountered in $M_1$ generation *i.e.*, general reduction in mean values and increase in variability. However, some exceptions were noticed like increase in mean values in TS-29 and decrease in CV. in BM 35-9-9 for number of treatments for different characters. The days to flowering was however delayed slightly in treated population of both the varieties.

**Table 4. Correlation coefficients between Stress Response Index (SRI) and $M_2$ - cv and $M_2$ - means for different characters in TS-29 and BM 35-9-9**

| Characters | $M_2$ cv Vs. SRI | | $M_2$ mean Vs. SRI | |
|---|---|---|---|---|
| | TS-29 | BM 35-9-9 | TS-29 | BM 35-9-9 |
| Plant height | 0.775 | 0.129 | -0.207 | 0.478 |
| Primary branches | -0.019 | 0.472 | 0.111 | 0.388 |
| Siliqua per plant | -0.542 | 0.796 | 0.738 | 0.354 |
| Siliqua length | 0.064 | 0.244 | -0.897 | -0.563 |
| Seeds per siliqua | 0.125 | -0.406 | -0.643 | -0.555 |
| Seed yield per plant | -0.586 | 0.183 | -0.409 | 0.263 |

* Significant correlation coefficient (P=0.05)

The mutagens at higher doses adversely affect growth and development of plants at different stages, which may be considered as a certain form of environmental stress. A large number of characters were used for estimation of a parameter 'Stress Response Index (SRI)', as a measure of physiological stress imposed by mutagens. The rationale for this approach was obtained from the observations of Johnson and Frey (1967) in oats and Sinha and Patnaik (1969) in rice regarding

phenotypic expression of quantitative characters under stress and non stress conditions. Same information was utilised for distinguishing mutagens as evocators of stress response and also distinguishing the genotypes for their response to mutagens as stress agents through the physiological effects. SRI was calculated for each variety-treatment combination adopting a method of Subudhi (1983), comprising of following steps:

All the characters noted in Table 1 and 2 were used.

For each of the character (growth and developmental quantitative traits), reduction in mean values compared to control was given an index score of 1. Similarly increase in cv compared to control was also given index score of 1. In the event of no change or reverse change, score was given 'o'. Thus for each of the 6 traits, index score would vary from 0to 2.

For flowering, appreciable delay in first flowering and 50 per cent flowering (3 days considered) was given index score of 1. Conversely the score '0' was given for no change or reverse change.

For each of the remaining two aspects, germination and survival, reduction to the tune of 10 per cents of control was given index score of '0' between 11-30 per cent was given the score '1' between 31-50 per cent was given score '2' and reduction beyond 50 per cent was scored as '3'.

These individual scores were summed up to obtain a total index score, that would have limits 0-20

The total index score was finally devided by 20 (the maximum value) to obtain SRI with the maximum value of 1.0

SRI values (Table 3) indicated that the range was 0.45 to 0.80 in TS-29 and 0.30 to 0.80 in case of BM 35-9-9. Comparing both the varieties for EMS, BM 35-9-9 appear to be less sensitive or variable than TS-29. However reverse trend was noticed for DES treatments *i.e.* TS-29 less sensitive or variable than BM 35-9-9. Considering this, EMS mutagenesis may be fruitful in TS-29 whereas DES mutagenesis may be recommended for improvement of mustard variety BM 35-9-9.

It is necessary to study the relationship between stress response of $M_1$ generation and changes in mean and variability of different traits in $M_2$ to ascertain whether physiological damage sets the limit for these parameters. Thus correlation coefficients were calculated between stress response indices and $M_2$ mean and cv taking into account the EMS and DES treatments.

Considering $M_2$ cvvs SRI in TS-29 (Table 4) highest but non- significant 'r' of 0.775 was observed for plant height while 'r' value of 0.796 for siliaua/plant followed by 0.472 for primary branches was noticed in BM 35-9-9. Thus, there is increase in micromutational variability with increase in stress imposed by the mutagens. In BM 35-9-9, most of the 'r' values were positive except seeds/siliqua whereeas the reverse was the case for TS-29. Data on $M_2$ mean Vs. SRI (Table 4) revealed significant negative correlation (-0.897) for siliaua length and 'r' of 0.738 for siliqua/plant in TS-29. Similarly, possitive correlations were observed for plant height, primary branches, siliqua/plant and seed yield/plant in BM 35-9-9. Thus the association of $M_2$ parameters with stress response depends on genotypic differences and the characters under consideration. This type of analysis of stress response may be helpful in predicting changes in mean and variability of specific traits like siliqua/plant, plant height etc. in favourable direction.

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