# INDUCED SEMI-DWARF MUTANTS *IN TRITICUM AESTIVUM* L

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Monosomic seed for chromosome 2A, 2B and 2D of variety Bersee was treated with 0.5 per cent EMS for 17 hours, as a result three semi-dwarf mutants were recovered in a homozygous euploid form, The height reductions for these semi-dwarf mutants varied between 25.46 and 40.81 per cent of Bersee. The semi-dwarf mutations seemed to be associated with a reduction in coleoptile length, low grain weight and reduced fertility.

## INTRODUCTION

A number of interesting mutants in wheat and other crop plants have been produced artificially through application of physical and chemical mutagens (Borojevic, 1960; Konzak *et al.* 1969 a; Bogyo *et al.* 1969; Qualset *et al.* 1970 Wall *et al.* 1971). Some of these mutants affect plant height. Artificially induced semi-dwarf mutants may offer additional sources for height reduction to the wheat breeders.

The induced semi-dwarf mutants in wheat may result due to a mutation at a single locus (Bozzini and Scarascia-Mugnozza, 1967; Konzak *et al.* 1969b; Qualset *et al.* 1970) and can either be recessive (Konzak *et al.* 1969a) or dominant (Konzak *et al*, 1969b; Qualset *et at.* 1970) in their expression.

Due to polyploid nature of hexaploid wheat many genes are duplicated and triplicated. It is this diversity of gene dosage which allows wheat to tolerate gross chromosomal aberrations. It also is responsible for masking the activities of many mutants that are "recessive" relative to alleles at homoeologous loci, so that dominant and semi-dominant genes are more frequently recovered in the hexaploid wheat compared with its tetraploid and diploid relatives. For the same reasons the frequency of mutant recovery is also much less in the hexaploid wheats (Borojevic 1970).

A possible way of increasing the rate of mutant recovery in wheat was suggested and exploited by Tsunewaki and Heyne (1959). They used monosomic rather than euploid lines in their experiment on mutagenesis in order to improve their chances of detecting and thereby recovering recessive mutations.

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The intention of the present investigation was to exploit monosomic lines of wheat for inducing semi-dwarf mutation.

## MATERIALS AND METHODS

So far the character plant height is concerned the most marked effect of monosomy has been produced by the chromosomes of homoeologous gronp 2 (Gale and Law 1973) of variety Bersee.

Seed collected from the selfed monosomic plants for chromosome 2A, 2B and 2D of the variety Bersee was treated with ethylmethanesulphonate (EMS). Aqueous solution of EMS was prepared in distilled water. The seed was soaked in EMS solution in a flask at 20°C. After treatment the solution was carefully decanted and washed for 15 minutes under running tap water. A concentration of 0.5 per cent for 17 hours was used which gave rise to approximately a 50.00 per cent germination rate. The germinated seedlings were grown to maturity in a glass-house.

The treated seedlings were grown in the glass house. Since the phenotypes of the monosomic plants of group 2 of Bersee are easily distinguishable from the euploid by their short stature and since the required mutants are also in the directions of reduced height, then selection for short stature at this stage will be composed of plants predominantly non-mutant and monosomic and a few monosomic mutants. The only exception to this will be the induction of a dominant mutant for dwarfism in a disomic or euploid individual. Spikes from the semi-dwarf plants were therefore carefully bagged to obtain selfed seed. $M_2$ generation was again grown in pots comprising 169 progenies selected from $M_1$ generation.

The $M_3$ generation, comprising 380 progenies was sown in the field during 1971. The families which were shorter than their controls were checked cytologically and their chromosome number ascertained. Only two families (i) 13-685-5 and (ii) 13-818-10 from $M_3$ population derived initially from monosomic 2 B were uniformally shorter than the control and were found to be disomic. A third semi-dwarf mutant 13-1047-3-1 was also recovered in a disomic form in the $M_4$ generation.

## RESULTS

A brief description of the semi-dwarf mutants is given separately as under.

i) MUTANT 13-685-5:

The mean plant height of this mutant was 86.30 cm (Table 1) which

is 29.46 per cent shorter than the parent variety Bersee. The reduction in total height is due to proportionate reductions in all internodes. However, if the individual internodes of the mutant are compared with respective internodes of Bersee, the top two internodes contributed a smaller proportion of the total height whereas the basal two internodes contributed a greater proportion than the control.

ii) MUTANT 13-818-10:

The mutant was awnless. The total plant height was 77.32 cm which is 36.80 per cent shorter than Bersee (Table 1). The reduction in total plant height appeared to be due to reductions in all the internode lengths. However, a major part of the reduction, 39.60 and 20.59 per cent respectively was found in the first and second internodes.

iii) MUTANT 13-1047-3-1 :

This semi-dwarf mutant was awned and the total plant height was 72.41 cm (Table 1) which is 40.80 per cent shorter than Bersee, The reduction in the total plant height was due to a proportionate reduction in all the internodes. The first and the second internodes contributed 33.03 and 21.23 per cent respectively of the total plant height which was not much different from the contribution of these two internodes in Bersee (Control).

AGRONOMIC CHARACTERS OF THE SEMI-DWARF MUTANTS:

All the three semi-dwarf mutants produced significantly ($P < 0.001$) shorter coleoptiles than the control variety Bersee (Table 2). The mutant line 13-1047-3-1 having shortest coleoptile was the shortest in total plant height.

The spike of Bersee contributed 10.49 per of the total height of the plant. The spike lengths in the mutants 13-818-10 and 13-1047-3-1 on the other hand, comprised 14.61 and 13.63 per cent of the total height respectively. Mutant 13-685-5 was however similar to Bersee since its spike length comprised 10.93 per cent, consequently for two of the mutants, the reduction in height had not been accompanied by a proportionate reduction in spike length. However, the mutant lines showed reductions in 250 grain weight, coleoptile length and fertility (Table 3). An association between the semi-dwarf mutant character and reduction in seed size, grain yield and coleoptile length has also been reported by earlier workers (Qualset *et al.* 1970; Djalepov 1971).

TABLE 1: *Total plant heights and lengths of the Internodes of the semi-dwarf mutants and Berse e.*

| Internode | Bersee | | Mutant 13—818—10 | | | Mutant 13-1047-3-1 | | | Mutant 13-685-5 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | length (cm) | Percentage of total height | length (cm) | Percentage of total height | Percentage of total reduction | length (cm) | Percentage of total height | Percentage of total reduction | length (cm) | Percentage of total height | Percentage of total reduction |
| Internode 1 | 46.20 | 37.76 | 30.62 | 39.60 | —34.61 | 23.92 | 33.03 | —44.62 | 29.57 | 34.26 | —46.14 |
| „ 2 | 27.48 | 22.46 | 15.92 | 20.59 | —25.68 | 15.37 | 21.23 | —24.25 | 16.80 | 19.47 | —29.63 |
| „ 3 | 17.43 | 14.25 | 10.69 | 13.83 | —14.97 | 11.04 | 15.25 | —12.80 | 11.71 | 13.57 | —15.87 |
| „ 4 | 11.03 | 9.02 | 6.55 | 8.47 | — 9.95 | 7.77 | 10.73 | — 6.53 | 9.60 | 11.12 | — 3.97 |
| „ 5 | 5.70 | 4.66 | 2.24 | 2.90 | —11.39 | 3.72 | 5.14 | — 7.31 | 6.76 | 7.83 | + 2.94 |
| „ 6 | 1.67 | 1.37 | — | — | — | — | — | — | 2.43 | 2.82 | + 2.11 |
| Spike | 12.83 | 10.49 | 11.30 | 14.61 | — 3.40 | 10.50 | 14.63 | — 4.49 | 9.43 | 10.93 | —29.43 |
| Total plant height | 122.34 | — | 77.32 | — | —36.80 | 72.41 | — | —40.81 | 86.30 | — | —29.46 |

TABLE 2: *Mean Coleoptile lengths of the Semi-dwarf mutants and Bersee.*

| *Line* | *Mean length in m m* |
|---|---|
| Bersee | 67.2475 ± 0.7737 |
| Mutant 13-818-10 | 59.5434 ± 06122** |
| Mutant 13-685-5 | 59.1794 ± .7871** |
| Mutant 13-1047-3-1 | 47.9176 ± 0.6585*** |

Difference from Bersee ** P 0.01-0.001 *** P <0.001

TABLE 3: *Grain weight and fertility (% seed set) of the semi-dwarf muntants and the parent variety Barsee.*

| *Line* | *250 grain weight in gm* | *Fertility (% seed set)* |
|---|---|---|
| Barsee | 12.68 | 92.97 |
| Muntant 13-818-10 | 12.06 | 85.00 |
| Muntant 13-1047-3-1 | 11.32 | 85.24 |
| Muntant 13-685-5 | 11.72 | 87.76 |

Correlation coefficients between height and other characters were calculated for these mutant lines and the results are presented in Table 4. A positive correlation exists between plant height, coleoptile lengths, fertility and 250 grain weight only. The results differ to some extent from those of Djelepov (1971), who established a positive correlation between plant height and spike length in a large number of mutants whose heights ranged from 55.20 to 19.30 cm. In the present case, this correlation although positive was not significant.

TABLE 4: *Correlation coefficients in Bersee and semi-dwarf mutants.*

| | Total plant height | 250 grain weight | Fertility | Coleoptile length |
|---|---|---|---|---|
| Spike length | 0.7108 | 0.8097* | 0.6168 | 0.7848* |
| Coleoptile length | 0.8409* | 0.9462*** | 0.7848* | |
| Fertility | 0.9882*** | 0.7954* | | |
| 250 grain weight | 0.8753** | | | |

* P 0.05—0.01** P 0.01—0.001*** P <0.001

## DISCUSSION

As a result of the EMS treatment of homoeologous group 2 monosomic

lines of Bersee, three semi-dwarf mutants, two appearing in $M_2$ generation and one in the $M_4$ generation were recovered in a disomic form ($2n = 42$). The mutants are homozygous and produce the semi-dwarf phenotype and also affect the morphological characters. The reduction in total plant height exhibited by these mutants compared with Bersee itself ranged from 29.46 to 40.81 per cent. The general pattern of internode elongation was similar to Bersee except in the case of mutant 13—685—5. In all cases, the top internode or peduncle constituted a larger proportion of total plant height than any of the other internodes, the second a slightly smaller proportion and so on.

The reduction of total plant height of the semi-dwarf mutants was also accompanied by a number of undesirable agronomic effects. Coleoptile length was reduced and so were 250 grain weight and fertility. Similar results have also been reported by other workers (Qualset *et al*, 1970; Djelepov 1971) There was also a reduction in spike length compared with the spike of Bersee but this reduction was not closely correlated with total plant height. Considering the contributions of each of the individual internodes and the spike to total plant height, it is evident that for the mutant 13—685—5 and Bersee, the spike contributed approximately 11 per cent of this whereas in the other two mutants the proportionate contribution of the spike was more than 14 per cent. Spike length therefore did not follow the similar patterns of reduction as shown by the internodes. The results however, differ from those of Djelepov (1971) who observed a positive correlation between plant height and spike length in a number of dwarf mutants.

The positive correlation shown by the semi-dwarf mutants for 250 grain weight, coleoptile length and fertility is of some concern. Reports of other induced semi-dwarf mutants also indicate lower yields, accompanied by reductions in other characters. Nilan (1966) has suggested that deleterious pleiotropic effects are a common feature of induced mutations in the higher plants. Many of the mutations produced by Gaul (1964) and Aastveit (1970) had also deleterious side effects and they have carried out breeding programmes which reduced the less desirable effects of the mutant but yet maintain its advantages (Aastveit, and Gaul, 1967; Aastveit, 1970).

Apparently these marked reductions in height brought about by single gene changes are frequently associated with changes in other characters, probably resulting from pleiotropy. In this connection it is perhaps worth mentioning that wheat breeders during early development of short statured

wheats in the USA were confronted with similar problems of low fertility, low grain weight and small coleoptiles (Briggle and Vogel, 1968). It is only after intensive selection in which other gene backgrounds were used, that these deleterious effects were reduced.

These observations possibly indicate that the mutant genes involved in height reduction affect basic developmental and growth process, so that many drastic side effects are likely. The homoeologous group 2 chromosomes have been implicated in gibberellin synthesis (Gale and Law, 1973) which is of course a process of fundamental importance in growth possibly affecting most developmental stages. Mutations among the genes affecting synthesis of gibberellin are therefore likely to produce these drastic effects on many characters apart from height.

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