# PROTEIN AND MALT QUALITY IN SOME GAMMA-RAY INDUCED HIGH YIELDING MUTANTS IN BARLEY (*HORDEUM VULGARE*)

S. V. S. CHAUHAN, R. KUMAR
Department of Botany, R. B. S. College, Agra-282002 (India)

and Toshiro KINOSHITA
Plant Breeding Institute, Faculty of Agriculture,
Hokkaido University, Sapporo 060, Japan

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## Introduction

Mutation breeding is widely used nowadays for improvement in various crops including barley.[1,6,13] The present paper summarizes the results, obtained on the protein and malt quality of some high yielding mutants obtained from *Hordeum vulgare* L. var. DL-36, a six-rowed variety, by gamma-ray irradiation.

## Materials and Methods

The dry seeds (moisture content 5.2 per cent) of variety DL-36 were irradiated with 10, 20 and 25 kR gamma-rays at the Indian Agricultural Research Institute, New Delhi. Pre-soaked seeds (12 h) were treated with 0.1, 0.2 and 0.3 per cent ethylmethane sulphonate (EMS) and 0.01, 0.02 and 0.03 per cent nitrosomethyl urea (NMU) for 4.5 h at $2.3\pm2$°C and sown in the field. From the plants thus raised three spikes per plant were collected at random. Progeny of individual spikes was raised by dibbling in a single row under randomized block design to obtain the $M_2$ generation. Five plants with higher effective tillering over control were screened from 25 kR gamma-ray treated population. The seeds of these plants were sown separately to observe their breeding behaviour in $M_3$. Grain proteins in the $M_2$ and $M_3$ generations of the mutant and control plants were estimated quantitatively by the microkjeldahl method after SNELL and SNELL.[12] The malting quality of grains of these mutants was compared with that of the parental variety by substituting the known values on seed size, hull percentage and protein percentage in the following formula recommended by M/S Mohan Meakins,

Brewers and Distillers, Mohan Nagar, Gazhiabad, U. P.[2)]

$$E = 94.3 - (0.48 \times \% \text{ husk}) - (0.85 \times \% \text{ protein}) + (0.14 \times \% \text{ seeds equal to or more than 2.8 mm in width})$$

## Results and Discussion

The frequency of high yielding mutants in variously treated populations is given in Table 1. As is evident from Table 1, five high yielding plants namely GRHy 1-GRHy 5 were obtained from a $M_2$ population of 21849. However, these mutants were screened from the 25 kR gamma-ray treated $M_2$ population.

TABLE 1. Total $M_2$ population, number of plants mutated and their frequency

| Mutagen | | Total $M_2$ plants | No. of plants mutated | % $M_2$ plants mutated |
|---|---|---|---|---|
| Gamma-rays | | | | |
| kR | 10 | 3452 | 0 | 0 |
| | 20 | 3021 | 0 | 0 |
| | 25 | 2952 | 5 | 0.17 |
| EMS (%) | 0.1 | 2328 | 0 | 0 |
| | 0.2 | 2226 | 0 | 0 |
| | 0.3 | 2109 | 0 | 0 |
| NMU (%) | 0.01 | 2006 | 0 | 0 |
| | 0.02 | 1870 | 0 | 0 |
| | 0.03 | 1885 | 0 | 0 |
| | Total | 21849 | 5 | 0.023 |
| | Control | 3211 | 0 | 0 |

Data on height, effective tillers per plant, days to maturity, spike length, seeds per spike, 1000 grain weight and total yield per plant in these mutants are presented in Table 2. It is apparent that all the high yielding mutants were taller than control plants. The spike length in the mutants was more or less similar to that of the control, but there was a slight increase in the number of the spikelets per spike. However, the maturity of these mutants was delayed by 6-8 days over control. The breeding behaviour of these mutants was observed in $M_3$ generation (Table 3).

TABLE 2. Plant height, number of effective tillers/plant, days to maturity, spike length, seeds/spike, 1000 grain weight and total yield/plant of the mutants screened in $M_2$

| | GRHy 1 | GRHy 2 | GRHy 3 | GRHy 4 | GRHy 5 | Control |
|---|---|---|---|---|---|---|
| Plant height (cm) | 96.0 | 100.0 | 92.0 | 96.0 | 90.0 | 76.0 |
| No. of tillers/plant | 51 | 50 | 49 | 52 | 50 | 8 |
| Days to maturity | 126 | 126 | 126 | 128 | 126 | 120 |
| Spike length (cm) | 16.0 | 15.8 | 15.0 | 15.0 | 16.0 | 13.5 |
| Seeds/spike | 52 | 50 | 50 | 51 | 51 | 48 |
| 1000 grain wt, (g) | 48.6 | 47.9 | 47.3 | 48.4 | 47.5 | 44.5 |
| Total yield/plant (g) | 151.15 | 148.25 | 139.35 | 149.32 | 148.80 | 17.63 |

TABLE 3. Plant height, number of effective tillers/plant, days to maturity, spike length, seeds/spike, 1000 grain weight and total yield/plant of the mutants in $M_3$ (Mean value of 50 plants)

| | GRHy 1 | GRHy 2 | GRHy 3 | GRHy 4 | GRHy 5 | Control |
|---|---|---|---|---|---|---|
| Plant height (cm) | 96.0 | 99.76 | 92.0 | 96.2 | 91.0 | 75.91 |
| | ±4.3 | ±3.6 | ±4.1 | ±2.9 | ±3.2 | ±3.2 |
| No. of tillers/plant | 51 | 51 | 50 | 52 | 51 | 8 |
| | ±2 | ±2 | ±3 | ±2 | ±2 | ±0 |
| Days to maturity | 125 | 127 | 126 | 129 | 127 | 120 |
| Spike length (cm) | 16.0 | 15.71 | 15.21 | 15.14 | 16.1 | 13.5 |
| | ±0.5 | ±0.62 | ±1.2 | ±0.9 | ±1.2 | ±0.6 |
| Seeds/spike | 54 | 52 | 51 | 53 | 52 | 49 |
| | ±4 | ±3 | ±2 | ±4 | ±2 | ±2 |
| 1000 grain wt, (g) | 49.4 | 48.7 | 47.7 | 49.1 | 46.9 | 43.6 |
| Total yield/plant (g) | 152.12 | 150.24 | 148.71 | 151.73 | 152.64 | 18.21 |

± standard deviation.

Improvement in vigour in barley through gamma-ray treatment has also been reported earlier by CONGER *et al.*[4], KOZACHENKO[8], KUMAR and CHAUHAN[9] and CHAUHAN and KUMAR.[3]

The boldness and uniformity of the grains in mutants were significantly higher as compared to those of control (Table 4). The 1000 grain weight

TABLE 4. Amount of protein, husk and malting potential of the mutants in $M_2$ and $M_3$ generations and control

| Mutants | Hull (%) | | Seeds equal or more than 2.8 mm (%) | | Protein | | Malt extract | |
|---|---|---|---|---|---|---|---|---|
| | $M_2$ | $M_3$ | $M_2$ | $M_3$ | $M_2$ | $M_3$ | $M_2$ | $M_3$ |
| GRHy 1 | 9.16 | 10.12 | 26.2 | 25.8 | 13.750 | 13.612 | 81.89 | 81.71 |
| GRHy 2 | 9.00 | 10.23 | 25.0 | 25.2 | 12.375 | 12.711 | 83.13 | 82.97 |
| GRHy 3 | 11.15 | 9.70 | 27.35 | 26.7 | 12.683 | 13.012 | 81.85 | 81.52 |
| GRHy 4 | 9.91 | 9.61 | 26.8 | 26.5 | 13.000 | 13.121 | 82.24 | 81.96 |
| GRHy 5 | 10.35 | 10.72 | 25.00 | 25.2 | 13.601 | 12.971 | 81.28 | 81.11 |
| Control | 8.45 | 9.21 | 4.4 | 4.3 | 12.291 | 12.621 | 86.57 | 85.99 |

in mutants increased significantly over control plants and was highest in the mutant GRHy 1 (49.400 g) as compared to that of control (43.600 g). It was encouraging to note that the overall yield of the mutants was approximately 8 times higher than the parental variety (Tables 2 & 3). Improvement in yield and yield attributes through mutation breeding in barley has been recorded by several investigators.[3,7,8,11] According to SHARMA and SUTAR,[11] grain weight, a polygenic trait, is a most dependable character since this shows a high heritability. Improvement in yield based on 1000 grain weight is more reliable than other polygenic traits like tillering and spike length, which are under the influence of the environment. The present experiment has also indicated clearly that high yielding mutants were superior in 1000 grain weight.

Table 4 shows the percentage of hull, protein and malt in grains of the mutants and control plants. These results indicate that there was only a slight difference in the protein contents of the grains of the mutants (GRHy 1, GRHy 4 and GRHy 5) as compared to that of parental variety. However, the malting quality of the mutants was slightly reduced. This may be due to an increase in hull percentage in the grains of the mutants (9–11.15 per cent) as compared with that of control (8.45 per cent). A positive correlation between seed size and protein percentage and selection for increased seed weight without concomitant decrease in grain number per plant is considered as a good phenotypic marker for better genotypes with higher yield and protein contents.[5,11]

All the mutants in the present study show a better yield than do control plants. According to ANNONYMOUS[2], high malt barley and uniform grains are needed with lower protein and less hull. Our results are not in agreement

with this, because the high yielding mutants had a higher percentage of hull and were inferior in malt extractability as compared with the parental variety.

These mutants are being subjected to further analysis to identify strains not only superior in yield and protein contents but also in malt quality. This is being attempted by crossing these mutants with sister isolates superior in these qualities.

## Summary

The results of various yield traits of five high yielding mutants isolated from 25 kR gamma-ray treated $M_2$ population of a six rowed barley var. DL-36 are reported. The data collected on these mutants showed that they were superior over control in height, number of effective tillers, total grain yield and protein percentage. Though the mutants possessed high grain yields, malt quality declined due to the increase in hull percentage.

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