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

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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 $2.3 \pm 2^\circ\text{C}$ 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.²⁹

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

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 ± 4.3	99.76 ± 3.6	92.0 ± 4.1	96.2 ± 2.9	91.0 ± 3.2	75.91 ± 3.2
No. of tillers/plant	51 ± 2	51 ± 2	50 ± 3	52 ± 2	51 ± 2	8 ± 0
Days to maturity	125	127	126	129	127	120
Spike length (cm)	16.0 ± 0.5	15.71 ± 0.62	15.21 ± 1.2	15.14 ± 0.9	16.1 ± 1.2	13.5 ± 0.6
Seeds/spike	54 ± 4	52 ± 3	51 ± 2	53 ± 4	52 ± 2	49 ± 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

\pm standard deviation.

Improvement in vigour in barley through gamma-ray treatment has also been reported earlier by CONGER *et al.*⁴⁾, KOZACHENKO⁸⁾, KUMAR and CHAUHAN⁹⁾ and CHAUHAN and KUMAR.⁹⁾

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 M₂ and M₃ 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 ANONYMOUS², 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 M₂ 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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