

## Study of M<sub>4</sub> and M<sub>5</sub> Generations of Finger Millet (*Eleusine coracana* L. Gaertn) and Quality Analysis of Promising Mutants

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**Abstract** A field experiment was conducted during *rabi* 2013 and *kharif* 2014 to study variability among the mutant cultures of Dapoli-1 cultivar of finger millet (*Eleusine coracana* Gaertn). The 58 mutant cultures during M<sub>4</sub> generation and 23 promising cultures during M<sub>5</sub> generations were evaluated for nine quantitative characters. The mean performance of different characters showed wide range of variation and the magnitude of change over the parent varied with the character. The estimates of heritability (BS) was very high for days to maturity (97.04%), length of finger (96.12%) and plant height (92.41%) for M<sub>4</sub> generation, while it was high for grain density (95.71%), days to first flowering (87.65) and days to 50% flowering (80.87%) in M<sub>5</sub> generation. Genetic advance estimates showed that selection in M<sub>4</sub> generation would be effective in bringing about improvement in yield/plant and its direct components like tillers/plant, fingers/ear and length of finger. Twenty three promising cultures selected from M<sub>4</sub> generation and 10 promising cultures identified from M<sub>5</sub> generation were isolated on the basis of higher yield and early maturity. Ten promising mutants were analyzed to determine their proximate composition of protein calcium and

iron content. These results indicate that the nutritional value of finger millet may be significantly improved by mutation breeding.

**Keywords** Finger millet, Physical mutagens, Variability, Quality parameters.

### Introduction

Finger millet probably originated in India as many of the forms exists in this country [1]. Finger millet is also called as Ragi, Nachani and Nagli. *Eleusine*, the generic name, after the *Elusine* the Greek Goddess of cereals and is a genus of grasses sometimes called by the common name goose grass (Wikipedia).

In Maharashtra, finger millet occupies an area of about 117 thousand ha with an annual grain production of 125 thousand tones with productivity 1068 kg ha<sup>-1</sup> [2, 3]. The largest area of finger millet is in Konkan region (47,100 ha) with an annual production 48,000 ton [4]. There is a need to improve the productivity of finger millet by utilizing the large number of germplasm or varieties in breeding program.

Unlike hybridization and selection, mutation breeding has the advantage of improving a defect in an otherwise elite cultivar, without losing its agronomic and quality characteristics [5]. Mutation breeding is the only straight forward alternative for crop improvement in plants having small size florets which

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is very difficult for emasculation and hybridization. Muduli and Misra [6] observed plant characters changes with mutagens, their doses and variety. The present investigation was undertaken to study the effect of gamma rays on yield and its component traits and to develop tolerant genotype to blast disease in an established variety of Finger millet Namely Dapoli-1.

### Materials and Methods

The study was conducted on 58 mutant lines selected from  $M_3$  generation developed by mutagenesis from Dapoli-1 variety of finger millet. Initially the seeds of the variety were treated with four doses of a physical mutagen ; gamma rays i.e. 400 Gy, 500 Gy, 600 Gy and 700 Gy during *kharif* 2011 with gamma rays ( $^{60}\text{Co}$ ) at BARC, Trombay. The  $M_1$ ,  $M_2$  and  $M_3$  generations along with control (untreated seeds), were grown subsequently at experimental farm of Botany Department, College of Agriculture, Dapoli and 58 desirable mutant lines were selected from  $M_3$  generation to raise  $M_4$  generation.

#### Harvesting of $M_4$ plants and raising of $M_5$ generation

The 58 mutant lines were grown to raise  $M_4$  generation along with control (untreated seeds of Dapoli-1) during *rabi* 20013-14. Observations on days to first flowering, days to 50% flowering and maturity were recorded separately in each replication. Observations on plant height (cm), length of finger (cm), tillers per plant, fingers per ear, grain density and grain yield per plant (g) were recorded on 5 randomly selected plants from each replications. Desirable 23 mutants were selected from  $M_4$  generation. The seeds of 23 mutants along with control were sown in *kharif* 2014 for raising  $M_5$  generation.

### Results and Discussion

Wide range of variation was observed during  $M_4$  and  $M_5$  generation for days to first flowering among the mutant cultures. The early mutant culture DML-7 and DML-33 flowered within 61.67 and 63 days respectively and the DML-74 (77.67) showed late flowering. First flowering among the mutant cultures was de-

layed during  $M_5$  (*kharif*). Similar results were also reported by Hayat et al. [7] in sorghum and Muduli and Mishra [6] in finger millet. Of the 58 cultures evaluated during  $M_4$  generation, 18 mutant cultures showed significantly earlier days to 50% flowering than the parent variety. The cultures DML-7, DML-33 and DML-17 showed 50% flowering earlier i.e. 67, 68.67 and 72.33 days, respectively. While during  $M_5$  generation, DML-33 and DML-29 showed early 50% flowering i.e. 83 and 93.50 days respectively. Such variation for days to 50% flowering is also reported by Chakravarti et al. [8] in aromatic rice. In  $M_4$  generation, population mean for maturity was observed in correspondence with parent variety. The cultures DML-33 (103), DML-7 (107.67) and DML-8 (110.67) showed early maturity during  $M_4$  generation. In  $M_5$  generation the mutant lines DML-7 and DML-33 showed early maturity within 116 and 117 days respectively. Muduli and Misra [9] in finger millet. In case of  $M_4$  generation most of the mutant cultures were significantly taller than parent variety. Among 58 mutant cultures DML-67 (96.93 cm) was the tallest, while DML-1 (56.27 cm), and DML-2 (58.33 cm) recorded lowest plant height. During  $M_5$  generation only DML-8 (94.10 cm), DML-7 (99.70 cm) and DML-11 (99.80 cm) mutant cultures were significantly shorter than the parent. Similar results were reported by Hayat et al. [7] in sorghum. The wide range of variation (4.77 to 11.63 cm) in finger length among the mutant cultures was observed during  $M_4$  generation. Among the 58 mutant cultures DML-55 (11.63 cm), DML-79 (9.97 cm) and DML-16 (9.90 cm) produced longest finger, while DML-49 (4.77 cm) produced shortest finger. During  $M_5$  generation among the 23 mutant cultures 7 cultures showed significant increase in finger length. The mutant cultures DML-7 (12.80 cm) and DML-55 (12.60 cm) produced longest finger. Such variation for finger length was also reported by Muduli and Misra [6, 9] in finger millet. During  $M_4$  generation 65% mutant cultures showed significantly lower tillers / plant while only two cultures i.e. DML-16 (5.87) and DML-28 (5.80) produced significantly more tillers as compared to parent variety. Significantly less tillers per plant were produced by all the 23 cultures than parent variety during  $M_5$  generation. Chakravarti et al. [8] also reported wide range of variation for tillers per plan in rice. Significantly more fingers / ear were observed in mutant cultures DML-10

**Table 1.** Mean, range and genetic parameters in  $M_4$  generation for all characters.

Characters	Mean	Range	Vg	Vp	PCV	GCV	$h^2_{(bs)}$	GA
Days to first flowering	73.48	61.67 to 77.67	8.49	9.79	4.26	3.96	86.73	5.59
Days to 50% flowering	77.12	67.00 to 83.33	7.04	10.49	4.20	3.44	67.13	4.48
Days to maturity	119.87	103.00 to 5.33	25.44	26.21	4.27	4.21	97.04	10.24
Plant height (cm)	80.11	56.27 to 96.93	158.49	171.51	16.35	15.71	92.41	24.93
Length of finger (cm)	8.35	4.47 to 11.63	1.11	1.16	12.86	12.61	96.12	2.13
Tillers / plant	3.35	1.87 to 5.87	1.23	1.57	37.32	33.10	78.66	2.03
Fingers / ear	6.86	5.20 to 10.47	1.05	1.62	18.52	14.92	64.87	1.70
Grain density	70.51	31.33 to 10.73	326.85	375.31	27.48	25.64	87.09	34.76
Grain yield / plant (g)	14.33	6.81 to 21.44	12.29	17.87	29.49	24.45	68.77	5.99

(10.47), DML-8 (9.53) and DML-11 (9.53) as compared to parent variety. The variation in fingers/ear during  $M_5$  generation was ranged from 4.40 to 11.30. Among the 23 mutant cultures 3 cultures i.e. DML-8 (11.30), DML-55 (10.60) and DML-11 (10.50) produced significantly more fingers/ear, while DML-56 (4.40) produced lowest fingers/ear. Wide range of variation for fingers per ear was also reported by Muduli and Misra [6]. During  $M_4$  generation, 34% mutant cultures showed significantly higher grain density in which, DML-75 (110/cm), DML-80 (105/cm) and DML-21 (101/cm) produced more grains per centimeter. During  $M_5$  generation, DML-80 (107.10) and DML-75 (104.00) produced more grains per centimeter. Similar variation for grain density was also reported by Muduli and Misra [6, 9] in finger millet. The highly increased yield potential was observed in the mutant

cultures during  $M_4$  generation. The results showed desirable (positive) shift for yield/plant. About 39 (67%) mutant cultures produced significantly higher grain yield over parent variety. The mutant culture DML-74 (21.44 g) produced highest grain yield per plant followed by DML-19 (20.46 g), DML-82 (20.14 g) and DML-69 (20.07 g) produced highest grain yield per plant. During  $M_5$  generation seven mutant cultures recorded significantly higher yield/plant over parent variety. The mutant lines DML-8 (15.19 g) and DML-62 (12.27 g) produced highest grain yield per plant. These results are in agreement with Muduli et al. [9] in finger millet and Hayat et al. [7] in sorghum cultivars.

#### Genetic components of variability

**Table 2.** Mean, range and genetic parameters in  $M_5$  generation for all characters.

Characters	Mean	Range	Vg	Vp	PCV	GCV	$h^2_{(bs)}$	GA
Days to first flowering	88.02	64.5 to 101.0	43.29	49.39	7.98	7.47	87.65	12.69
Days to 50% flowering	94.16	83.0 to 105.0	17.45	21.58	4.93	4.44	80.87	7.74
Days to maturity	125.5	116.0 to 33.5	18.93	24.76	3.96	3.47	76.47	7.84
Plant height (cm)	108.5	94.1 to 114.8	19.35	45.33	6.21	4.05	42.70	5.92
Length of finger (cm)	10.5	8.4 to 12.8	0.84	1.50	12.18	9.11	55.93	1.41
Tillers / plant	1.49	1.0 to 2.1	0.19	0.26	34.29	29.25	72.75	0.77
Fingers / ear	6.74	4.4 to 11.3	2.89	3.83	29.03	25.22	75.49	3.04
Grain density	75.17	44.3 to 107.1	264.68	276.54	22.12	21.64	95.71	32.79
Grain yield / plant (g)	9.64	6.24 to 15.19	3.11	6.01	25.41	18.28	51.74	2.61

**Table 3.** Protein, calcium and iron content in 10 mutant lines and parent (Dapoli-1).

Sl. No.	Mutant line	Protein (%)	Calcium (mg/100 g)	Iron (mg/100 g)
1	DML-4	4.9	225	12
2	DML-7	5.25	252	11
3	DML-8	5.77	248	8
4	DML-10	6.12	216	7
5	DML-33	6.47	172	7.7
6	DML-55	4.9	226	6.5
7	DML-58	4.02	242	10
8	DML-62	4.2	168	9
9	DML-70	4.72	198	4.5
10	DML-75	4.37	234	9
11	Dapoli-1	5.07	231	9.6

During the  $M_4$  generation phenotypic coefficient of variation was high for tillers per plant (37.32), grain yield per plant (29.49), grain density (27.28) and fingers per ear (18.52). Similar results were also observed by Haradari et al. [10]. In case of  $M_5$  generation phenotypic coefficient of variation was high for tillers per plant (34.29), fingers per ear (29.03) and grain yield per plant (25.41). High phenotypic coefficient for these characters was also observed by Hayat et al. (7). The genotypic coefficient of variation during  $M_4$  generation was higher for tillers per plant (33.10), grain density (25.64) and grain yield per plant (24.45). In case of  $M_5$  generation it was higher for tillers per plant (29.25), fingers per ear (25.22), grain density (21.64). These results were in correspondence with Nirmalakumari et al. [11].

#### Heritability and genetic advance

Three characters out of nine characters showed more than 90% heritability for days to maturity (97.04), length of finger (96.12) and plant height (92.41). The heritability observed during  $M_5$  generation was highest for grain density (95.71), days to first flowering (87.65). These results were in accordance with Haradari et al. [10]. In the present investigation, the highest genetic advance was observed for grain density (34.70), plant height (24.93) and days to maturity (10.24) during  $M_4$  generation and was highest for grain density (32.79) and days to first flowering (12.69) during  $M_5$  generation. These results are in agreement with Nirmalakumari et al. [11] in little millet.

#### Quality parameters (protein, iron and calcium)

Study of three quality parameters which are protein, calcium and iron was carried out in 10 mutant cultures and one parent (Dapoli-1). The results obtained from this analysis showed that the mutant lines showed much variation for protein, calcium and Iron content (Table 3). The protein content varied from 4.02 to 6.47% among 10 mutant lines while the parent variety contains 5.07% protein. Similar results were observed by Barbeau et al. [12] in domesticated cultivars of finger millet. Calcium content varied from 168 to 252 mg/100 g. Four mutant lines showed higher calcium content as compared to parent variety (231 mg/100 g). Similar results were observed by Shashi et al. [13]. Iron content varied from 4.5 to 12 mg/100 g. The mutant lines DML-4, DML-7 and DML-10 showed higher Iron content as compared to parent (9.6 mg/100 g). Bashir et al. [14] obtained similar results in pearl millet.

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