Micro mutational response of finger millet (*Eleusine coracana* Gaertn.) to gamma rays, EMS and NG

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ABSTRACT: The present investigation was undertaken to study the extent of micro mutational variability induced by gamma rays, EMS and NG in two morphologically distinct varieties of finger millet ('Indaf 5' and 'Mutant 18') for six polygenic traits. The mutagen treated populations showed increased population variance over the untreated control population for all six characters studied in M_2 generation. However the magnitude of increase in population variance varied with mutagens, their concentration, parental genotypes and the character under consideration. Increase in population variance in the treated populations was high for plant height, fingers/ ear head and finger length in 'Indaf 5', while in case of 'Mutant 18' all the characters were affected more or less in similar extent except yield/plant. Micro mutational response of 'Mutant 18' was more as compared to 'Indaf 5'. Among the mutagens, EMS treated populations induce more variability in both the varieties.

Key words: EMS, Finger millet, gamma rays, micromutation, NG, response index.

Among the millets of world, ragi or finger millet (*Eleusine coracana* Gaertn.) ranks fourth after pearl millet, fox-tail millet and proso millet. The most important aspect of ragi grain is its quality as a food. It is an excellent source of calcium and also has good amount of magnesium, phosphorus, iron and potassium. Among the cereals and millets, it has a relatively favourable amino acid spectrum which includes cystine, tyrosine, tryptophan and methionine (Rachie, 1975). It is usually grown in marginal lands under moisture stress and low fertility. It forms a component of risk prone dryland/rainfed agriculture. Improvement in yielding ability of finger millet can be achieved by improving its yield attributing traits.

An essential aspect of its yield improvement is the utilization of the available genetic variation to produce high yielding varieties. But when available genetic variability is narrowed using traditional breeding methods for a long period, it would be better to opt for hybridization/ induced mutation. Ragi is highly self-pollinated in nature and hybridization is very difficult because of its tiny florets and being tightly packed in spikelet. Therefore induced mutations are alternative way in creating a wealth of desirable genetic variability in ragi to overcome the bottleneck conditions. The present investigation is aimed at creating micro mutational variability through gamma rays, EMS and NG in two morphologically distinct finger millet varieties.

MATERIALS AND METHODS

Micro mutational response of two morphologically distinct finger millet varieties 'Indaf 5' (brown grained) and 'Mutant 18' (white grained) was studied in M_2 generation. Seed samples of both varieties were treated with varying doses/concentrations of gamma rays, EMS (Ethyl methane sulphonate) and NG (N-methyl-N'-nitro-nitrosoguanidine) . The mutagenic treatments were 10KR , 20KR, 25KR of gamma rays (G1, G2, G3); 0.1%, 0.2%, 0.3% EMS (E1, E2, E3); and 0.01%, 0.02%, 0.03% NG (N1, N2, N3). Ten grams of well filled and matured seeds were taken for each treatment. Dry seeds of these two varieties were irradiated with gamma rays at BARC, Trombay. For treatment with chemical mutagens, the seed were soaked separately in distilled water for 12 hours and then blotted seeds were treated with freshly prepared solutions of chemical mutagens of appropriate concentration for 6 hours. After treatment with chemical mutagens the seeds were thoroughly washed in tap water for five to six times. The treated seed of the two varieties were sown in two separate field trials in M_1. Seeds of all M_1 plants of each treatment were bulked and the M_2 generation was grown in RBD with three replications in two separate trials at plant breeding farm, OUAT. Each treatment was represented by 10 rows of 3 m length. Spacing between rows was 30 cm and between plants was 10 cm with a single seedling plant/hill. In M_2 generation, observations on plant height (cm), productive tillers/plant, fingers/ear head, ear head weight / plant (g),

finger length (cm) and yield / plant (g) were recorded on 30 normal looking randomly chosen plants per treatment per replication. Population mean and variance were calculated following Panse & Sukhatme (1985) in M_2 generation. The data on population mean and population variance of each treatment for different quantitative traits were subjected to ANOVA to compare mutagenic response of two varieties.

RESULTS AND DISCUSSION

Population mean

Micro mutational response of 'Indaf 5' and 'Mutant 18' as expressed as population mean in respect of six polygenic traits are presented from Figure 1 to Figure 6 for plant height, productive tillers/plant, fingers/ear head, ear head weight / plant, finger length and yield / plant respectively.

The analysis of variance in respect of plant height indicated significant differences among the population mean in both the varieties. Mean plant height of the treated populations of 'Indaf 5' ranged from 88.69 cm to 97.34 cm and that of 'Mutant 18' ranged from 98.31 cm to 99.38 cm. In 'Indaf 5', the mean plant height of all treated populations except N2 (NG 0.02%) and N3 (NG 0.03%) were lower than control (Figure 1).

In Mut.18, the mean plant height of all treated populations were lower than control but significant

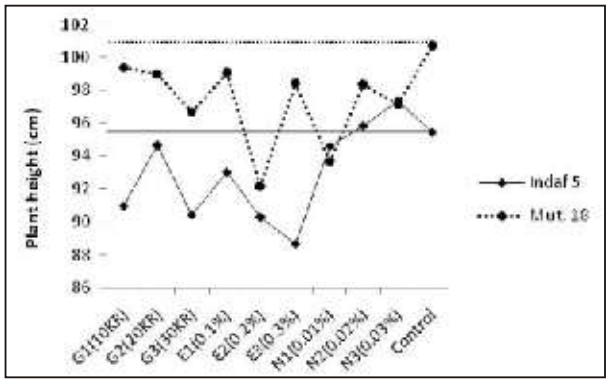

Fig. 1: Population mean for plant height

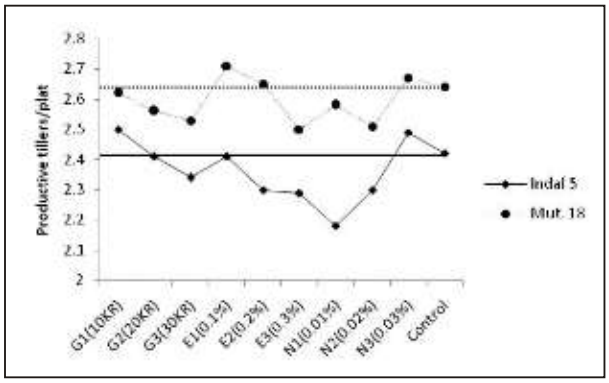

Fig. 2: Population mean for productive tillers/plant

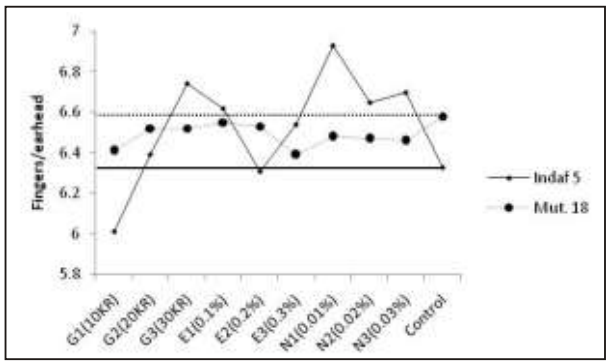

Fig. 3: Population mean for fingers/earhead

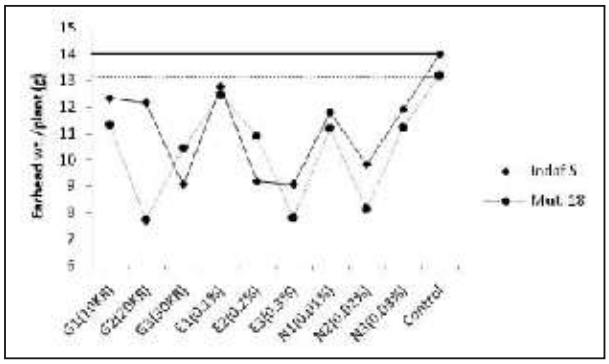

Fig. 4: Population mean for earhead wt./plant

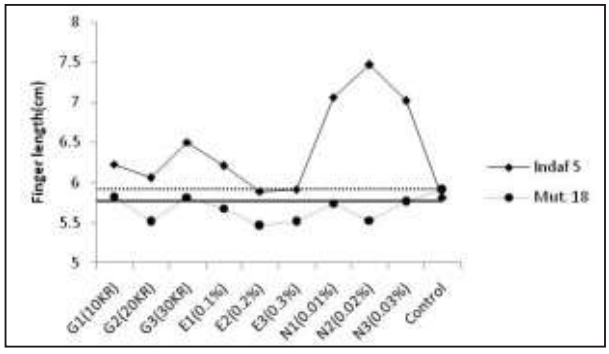

Fig. 5: Population mean for finger length

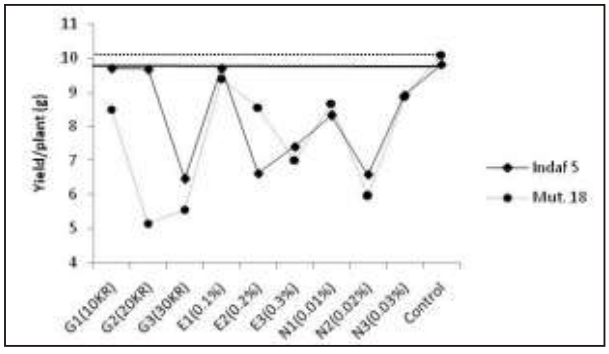

Fig. 6: Population mean for yield/plant

decrease over control was in E2 (EMS 0.2%) and N1 (NG 0.01%). Maximum decrease in plant height was induced by EMS treatments in Indaf 5 but by NG treatments in Mutant 18. In case of productive tillers/plant and fingers/earhead, none of the treatments shown significant differences in both the varieties as compared to control. The mean values in treated populations shifted in negative direction compared to control in both the varieties except in N3 (NG 0.03%) and G1 (gamma ray 10KR) in 'Indaf 5' and in N3 (NG 0.03%), E1 (EMS 0.1%) and E2 (EMS 0.2%) in 'Mutant 18'. Analysis of variance indicated significant differences among mutagen treated population means of both the varieties in respect of earhead weight/plant. Mean of treated populations ranged from 9.08 g to 14.01 g in 'Indaf 5' whereas it ranged from 7.72 g to 13.18 g in 'Mutant 18'. The mean was lower than the control in all treated populations of both the varieties but the reduction was statistically significant in G3 (gamma ray 30KR), E2 (EMS 0.2%), E3 (EMS 0.3%), N1 (NG 0.01%), N2 (NG 0.02%) and N3 (NG 0.03%) in 'Indaf 5' and in G2 (gamma ray 20KR), G3(gamma ray 30KR), E2 (EMS 0.2%), E3 (EMS 0.3%) and N2 (NG 0.02%) in 'Mutant 1'8. Maximum reduction was brought about by EMS in 'Indaf 5' and by gamma rays in 'Mutant 18'. All the mutagenic treatments produced positive response in respect of finger length as compared to control in 'Indaf 5'. Finger length was found to vary from 5.89 cm to 7.47 cm in treated populations and it was 5.81 cm in control. E1 (EMS 0.1%), N1 (NG 0.01%), N2 (NG 0.02%) and N3 (NG 0.03%) produced significantly higher finger length than control in 'Indaf 5'. In case of 'Mutant 18' all the treatments produced negative impact as compared to control. All mutagenic treatments had negative effect on yield/plant in both the varieties. In 'Indaf 5', yield/plant was highest in gamma ray 10KR (9.70 g) and E1 (9.70 g) population which were at par with control (9.81 g). Mutagenic treated populations like G3 (gamma ray 30KR), E2 (EMS 0.2%), E3 (EMS 0.3%) and N2 (NG 0.02%) gave significantly lower yield/plant in 'Indaf 5'. In 'Mutant 18', E1 (EMS 0.1%) gave the highest yield/plant (9.40 g) which was not significantly lower than control (10.10 g) and significant reduction was brought by gamma rays treatment.

Population variance

The variances produced by mutagenic treated populations in respect of different polygenic traits of 'Indaf 5' and 'Mutant 18' were presented in Table 1 and Table 2 respectively. The variance of treated populations ranged from 50.03 to 69.54 and 34.44 to 71.22 as against 47.92 and 21.12 in control populations of 'Indaf 5' and 'Mutant 18' respectively. As compared to respective controls higher variance was observed in all the treated populations of 'Mutant 18' but only five populations i.e gamma ray (10KR), gamma ray (20KR), gamma ray (30KR), EMS (0.1)% and NG (0.02%) in 'Indaf 5'. The variance was highly increased following gamma rays treatments in both the varieties. In 'Indaf 5', all mutagen treated populations produced higher variance in respect of productive tillers/plant except NG (0.03%). EMS (0.3%) produced the highest significant variation (0.79) as compared to control (0.50) in respect of productive tillers/plant followed by NG (0.01%) and gamma ray (30KR). Significant increase in variance over the controls was observed in all the treated populations of 'Mutant 18' in respect of productive tillers/plant. Highest average variance was realized by EMS treatment in both the varieties. EMS (0.3%) and NG (0.01%, 0.02%, and 0.03%) were found to produce significantly higher variance in 'Indaf 5' in respect of fingers/earhead whereas gamma rays, EMS and NG at all the given concentrations produced significant variation than control in 'Mutant 18'. None of the mutagenic treatment except EMS (0.1%) produced significant variation for the trait earhead

Table 1: Treatment population variance for various quantitative traits in variety 'Indaf 5' in M_2 generation

Treatment code	Plant height (cm)	Productive tillers/ plant	Fingers/ ear head	Ear head weight/plant(g)	Finger length (cm)	Yield/Plant (g)
G1(10KR)	67.25*(2)	0.57 (1)	0.92 (1)	25.28(1)	1.27 (1)	18.17* (1)
G2(20KR)	82.47*(2)	0.52(1)	0.72(0)	20.48(0)	1.74*(2)	13.40(1)
G3(30KR)	66.15*	0.61*	0.84	24.16	1.48*	10.84
E1(0.1%)	69.54*	0.60	0.91	27.15*	2.11*	14.38*
E2(0.2%)	50.03	0.50	0.62	14.06	1.58*	9.60
E3(0.3%)	53.49	0.79*	1.08*	21.51	1.48*	13.34
N1(0.01%)	50.41	0.62*	1.17*	20.49	1.15	12.86
N2(0.02%)	65.77*	0.59	1.02*	25.90	0.62	17.42*
N3(0.03%)	56.15	0.41	1.04*	15.49	0.73	10.59
C	47.92	0.50	0.82	20.36	1.06	11.86
CD (5%)9.62	0.10	0.13	6.32	0.35	1.76	

* Significant increase of variance than control at P = 0.05

Table 2: Treatment population variance for various quantitative traits in variety 'Mutant 18' in M_2 generation

Treatment code	Plant height (cm)	Productive tillers/ plant	Fingers/ ear head	Ear head weight/plant(g)	Finger length (cm)	Yield/Plant (g)
G1(10KR)	50.69*	0.34*	0.46*	14.85*	0.22	7.75
G2(20KR)	71.22*	033*	0.35*	6.97	0.34*	3.59
G3(30KR)	54.19*	0.36*	0.64*	13.42*	0.32*	8.14
E1(0.1%)	30.70*	049*	0.44*	13.46*	0.31*	8.33*
E2(0.2%)	51.26*	0.37*	0.38*	10.62	0.35*	6.95
E3(0.3%)	34.44*	0.37*	0.48*	9.08	0.27*	4.35
N1(0.01%)	47.68*	0.33*	0.53*	9.32	0.36*	7.12
N2(0.02%)	59.74*	0.32*	0.30*	8.75	0.29*	6.91
N3(0.03%)	53.93*	0.34*	0.42*	13.65*	0.25*	7.68
C	22.12	0.14	0.21	8.81	0.20	5.63
CD (5%)	8.19	0.08	0.06	3.31	0.06	2.69

* Significant increase of variance than control at P = 0.05

weight/plant as compared to control in 'Indaf 5'. In 'Mutant 18', gamma ray (10KR and 30 KR), EMS (0.1%) and NG (0.03%) treatments resulted in significant variation than control in respect of earhead weight/plant. Gamma rays (20 KR and 30 KR) and EMS (0.1%. 0.2%, 0.3%) exhibited significant variation for finger length in 'Indaf 5' whereas all the treatments generated significant variation in 'Mutant 18' except gamma ray (10 KR). In 'Indaf 5', gamma ray (10KR), EMS (0.1%) and NG (0.02%) resulted in significant variation but in 'Mutant 18' only EMS (0.1%) produced significant variation in respect of yield/plant than control.

Response index of different treatment was evaluated as follows to conclude the degree of response of two varieties to different mutagenic treatments. The variance of treatments in respect of a particular character was scored as "1" if it is significantly higher than control; "0" if variance is simply greater than or less than control or equal to control. Finally the scored values of six polygenic traits are added to get response index. The response index produced by gamma rays, EMS and NG at different concentrations in 'Indaf 5' are found to be less than response index produced by the these mutagens in 'Mutant 18' at corresponding concentrations (Figure 7). This indicates that 'Indaf 5' is less sensitive than ' Mutant 18'.

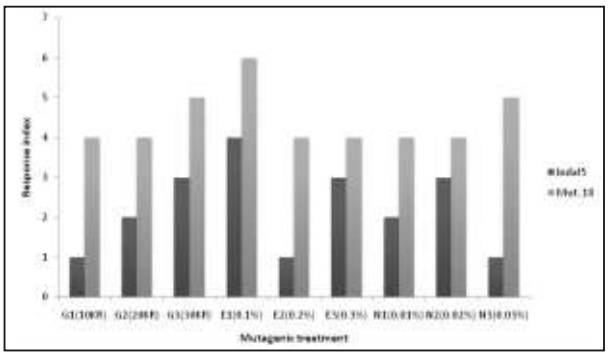

Fig. 7: Response index of different mutagenic treatments in 'Indaf 5' and 'Mutant 18' in M_2 generation.

In the present study it is observed that the magnitude of change in mean and variance varied with mutagen, their dose/concentrations and the parent. Differential increase in variability following treatments with various physical and chemical mutagens were reported by Selvam *et al.(*2010), Mishra *et al.* (2010) in blackgram; Sakin (2002) in durum wheat; Mittal *et al*. (2001), Singh and Rao (2008), Mishra *et al*. (2013) in greengram; Kartik and Subbaalakshmi (2006), Khan and Tyagi (2010) in soyabean; Shah *et al.* (2011) in chickpea; Bolbhat *et al.* (2012) in horse gram; Muduli and Misra (2008) in finger millet.

The present investigation revealed that the mutagen treated populations exhibit decrease in mean and increase in variance for plant height, earhead weight/plant, finger length and yield/plant in both the varieties. Mutant 18 is found to be more sensitive to the mutagenic action of gamma rays, EMS and NG than Indaf 5.The results of this study demonstrate the potentiality of induced variability for polygenic traits in both the varieties, which can form good base for selection.

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