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# Inheritance of Kernel Elongation in Rice

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## ABSTRACT

In the present investigations, an attempt was made to know the inheritance pattern of cooked kernel elongation in Mahsuri Mutant crosses. In all the three Mahsuri Mutant crosses, the frequency distribution of kernel elongation ratio of segregating populations always formed a bimodal curve. However, in crosses of Mahsuri Mutant and Mahsuri (even in the reciprocal cross) the bimodal curve progressed towards lower kernel elongation. So it can be assumed that this character may be governed from 1 or 2 loci. But in crosse of Mahsuri Mutant and 9192 a very smaller peak compared to the other was noted, which denotes the predominance of one major gene along with few modifier genes.

**Key Words:** Mahsuri mutant; Cooked kernel elongation; Controlling genes

## INTRODUCTION

Linear elongation of kernel on cooking is one of the major characteristics of fine rice (Sood *et al.*, 1979). Genetic evaluation of kernel appearance and its cooking quality form important objectives in rice grain quality improvement programmes. Grain size and shape largely determine the market acceptability of rice, while cooking quality is influenced by the properties of starch. Some varieties expand more in size than others upon cooking. Lengthwise expansion without increase in girth is considered a high desirable trait in high quality rice (Khush *et al.*, 1979; Sood *et al.*, 1983). Grain elongation of pre-soaked milled rice seems greater with intermediate-amylase, low-gelatinization temperature (Juliano & Perez, 1984). Different type of Indian and Pakistani Basmati, Afghanistan's Sadri and Myanmar's D25-4 (Nga Kyee) posses this extreme elongation property. University Kebangsaan Malaysia and Malaysian Agricultural Research Institute developed Mahsuri Mutant as blast resistant line. Later on, it becomes more popular for its high cooked kernel elongation ratio (Hadjim *et al.*, 1994; Faruq *et al.*, 2003). The interesting observation is that only through aging condition this Mutant show its kernel elongation character and according to Sood and Siddiq's (1980) classification the degree of kernel elongation of this mutant can be considered as high (proportionate change 0.57-0.74) like several Basmati type of rice varieties. But without aging this mutant cannot perform high kernel elongation like Thai Jasmine or different basmati type fine rice varieties in Pakistan and India. So, it can be assumed that the nature of kernel elongation in Mahsuri Mutant is quit different compare to the common fine rice varieties. In the present work we sought to identify a procedure to study the segregation pattern of cooked kernel elongation ability in a suitable $F_2$ population of three Mahsuri Mutant crosses.

## MATERIALS AND METHODS

Three crosses were made among Mahsuri Mutant, Mahsuri and 9192. $F_1$ and $F_2$ populations were raised at Malaysian Agricultural Development Research Institute. Kernel elongations of $F_2$ populations were measured at following by partially modified protocol of Sood and Siddiq (1980). About 210 plants representing $F_2$ generation of each cross were analysed to study the segregation pattern of kernel elongation. It was not possible to measure elongation ratio in $F_1$ seeds, because of their weak stature.

## RESULTS AND DISCUSSION

Elongation ratio and grain shape of the parental materials have been described in Table I. The fitness of Mendelian inheritance pattern of these crosses has been stated in Table II.

**Cross-of Mahsuri Mutant X Mahsuri.** This cross of Mahsuri Mutant and Mahsuri involved a high and low kernel elongation ratio parents. The mean of elongation ratio was within the parental limits. Range of variation was

**Table I. Cross descriptions**

| Cross | Elongation ratio | Grain shape |
|---|---|---|
| Mahsuri Mutant X Mahsuri | High X Low | Long X Short |
| Mahsuri Mutant X 9192 | High X Medium | Long X Long |
| Mahsuri X Mahsuri Mutant | Low X High | Short X Long |

substantially high in $F_2$, indicating generation of additional variation for this grain quality character (Kernel elongation ratio). The frequency distribution of this character in $F_2$ generation formed a bimodal curve (Fig. 1) with transgression towards low kernel elongation, which indicated the predominance of major genes in controlling this trait. The mean elongation ratio of the $F_2$ populations was (2.04), where as the lowest and the highest values observed in parental lines, Mahsuri and Mahsuri Mutant, were 1.70 and 2.14, respectively (Table III). The ranges of the $F_2$ populations were 1.65-2.31, whereas the ranges of 2.00-2.31 and 1.55-1.86 were observed in parental lines (Table III).

**Table II. Mode of segregation of kernel elongation ratio in $F_2$ populations of Mahsuri Mutant based 3 crosses**

| Cross | Observed segregation Elongation | | | Expected ratio | $\chi^2$ | P |
|---|---|---|---|---|---|---|
| | High | Low | Very Low | | | |
| Mahsuri Mutant X Mahsuri | 148 | 60 | 1 | 3:1 | 2.17 | 0.10-0.25 |
| Mahsuri Mutant X 9192 | 161 | 49 | - | 3:1 | 0.69 | 0.25-0.50 |
| Mahsuri X Mahsuri Mutant | 153 | 57 | - | 3:1 | 0.51 | 0.25-0.50 |

**Table III. Mean and range of kernel elongation of parents and $F_2$ Segregations**

| Parents / Cross | Mean | Range | Variance | CV |
|---|---|---|---|---|
| Mahsuri | 1.70 | 1.55 - 1.86 | 0.00 | 1.5 |
| Mahsuri Mutant | 2.14 | 2.00 - 2.31 | 0.00 | 2.1 |
| 9192 | 1.92 | 1.73 - 2.29 | 0.02 | 1.8 |
| $F_2$ of Mahsuri Mutant X Mahsuri | 2.04 | 1.65 - 2.31 | 0.07 | 11.3 |
| $F_2$ of Mahsuri Mutant X 9192 | 2.07 | 1.78 - 2.28 | 0.09 | 10.6 |
| $F_2$ of Mahsuri X Mahsuri Mutant | 2.02 | 1.62 - 2.30 | 0.02 | 6.9 |

**Fig. 1. Frequency distribution of kernel elongation ratio in $F_2$ Populations of the cross Mahsuri Mutant X Mahsuri**

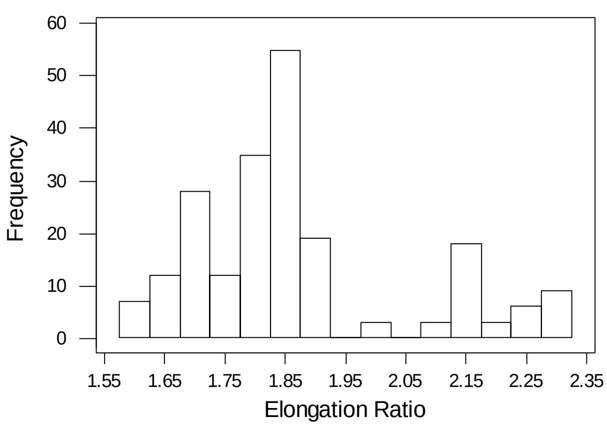
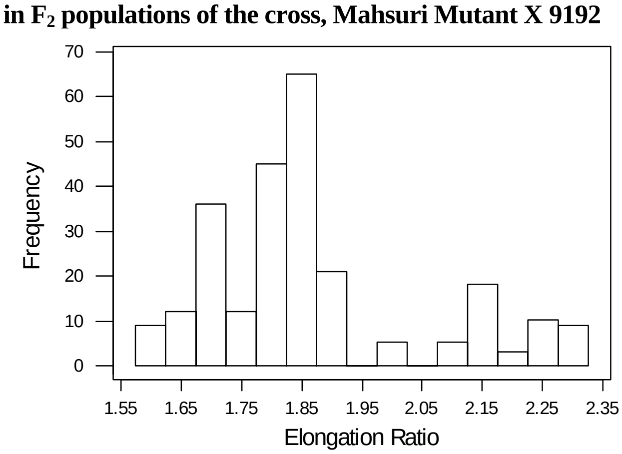


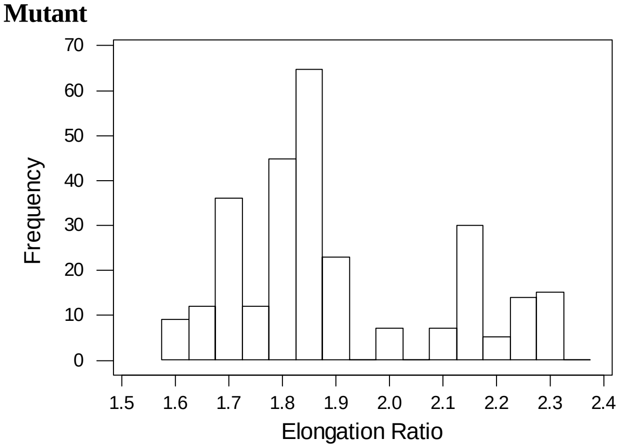

**Fig. 2. Frequency distribution of kernel elongation ratio in $F_2$ populations of the cross, Mahsuri Mutant X 9192**




**Cross-of Mahsuri Mutant X 9192.** This cross also involved a high and a medium kernel elongation ratio parents. The range of variation in $F_2$ was also in the parental limits, indicating the absence of transgressive segregation. The frequency distribution of this character in $F_2$ generation formed a bimodal curve (Fig. 2) where one of the peaks was much smaller than the other, indicates the predominance of one major gene along with few modifier genes. The mean elongation ratios of the $F_2$ populations were observed as 2.07, whereas the highest ratio and the lowest ratio observed in parental lines were 2.14 and 1.92, respectively. The ranges of the $F_2$ populations were 1.78-2.28, whereas the ranges in parental materials were 2.00-2.31 and 1.73-2.29, respectively (Table III). The CV in $F_2$ was highest for kernel elongation (11.3) in Mahsuri Mutant/Mahsuri, followed by 10.6 in Mahsuri Mutant/9192 and 6.9 in Mahsuri/ Mahsuri Mutant.

**Cross-of Mahsuri X Mahsuri Mutant.** This cross-involved a low and a high kernel elongation ratio parents like the first cross and only maternal parents was changed. Here the mean elongation ratio was also within the parental limits. Ranges of variation were substantially high in $F_2$, indicating generation of additional variation for the kernel elongation ratio. The frequency distribution of this character in $F_2$ generation formed a bimodal curve (Fig. 3) with the values towards low kernel elongation, which indicated the predominance of major genes in controlling this trait. Hadzim *et al.* (1994) mentioned that in the Mahsuri Mutant the low kernel elongation ratio was dominant over higher

**Fig. 3. Frequency distribution of kernel elongation ratio in $F_2$ populations of the cross Mahsuri X Mahsuri Mutant**



kernel elongation ratio. The mean elongation ratios of the $F_2$ populations were 2.02, whereas the highest ratio and the lowest ratio observed in parental lines were 2.14 (Mahsuri Mutant) and 1.70 (Mahsuri), respectively. The ranges of the $F_2$ populations were observed as 1.62-2.30, whereas the 2.00-2.31 and 1.55-1.86 were observed in parental lines (Table III).

## CONCLUSION

From the observed findings, it can be concluded that kernel elongation ratio is controlled by 1 or 2 major genes and those were influenced with few modifier genes. However, it is noted that nature of kernel elongation of Mahsuri Mutant is totally different compare too Basmati type rices. Because only through aging this Mutant perform good kernel elongation ratio.

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