Electronic Journal of Plant Breeding, 9 (2) : 429-432 (June 2018) DOI: 10.5958/0975-928X.2018.00053.4
ISSN 0975-928X

Research Article

Inheritance of kernel length and kernel elongation in basmati rice (*Oryza sativa* L.)

Vikas Kumar[1], N. K. Rastogi[1], N. B. Patel[1] and Swarup Nanda Mandal[2*]
[1]Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Viswavidyalaya, Raipur– 492012, Chhattisgarh, India
[2]College of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Burdwan Sadar-713101, West Bengal, India
E-mail: snmandaledu@gmail.com

(Received: 21 Apr 2017; Revised: 24 May 2018; Accepted:24 May 2018)

Abstract
Understanding the genetics of kernel length and cooked kernel elongation is the prerequisite for developing premium quality Basmati lines/varieties. In the present investigation, an attempt was made to determine the inheritance pattern of kernel length and cooked kernel elongation in the cross Taroari Basmati x RAU 3036, and Pusa Basmati 1121 x Chhatri, respectively. The crosses were made during *Kharif* 2014 and F_1 and F_2 populations along with their parents were raised during *Rabi*, summer 2014-15 and *Kharif* 2015, respectively. In both F_2 populations, the frequency distribution of kernel length and kernel elongation ratio of segregating populations formed bimodal curve, which indicates the predominance of major genes along with few modifier genes in genetic control of both traits. From the observations, it can be concluded that kernel length and kernel elongation ratio is controlled by one or two major genes and those were influenced by few modifier genes. Also there is no consensus yet on the nature of inheritance of kernel length and kernel elongation.

Key words
Rice, Kernel length, Kernel elongation, Inheritance

Introduction

Scented rice, especially Basmati rice is nature's gift exclusively to the Indian subcontinent. Basmati rice is characterized by extra-long slender grains, distinct aroma, light texture of the cooked rice Nagaraju *et al*.(2002). Kernel length, L/B ratio and linear elongation of the kernel on cooking play a pivotal role in consumer preference as well as the commercial success of a variety, especially in quality rice. Hence improvements of these characters are of paramount importance in any breeding programme. For commercial purposes, the grains of rice are classified according to the kernel length as short grain, medium grain, long grain and extra-long grain. The scented rice varieties fall in all the four categories, but the long slender grain type scented rice varieties fetch the maximum premium in international market. Basmati rice exhibits kernel length above 6.6 mm, L/B ratio of more than 3, and high kernel elongation after cooking (ratio above 1.8).

There are very few investigations on inheritance of kernel length and kernel elongation in basmati ric**e**. Kernel length and kernel elongation in rice are known to be genetically controlled Krishna Veni and Shobha Rani, (2008). The present study on comprehensive assessment of the genetics of kernel length and cooked kernel elongation of basmati rice, to our knowledge, is unique to determine the nature of inherent kernel length, and kernel elongation in cross combination along with contrasting trait.

Materials and Methods

The present investigation was carried out on two F_2 populations derived from the crosses of Taroari Basmati (Long slender) X RAU 3036 (Short bold) and Pusa Basmati 1121 (High kernel elongation) X Chhatri (Low kernel elongation). The crossing was done during *Kharif* 2014. The F_1 and F_2 populations along with their parents were raised during *Rabi* summer 2014-15 and *Kharif* 2015, respectively at Research cum Instructional Farm, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Viswavidyalaya, Raipur (Chhattisgarh). Standard cultural practices and need based plant protection measures were undertaken during the crop growth. Five competitive plants from each of P_1, P_2 & F_1 and 300 F_2 plants per cross were taken at random to record observations on kernel length and kernel elongation. Ten dehusked kernels per plant were taken randomly to record observations on kernel length using dial micrometer at crop quality laboratory, Department of genetics and Plant Breeding, IGKV, Raipur by following the procedure described by Murthy and Govindaswamy (1967). Cooked kernel elongation was measured by following modified protocol of Sood and Siddiq (1980).

Results and Discussion

For kernel length, the mean length measured in F_1 and F_2 were within the parental limits (Table 1). The mean kernel length of the F_2 population was

observed as 6.04 mm, whereas the highest and the lowest kernel length observed in parental lines were 7.76 mm and 4.52 mm, respectively. The ranges of the F_2 populations were 4.10 – 8.87, whereas the ranges in parental lines were 7.56 – 8.16 and 4.32 – 4.63, respectively (Table 1). The range of variation and coefficient of variance for kernel length in F_2 were higher than the parents and F_1's, indicating generation of additional variation for the kernel length. The frequency distribution of kernel length in F_2 formed bimodal curve (Figure 1) with transgression towards longer kernel, which indicate the predominance of major genes along with few modifier genes in controlling this trait. Krishna Veni and Shobha Rani (2008) studied gene action governing the inheritance of kernel length in three cross combinations *viz*., lET 13554/ Ranga Joha 2, Pusa Basmati 1/ Ranga Joha 2 and IR 64/ Badshabhog. In the former two crosses, kernel length was under polygenic control along with few modifier genes. However, in IR 64/ Badshahbhog, the inheritance of kernel length was under monogenic control with long and slender grain types being dominant. Takita (1985) examined several F_2 populations of crosses between varieties with long and short kernel size and detected that two to five cumulative genes were responsible for the inheritance of kernel length. These findings also supported the present result.

For kernel elongation, the mean elongation ratio of the F_2 population was 1.74, whereas the lowest and the highest values observed in parental lines, Chhatri and Pusa Basmati 1121, were 1.40 and 2.04, respectively. The range of F_2 population was 1.34 – 2.27, whereas the ranges of 1.96 – 2.15 and 1.34 – 1.49 were observed in parental lines (Table 2). Range of variation was substantially high in F_2, indicating generation of additional variation for this grain quality trait. The frequency distribution of this character in F_2 generation formed bimodal curve (Figure 2) with transgression towards high kernel elongation, which indicate the predominance of major genes along with few modifier genes in controlling this trait.

The present result confirms the findings of Faruq *et al*. (2004), who reported inheritance of cooked kernel elongation in three crosses using cultivar Mahsuri Mutant. In all three Mahsuri Mutant crosses, the frequency distribution of kernel elongation of segregating populations formed a bimodal curve. However, in crosses of Mahsuri Mutant and Mahsuri (and its reciprocal cross) the bimodal curve was skewed towards lower kernel elongation. This suggests that this character may be governed by one or two loci. In crosses 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.

From the observed findings, it can be concluded that kernel length and kernel elongation ratio is controlled by one or two major genes and those were influenced by few modifier genes. Also there is no consensus yet on the nature of inheritance of kernel length and kernel elongation as described above. The lack of agreement among many researchers appears to be related with the differences in varieties used. Like aroma, kernel elongation is also influenced both by genetic factors and environment, especially temperature at the time of ripening Dela Cruz *et al*.(1989). The ambient temperature of about 25°C during day time and 21°C during night at ripening has been found to have favourable effect. Maximum elongation was reported in grains matured at these temperatures. Besides, aging and pre- soaking before cooking add to kernel elongation.

Acknowledgment

We thank Department of Science and Technology, Govt. of India for providing the senior author (Vikas Kumar) an INSPIRE Fellowship during the study and Department of Biotechnology, Govt. of India, for funding the work.

References

Dela Cruz; N., Kuma;, I., Kaushik; R.P. and Khush, G.S. 1989. Effect of temperature during grain development on the performance and stability of cooking quality components of rice. *Jpn J Breed.*, **39**: 299-306.

Faruq, G.; Mohamad, O.; Hadjim, K. and Craig, A.M. 2004. Inheritance of kernel elongation in rice. *Int J Agri Biol.,* **5**: 813-815.

Krishna, V.B.and Shobha Rani, N. 2008. Inheritance of grain size and shape in rice. *Oryza.,* **45**(3): 242-244.

Murthy, P.S.N.and Govindaswamy. 1967. Inheritance of grain size and its correlation with the hulling and cooking qualities. *Oryza.*, **4**(1): 12-21.

Nagaraju, J.; Kathrine, M.; Kumar, R.R.; Siddiq, E.A.and Hasnain, S.E. 2002. Genetic analysis of traditional and evolved Basmati and non-Basmati rice varieties by using fluorescence-based ISSR-PCR and SSR markers. *Proc Natl Acad Sci.* USA., **99**(9):5836–5841

Sood, B.C.and Siddiq, E.A., 1980. Studies on component quality attributes of basmati rice. *J Plunzenzuecht.,* **84**: 294-301.

Takita, T. 1985. Inheritance of grain size and the relationship between grain size and other characters in rice. *Bull Nat Agric Res Cent.,* **3**:55- 71.

Table 1. Mean, range and coefficient of variation (CV) of kernel length of the cross, Tarori Basmati X RAU 3036

Trait	Parents/ Generation	Mean	Range	CV
Kernel length (mm)	Tarori Basmati	7.76	7.56 – 8.16	2.47
	RAU 3036	4.52	4.32 – 4.63	2.64
	F_1	4.96	4.70 – 5.26	3.65
	F_2	6.04	4.10 – 8.87	19.63

Table 2. Mean, range and coefficient of variation (CV) of kernel elongation of the cross, Pusa Basmati 1121 X Chhatri

Trait	Parents/ Generation	Mean	Range	CV
Kernel elongation	Pusa Basmati 1121	2.04	1.96 – 2.15	3.52
	Chhatri	1.40	1.34 – 1.49	3.70
	F_1	1.43	1.36 – 1.50	3.28
	F_2	1.74	1.34 – 2.27	12.62

 DOI: 10.5958/0975-928X.2018.00053.4

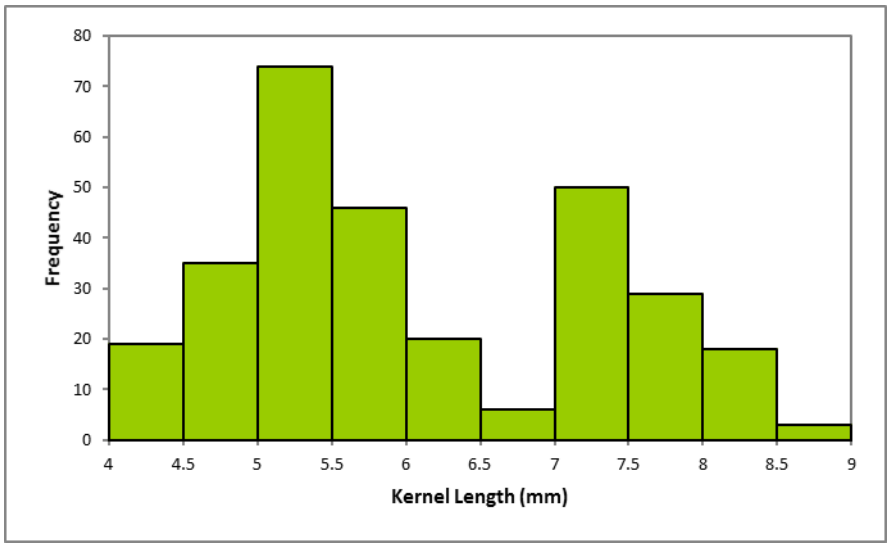

Fig.1. Frequency distribution of kernel length in F_2 population of the cross, Tarori Basmati x RAU 3036

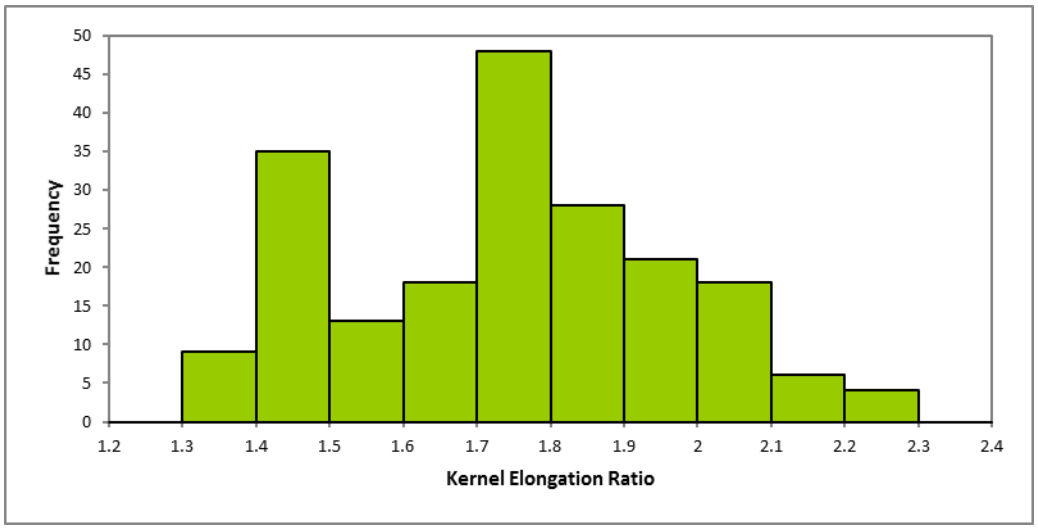

Fig. 2. Frequency distribution of kernel elongation in F_2 population of the cross, Pusa Basmati 1121 X Chhatri