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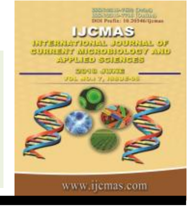

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Studies on Frequency Distribution of Sorghum Downy Mildew Resistant BC_3F_1 Progenies in Maize

K. Sumathi[1*], K. N. Ganesan[2] and N. Senthil[3]

[1]*Centre for Plant breeding and Genetics, TNAU Coimbatore, India*
[2]*Millet Breeding Station, TNAU Coimbatore, India*
[3]*Centre for Plant Molecular Biology, TNAU Coimbatore, India*
**Corresponding author*

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A B S T R A C T

The present investigation was carried out at Eastern Block of the Central Farm Unit, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India to identify the gene interaction for yield contributing characters to increase the yield. For this purpose twelve biometrical characters of fifteen SDM resistant progenies *viz.*, UMI 79/936-C1-3-2 ,UMI 79/936-C1-3-4,UMI 79/936-C1-7-2, UMI 79/936-C1-7-7, UMI 79/936-C1-29-8, UMI 79/936-C1-29-9, UMI 79/936-C1-29-13, UMI 79/936-C1-29-23, UMI 79/936-C1-29-35, UMI 79/936-C1-29-36, UMI 79/936-C1-67-3, UMI 79/936-C1-67-12, UMI 79/936-C1-67-25, UMI 79/936-C1-101-12 and UMI 79/936-C1-101-14 were used for frequency distribution studies. Analysis of skewness and kurtosis revealed that, the selected progenies for resistant to SDM showed positive skewness and negative kurtosis for most of the traits under study *viz.*, 50% tasseling, days to 50% silking, days to maturity, plant height cob length, cob diameter, 100 grain weight and grain yield per plant. Indicating that, these characters were governed by complementary gene action was and the gain is slower with mild selection but is faster with intensive selection.

Introduction

Maize (*Zea mays* L.) plays a unique role in world agriculture as a food, feed and industrial crop. It is the world‘s third most important crop after rice and wheat. Globally, it is known as queen of cereals because it has the highest genetic yield potential among the cereals. Plant breeders are interested in developing cultivars resistant to pest and disease with improved yield and other phenological characters. In order to achieve this goal, the breeders had the option of selecting desirable genotype in early generations or delaying intense selection until advanced generations. Downy mildews are important maize diseases in many tropical regions of the world. They are particularly destructive in many regions of tropical Asia where losses in excess of 70% have been documented. Globally, downy mildew affected areas with significant economic losses are reported to be as high as 30% (Jeffers *et al*., 2000).

Frequency distribution is an organized tabulation/graphical representation of the number of individuals in each category on the scale of measurement. It allows the researcher to have a glance at the entire data conveniently. It shows whether the observations are high or low and also whether they are concentrated in one area or spread out across the entire scale. Thus, frequency distribution presents a picture of how the individual observations are distributed in the measurement scale. It also gives the cumulative and relative frequency that helps to interpret the data more easily.

Skewness describes the degree of departure of a distribution from symmetry and kurtosis characterizes the peakedness of a distribution. In a frequency distribution of a segregating generation, skewness could result when certain combinations of genes are lethal or when there is incomplete linkage of certain genes controlling the trait or when there is presence of epistasis or due to non additive effects (dominance or over dominance) or due to the presence of genotype x environment interaction or when one gene has much larger effect than others.

Kurtosis will occur if either a few genes are controlling the phenotypic distribution or there are inequalities in the additive genetic effects at different loci. Traits for which data showing leptokurtic distribution are usually those under control of relatively few segregating genes, whereas data showing a platykurtic distribution usually represent characters that are controlled by many genes.

Materials and Methods

The experiments were conducted in Eastern Block of the Central Farm Unit, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India during *Rabi* 2013. BC_3F_1 population was used in the present study. It is derived from crossing the inbred UMI 79 which is susceptible for sorghum downy mildew and UMI 936 (w) which has resistance for sorghum downy mildew and backcrossing progenies with UMI79.

Fifteen SDM resistant progenies *viz.*, UMI 79/936-C1-3-2 ,UMI 79/936-C1-3-4,UMI 79/936-C1-7-2, UMI 79/936-C1-7-7, UMI 79/936-C1-29-8, UMI 79/936-C1-29-9, UMI 79/936-C1-29-13, UMI 79/936-C1-29-23, UMI 79/936-C1-29-35, UMI 79/936-C1-29-36, UMI 79/936-C1-67-3, UMI 79/936-C1-67-12, UMI 79/936-C1-67-25, UMI 79/936-C1-101-12 and UMI 79/936-C1-101-14 were used for frequency distribution studies. In these fifteen progenies the data on twelve quantitative characters viz., days to 50% tasseling, days to 50% silking, plant height, Ear height, Cob length, Cob diameter, Number of rows per cob, Number of kernels per row, Cob weight, Yield per plant, 100 grain weight and shelling percentage were recorded.

Frequency distribution

The phenotypic data of BC_3F_1 along with the parents were utilized for studying the frequency distribution in days to 50% tasseling, days to 50% silking, plant height, Ear height, Cob length, Cob diameter, Number of rows per cob, Number of kernels per row, Cob weight, Yield per plant, 100 grain weight and shelling percentage to know about the extremes in the population. It was calculated by taking minimum and maximum value of the trait. Then the difference between the maximum and minimum values is recorded as 'X' and the class interval is fixed as 10. Then the bin range was fixed by dividing the value 'X' with class interval. With the bin range, the frequency of population is obtained.

Skewness and Kurtosis were calculated using the frequency distribution (Kapur, 1980) of the characters mentioned.

β_1 = Skewness

If, $\beta_1 > 0$, then positively skewed
$\beta_1 < 0$, then negatively skewed
$\beta_1 = 0$, then symmetric distribution

β_2 = Kurtosis
If, $\beta_2 > 1$, then leptokurtic
$\beta_2 < 1$, then platykurtic
$\beta_2 = 0$, then mesokurtic

$$\beta_1 = \frac{\mu_3^{\,2}}{\mu_2^{\,2}}$$

$$\beta_2 = \frac{\mu_4^{\,2}}{\mu_2^{\,2}}$$

Where,

$$\mu^2_2 = \frac{1}{N}\sum fi(Xi-\bar{X})^2$$

$$\mu^2_3 = \frac{1}{N}\sum fi(Xi-\bar{X})^3$$

$$\mu^2_4 = \frac{1}{N}\sum fi(Xi-\bar{X})^4$$

Where,

X_i is the individual observation
X is the mean of the character under observation and
N is the number of observations

Significance

The skewness and kurtosis was divided by the respective standard errors to calculate t value. The calculated 't' value was compared with 't' table value with (n-1) degrees of freedom to assess significance.

$$SE_{\beta 1} = \frac{\sqrt{6}}{N}$$

$$SE_{\beta 2} = \frac{\sqrt{24}}{N}$$

Results and Discussion

A frequency distribution graph is a diagrammatic illustration of the information in the frequency table. A histogram is a graphical representation of the variable of interest in the *X* axis and the number of observations (frequency) in the *Y* axis. Percentages can be used if the objective is to compare two histograms having different number of subjects. A histogram is used to depict the frequency when data are measured on an interval or a ratio scale.

Skewness helps us to draw the conclusion about the gene action for a particular trait. The positive skewness indicates the presence of complementary epistatic gene action for the trait and the gain is slower with mild selection and gain is faster with intensive selection. The negative skewness indicates the presence of duplicate epistasis gene action and the gain is faster with mild selection and rapid with intense selection (Snape and Riggs, 1975).

The positive values of kurtosis indicate leptokurtic curve while negative kurtosis indicate platykurtic curve and if values are zero, it indicates mesokurtic *i.e.* normal distribution. The platykurtic and leptokurtic nature indicates the wider and narrow variability of the population respectively. The platykurtic nature of the population will help in the selection programme due to wider variability in that population for the specific character.

Frequency distribution of BC_3F_1 progenies

Frequency distribution indicated that all the progenies showed positive skewness for the trait days to 50% tasseling ranged from 0.12 (UMI 79/936-C1-3-2) to 1.36 (UMI 79/936-C1-101-12) except UMI 79/936-C1-3-4 (-0.14) and UMI 79/936-C1-29-8 (-0.18) and negative kurtosis was observed in all the progenies for this trait. Most of the progenies recorded positive skewness for the trait days to 50% silking ranged from 0.16 (UMI 79/936-C1-29-13) to 0.91 (UMI 79/936-C1-101-14) and all the progenies showed negative kurtosis for this trait. All the progenies showed positive skewness for the trait plan height ranged from 0.06 (UMI 79/936-C1-67-12) to 1.26 (UMI 79/936-C1-101-12) except UMI 79/936-C1-3-4 (-0.14) and UMI 79/936-C1-29-8 (-0.18) while negative kurtosis was observed in all the progenies in respect of pant height (Table.1 and 2).

Most of the progenies recorded positive skewness and negative kurtosis for the trait ear height ranged from 0.15 (UMI 79/936-C1-7-2) to 0.62 (UMI 7(UMI 79/936-C1-67-12) 9/936-C1-101-14) and -1.15 (UMI 79/936-C1-101-12) to -0.11 (UMI 79/936-C1-29-13) respectively. Negative skewness was observed in most of the progenies for cob length ranged from -0.93 (UMI 79/936-C1-67-25) to -0.02 (UMI 79/936-C1-7-2) while all the progenies recorded negative kurtosis ranged from -1.60 (UMI 79/936-C1-29-35) to -0.02 (UMI 79/936-C1-3-4). All the progenies recorded negative skewness cob breath ranged from -1.20 (UMI 79/936-C1-67-25) to -0.13 (UMI 79/936-C1-7-7) except (UMI 79/936-C1-3-4) and (UMI 79/936-C1-29-13) and most of the progenies showed negative kurtosis for this trait ranged from -1.08 (UMI 79/936-C1-7-7) to -0.16 (UMI 79/936-C1-101-14).

Eight progenies recorded positive skewness for number of rows per cob with range from 0.07 (UMI 79/936-C1-29-23) to 0.60 (UMI 79/936-C1-67-3) remaining recorded negative skewness and all the progenies showed negative kurtosis for this trait ranging from -1.53 (UMI 79/936-C1-29-23) to -0.16 (UMI 79/936-C1-101-12).

All the progenies recorded negative skewness for number of grains per row ranged from -0.85 (UMI 79/936-C1-29-8) to -0.01 (UMI 79/936-C1-29-13) except (UMI 79/936-C1-7-7) (UMI 79/936-C1-67-3), (UMI 79/936-C1-67-12) and (UMI 79/936-C1-101-14) while all the progenies showed negative kurtosis for this trait ranged from -0.12 (UMI 79/936-C1-67-3) to -0.14 (UMI 79/936-C1-3-2). Seven progenies recorded positive skewness for cob weight ranged from 0.06 (UMI 79/936-C1-7-7) to 0.94 (UMI 79/936-C1-3-2) remaining progenies showed negative skewness while all the progenies showed negative kurtosis for this trait ranged from -1.50 (UMI 79/936-C1-29-36) to -0.05 (UMI 79/936-C1-7-7) except (UMI 79/936-C1-3-2) and (UMI 79/936-C1-101-14).

Twelve progenies recorded positive skewness for the trait yield per plant ranged from 0.18 (UMI 79/936-C1-67-3) to 1.06 (UMI 79/936-C1-7-2) and most of the progenies showed negative kurtosis for this trait ranged from -1.48 (UMI 79/936-C1-7-7) to -0.38 (UMI 79/936-C1-29-13). Seven progenies recorded positive skewness for 100 grain weight with range from 0.01 (UMI 79/936-C1-29-35) to 0.85 (UMI 79/936-C1-3-2) and remaining progenies showed negative skewness and all the progenies showed negative kurtosis for this trait ranged from -1.20 (UMI 79/936-C1-7-2) to -0.03 (UMI 79/936-C1-67-12) except (UMI 79/936-C1-7-2) and (UMI 79/936-C1-101-12). Most of the progenies recorded negative skewness and negative kurtosis for shelling % ranged from -1.15 (UMI 79/936-C1-67-25) to -0.13 (UMI 79/936-C1-101-12) , -1.27 (UMI 79/936-C1-7-7) to -0.04 (UMI 79/936-C1-29-13) respectively.

To conclude that all the progenies showed positive skewness for days to 50% tasseling and days to 50% silking except UMI 79/936-C1-3-4 and UMI 79/936- C1-29-8.In respect of plant height all the progenies showed positive skewness except UMI 79/936-C1-7-2 and UMI 79/936- C1-7-7. Most of the progenies showed negative skewness for ear height, number of rows per cob and number of grains per row.

Table.1 Skewness and Kurtosis observed in the SDM resistant progenies of BC_3F_1 generation

Progeny no	50% tasselling		50% silking		plant height		ear height		cob ength		cob breadth	
	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis
UMI 79/936-C1-3-2	0.12	-1.61	0.31	-1.67	0.21	-0.82	0.58	0.46	-0.39	-0.54	-0.27	-1.17
UMI 79/936-C1-3-4	-0.14	-1.31	-0.16	-1.16	0.08	-1.19	-0.09	-0.35	-0.43	-0.55	-0.84	-0.02
UMI 79/936-C1-7-2	0.72	-0.07	0.90	0.14	-0.11	-0.77	0.15	-1.09	-0.02	-1.13	-0.32	-0.45
UMI 79/936-C1-7-7	0.84	-0.59	0.84	-0.59	-0.16	-0.80	0.52	-1.00	0.31	-0.56	-0.13	-1.08
UMI 79/936-C1-29-8	-0.18	-1.00	-0.43	-1.25	0.10	-1.12	0.26	-0.73	1.02	-0.39	0.68	-0.08
UMI 79/936-C1-29-9	0.89	-1.05	0.89	-1.05	0.66	-0.29	0.37	-0.32	0.86	0.09	0.55	-0.90
UMI 79/936-C1-29-13	0.16	-0.77	0.16	-1.12	0.35	-1.05	-0.39	-0.57	0.98	0.02	1.16	0.16
UMI 79/936-C1-29-23	0.32	-1.00	0.23	-1.36	0.30	-1.26	-0.28	-0.11	0.40	-0.72	-0.05	-0.51
UMI 79/936-C1-29-35	0.38	-0.96	0.30	-1.20	0.37	-1.19	-0.16	-0.37	0.91	0.25	0.07	-0.53
UMI 79/936-C1-29-36	0.38	-1.01	0.32	-1.26	0.58	-1.08	0.28	-0.85	0.51	-0.99	0.38	-1.10
UMI 79/936-C1-67-3	0.40	-1.12	0.26	-1.46	0.54	-0.97	-0.11	-0.63	0.59	-0.76	-0.53	-0.76
UMI 79/936-C1-67-12	0.27	-1.00	0.22	-1.34	0.06	-1.14	-0.39	0.43	0.60	-1.08	0.31	-1.27
UMI 79/936-C1-67-25	0.66	-0.69	0.61	-1.05	0.46	-1.10	0.52	-0.85	0.35	-1.37	0.39	-1.39
UMI 79/936-C1-101-12	1.36	1.17	0.44	-0.69	1.26	-0.05	0.49	-1.15	-0.24	-1.58	-0.24	-1.58
UMI 79/936-C1-101-14	0.49	-0.30	0.91	0.51	0.43	-1.41	0.62	-0.63	0.17	-0.78	-0.39	-1.04

Table.2 Skewness and Kurtosis observed in the SDM resistant progenies of BC3F1 generation

Progeny no	no.of rows per cob		no.of kernels per row		cob weight		grain yield		100 seed weight		shelling %	
	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis
C	-0.59	-0.32	1.36	2.31	0.87	0.59	1.18	1.94	0.85	0.14	0.13	-0.80
UMI 79/936-C1-3-4	1.06	0.62	0.52	-0.89	1.34	1.31	1.32	1.12	0.26	-0.46	-0.10	-0.19
UMI 79/936-C1-7-2	0.12	-0.85	-0.02	0.36	0.88	0.65	0.59	0.01	0.04	-1.20	-0.65	0.53
UMI 79/936-C1-7-7	-0.45	-0.31	0.14	-1.39	0.06	-1.08	-0.07	-1.48	0.29	-1.18	-0.15	-1.27
UMI 79/936-C1-29-8	0.75	-0.62	0.52	-1.21	0.71	-1.06	0.91	-0.96	0.95	0.66	-0.43	0.99
UMI 79/936-C1-29-9	1.23	0.96	1.41	1.27	0.70	-1.35	0.67	-1.43	1.80	3.56	0.46	-1.58
UMI 79/936-C1-29-13	0.89	0.01	0.87	0.58	1.41	1.08	1.60	1.96	0.43	-0.71	0.08	-0.28
UMI 79/936-C1-29-23	0.81	0.22	0.72	0.04	0.61	-0.80	0.76	-0.74	0.44	-0.80	0.20	-0.88
UMI 79/936-C1-29-35	0.30	0.23	0.46	-0.62	-0.06	-1.02	-0.15	-1.44	0.22	-1.22	-0.26	-1.19
UMI 79/936-C1-29-36	0.73	-0.40	1.08	0.59	0.37	-1.27	0.61	-1.00	0.48	-0.81	0.23	-0.93
UMI 79/936-C1-67-3	-0.26	0.04	0.20	-0.49	0.20	-0.49	1.12	0.83	0.02	-1.45	-0.72	-0.48
UMI 79/936-C1-67-12	0.67	-0.46	0.97	-0.07	0.42	-1.22	0.55	-1.17	0.14	-1.01	0.01	-0.89
UMI 79/936-C1-67-25	0.68	0.47	0.62	-0.65	0.16	-1.49	0.38	-1.33	0.18	0.25	0.12	-1.08
UMI 79/936-C1-101-12	-0.09	-0.90	-0.47	-0.47	0.37	-1.43	0.43	-1.21	0.83	0.40	0.28	-0.99
UMI 79/936-C1-101-14	0.37	-0.80	-0.04	-0.45	0.26	-0.92	0.49	-0.82	0.31	-0.77	-1.00	1.94

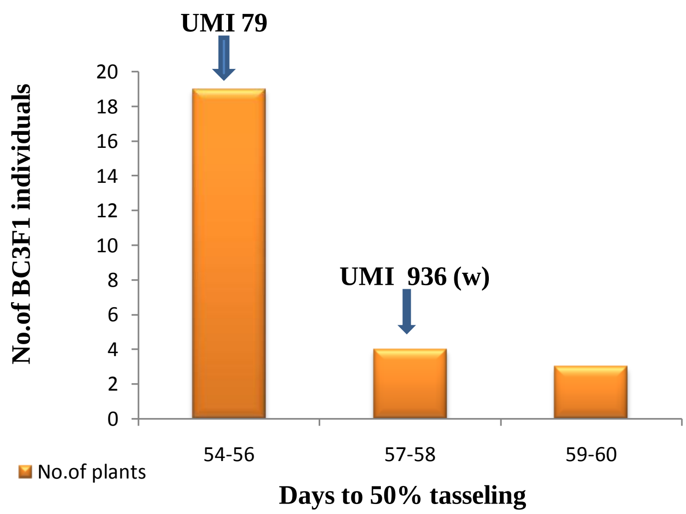

Fig. 1. Frequency distribution for days to 50 per cent tasseling of UMI 79/936 –C1-7-7 in BC_3F_1 generation

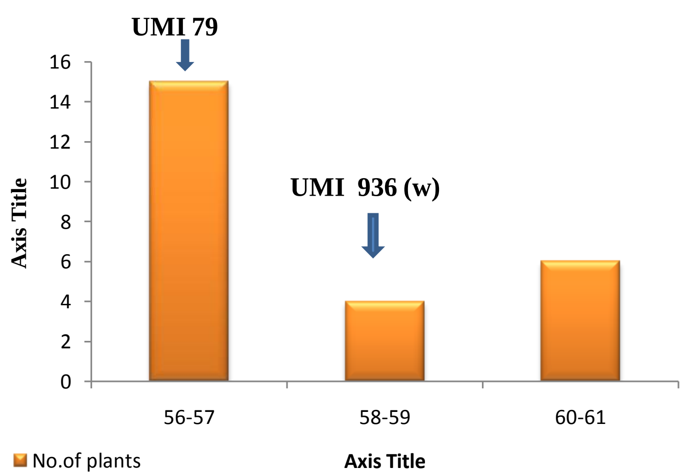

Fig. 2. Frequency distribution for days to 50 per cent silking of UMI 79/936 –C1-7-7 in BC_3F_1 generation

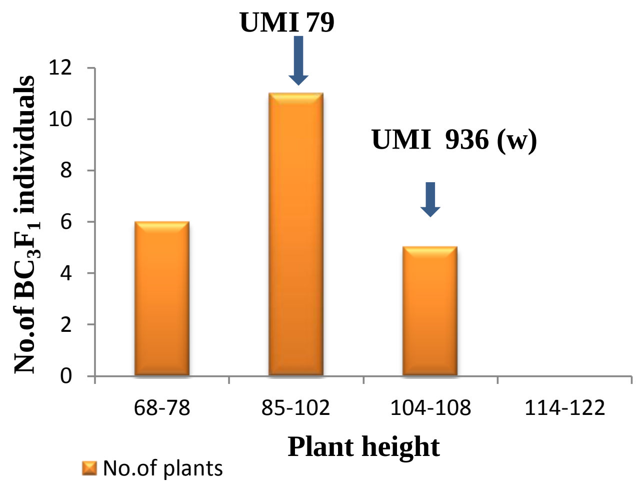

Fig. 3. Frequency distribution for plant height of UMI 79/936 –C1-7-7 in BC_3F_1 generation

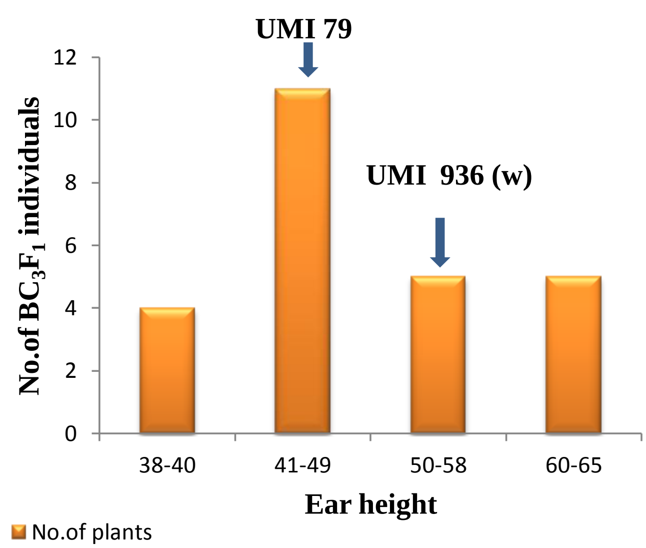

Fig. 4. Frequency distribution for ear height of UMI 79/936 –C1-7-7 in BC_3F_1 generation

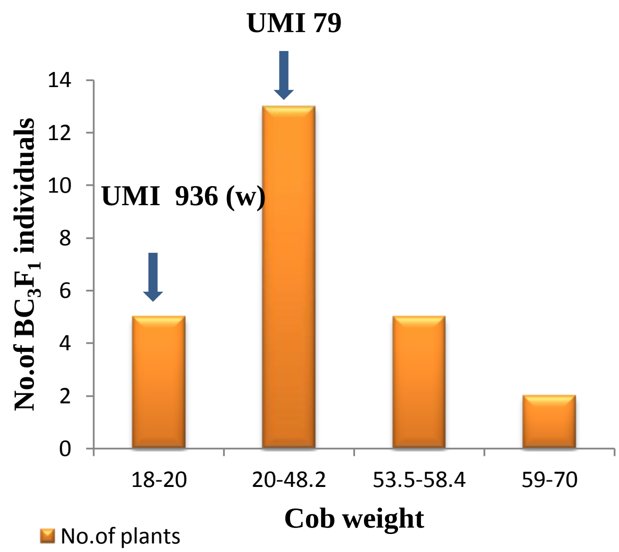

Fig. 5. Frequency distribution for cob weight of UMI 79/936 –C1-7-7 in BC_3F_1 generation

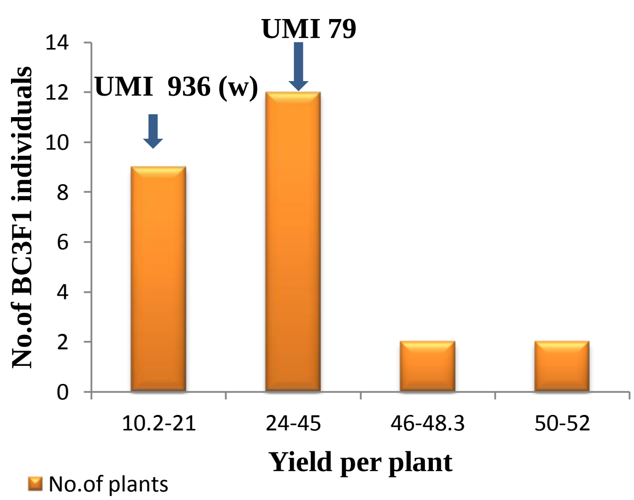

Fig. 6. Frequency distribution for yield per plant of UMI 79/936 –C1-7-7 in BC_3F_1 generation

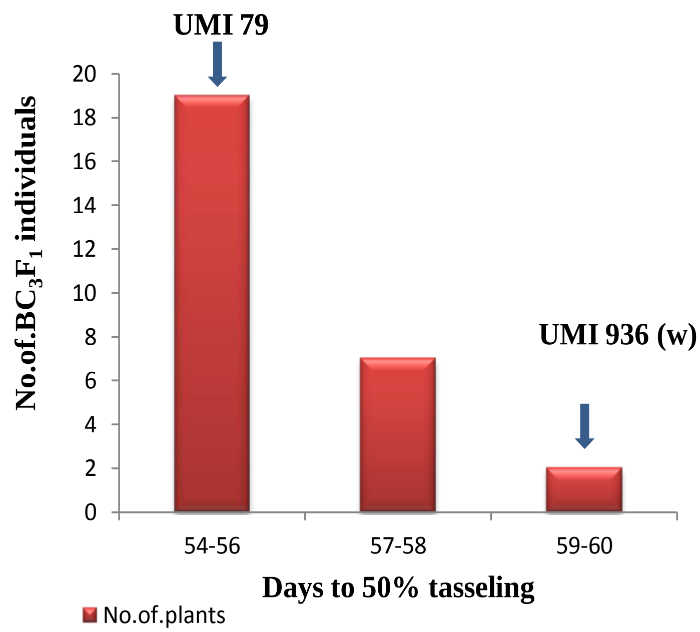

Fig. 7. **Frequency distribution for days to 50 per cent tasseling of UMI 79/936 –C1-7-2 in BC_3F_1 generation**

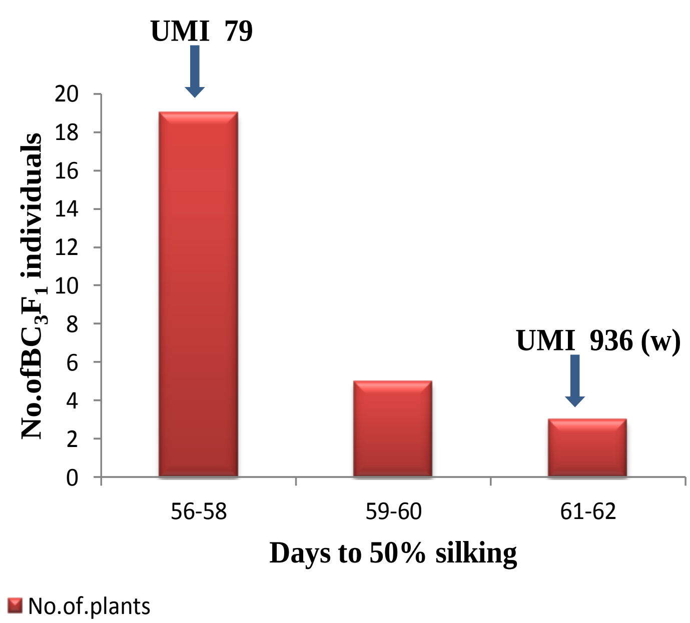

Fig. 8. **Frequency distribution for days to 50 per cent silking of UMI 79/936 –C1-7-2 in BC_3F_1 generation**

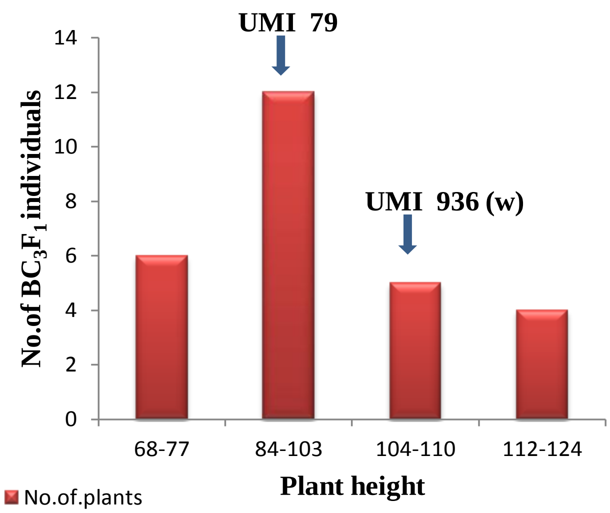

Fig. 9. Frequency distribution for plant height of UMI 79/936 –C1-7-2 in BC_3F_1 generation

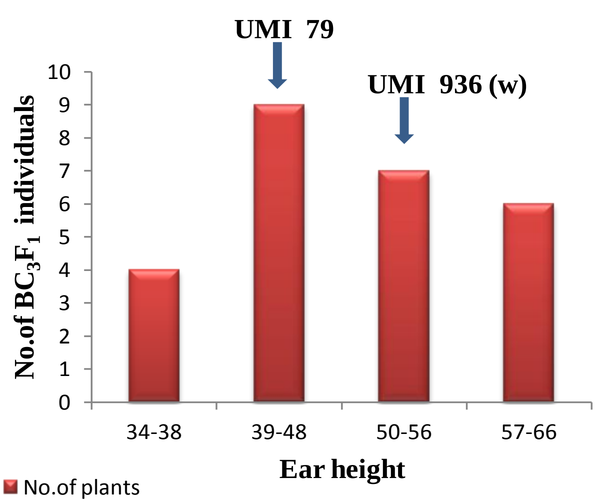

Fig. 10. Frequency distribution for ear height of UMI 79/936 –C1-7-2 in BC_3F_1 generation

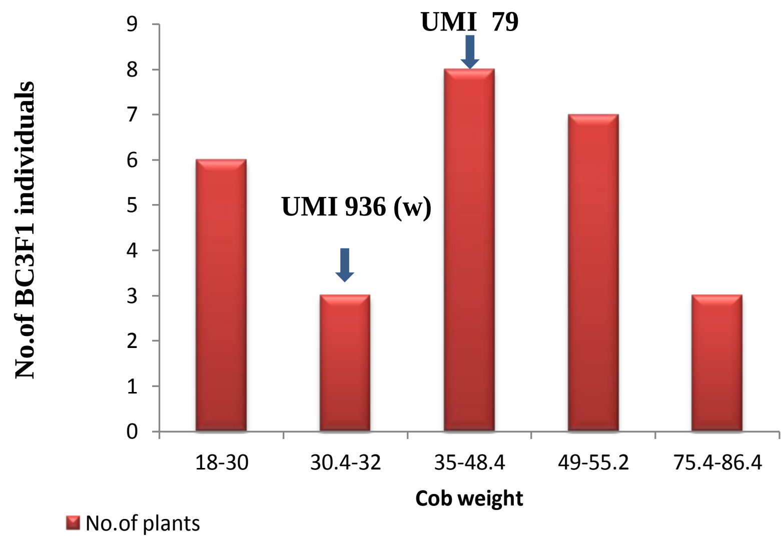

Fig. 11. Frequency distribution for cob weight of UMI 79/936 –C1-7-2 in BC_3F_1 generation

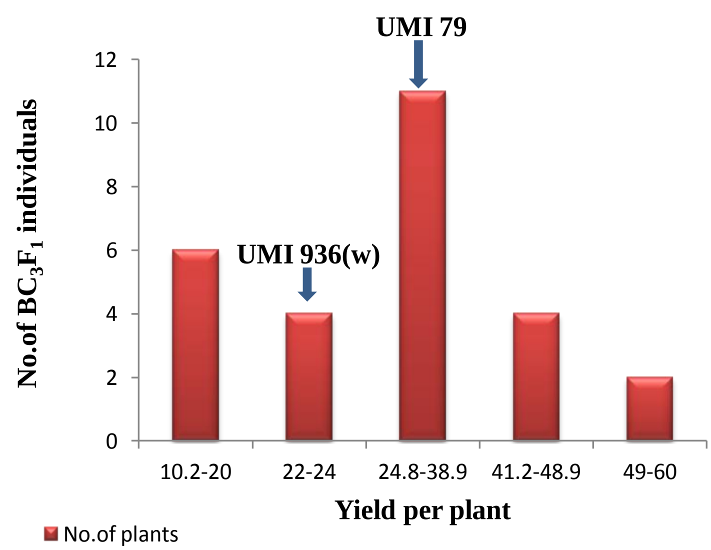

Fig. 12. Frequency distribution for yield per plant of UMI 79/936 –C1-7-2 in BC_3F_1 generation

All the progenies exhibited negative skewness for cob length and cob diameter except UMI 79/936- C1-29-9 and UMI 79/936- C1-29-13.Five progenies recorded positive skewness for cob weight remaining progenies recorded negative skewness.

All the progenies exhibited positive skewness for yield per plant except UMI 79/936- C1-7-7 UMI 79/936- C1--29-8 and UMI 79/936- C1-101-12.Similar results were reported in maize by Suresh Kumar (2014) and Sruthy Menon (2014).Almost all the progenies showed negative kurtosis for the traits under study. Tamilkumar (2012) and Sruthy Menon (2014) reported similar results for grain yield. This indicates platykurtic curve which means that flat values are present in the distribution and characters are controlled by many genes. If selection for these characters were made intensively, the gain will be faster.

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