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Studies on Variability Parameters of Sorghum Downy Mildew Resistant BC_3F_1 Back Cross 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 experiment was conducted at Eastern Block of the Central Farm Unit, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India to identify the best performing Sorghum Downy Mildew resistant progeny for agronomical traits. The objective of this study was to identify the better biometric performance of the resistant progeny. Twelve biometrical characters of four SDM resistant BC_3F_1 back cross progenies *viz.*, UMI 79/936-C1-3-2, UMI 79/936-C1-3-4, UMI 79/936-C1-7-2, and UMI 79/936-C1-7-7 were used for variability studies. Variability analysis revealed that mean values of days to 50% tasseling and days to 50% silking for all the four progenies showed that mostly similar to recurrent parent. In the case of yield contributing characters viz., Cob length, Cob diameter, Number of rows per cob, Number of kernels per row, Cob weight, Yield per plant and 100 grain weight for all the progenies showed moderate to high levels of variability and heritability. Among the four progenies the progeny no. UMI 79/936-C1-7-7 showed better *per se* performance for yield contributing characters. It exhibited more mean values than the parents for the characters viz., Cob length, Cob diameter, No.of rows per cob, No.of. Kernels per row, Cob weight, Yield per plant, 100 grain weight. Based on the variability analysis the progeny no UMI 79/936-C1-7-7 was confirmed as the best progeny.

Introduction

Maize *(Zea mays L)* is the third most important cereal food crop of the world after wheat and rice. In India, maize ranks third next to rice and wheat. Among the cereals maize is rich in starch, oil and sucrose. Globally 67 % of maize is used for livestock feed, 25% human consumption, industrial purposes and balance is used as seed and demand for grain is increasing worldwide. 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).

Moreover, due to the economical cost of the chemicals and the emergence of chemical resistance in the downy mildew pathogens (Raymundo, 2000), the use of host plant resistance seems to be the most effective, economical and it is meant as a safer way of controlling SDM in maize (Rathore and Jain, 2000). The genetic information relating to host resistance is vital for making breeding decisions. Selection is effective when there is genetic variability among the individuals in a population. Hence, insight into the magnitude of genetic variability present in a population is of paramount importance to a plant breeder for stating a judicious breeding programme. Knowledge of heritability and genetic advance of the character indicate the scope for the improvement through selection. Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection then heritability estimates alone (Johnson *et al.,* 1955). Hence, the present studies were undertaken to identify the best performing SDM resistant progeny for yield contributing characters through variability analysis.

Materials and Methods

Maize *(Zea mays L)* is the third most important cereal food crop of the world after wheat and rice. In India, maize ranks third next to rice and wheat. Among the cereals maize is rich in starch, oil and sucrose. Globally 67 % of maize is used for livestock feed, 25% human consumption, industrial purposes and balance is used as seed and demand for grain is increasing worldwide. 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).

Moreover, due to the economical cost of the chemicals and the emergence of chemical resistance in the downy mildew pathogens (Raymundo, 2000), the use of host plant resistance seems to be the most effective, economical and it is meant as a safer way of controlling SDM in maize (Rathore and Jain, 2000). The genetic information relating to host resistance is vital for making breeding decisions. Selection is effective when there is genetic variability among the individuals in a population. Hence, insight into the magnitude of genetic variability present in a population is of paramount importance to a plant breeder for stating a judicious breeding programme. Knowledge of heritability and genetic advance of the character indicate the scope for the improvement through selection. Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection then heritability estimates alone (Johnson *et al.,* 1955). Hence, the present studies were undertaken to identify the best performing SDM resistant progeny for yield contributing characters through variability analysis.

Results and Discussion

The potentiality of a cross and any progeny is measured not only by mean performance but also on the extent of variability. Knowledge on nature and magnitude of genotypic and phenotypic variability present in any crop species plays an important role in formulating successful breeding programmes (Allard, 1960). The genetic advance is a useful indicator of the progress that can be expected as result of exercising selection on the pertinent population. Heritability in conjunction with genetic advance would give a more reliable index of selection value (Johnson et al. 1955). .Plant breeders are commonly faced with problems of handling segregating populations and selection procedures. Mean and variability are the important factors for selection. Mean serves as a basis for eliminating undesirable crosses or progenies. Variability helps to choose a potential cross or progeny since variability indicates the extent of recombination for initiating effective selection procedures.

Selection of parents is one of the most important step in any breeding programme. Selection method can extract good cultivars if the parents used in the breeding programme are suitable. Therefore, an elite inbred UMI 79 was selected to introgress Sorghum Downy Mildew resistance from UMI 936(W). Inclusion of elite inbred as parent (UMI 79) will largely help to ensure the recovery of a high proportion of progenies with adaptation and quality that would in turn helpful in developing superior hybrids with SDM resistance. The important biometrical traits *viz.*, days to 50% tasseling, days to 50% silking, , plant height, Ear height,cob length, cob diameter, number of rows per cob, number of grains per row, cob weight, 100 grain weight grain yield per plant and shelling % were studied in the four SDM resistant progenies of BC_3F_1 population (Table 1 to 4).

In the present investigation, analysis of variability parameters revealed that, the parent UMI 79 showed better *per se* performance than the parent for yield contributing characters *viz.*, number of rows per cob, number of grains per row, cob weight, 100 grain weight grain yield per plant and shelling %. In all the four progenies *viz.*, UMI 79/936-C1-3-2, UMI 79/936-C1-3-4, UMI 79/936-C1-7-2, and UMI 79/936-C1-7-7 for the character days to 50% taselling and days to 50% silking showed low levels of phonotypic and genotypic co-efficient variation 2.72% (UMI 79/936-C1-3-2) to 4.10% (UMI 79/936-C1-3-4) and 2.69% (UMI 79/936-C1-7-2) to 6.50% (UMI 79/936-C1-3-2) respectively. These characters exhibited high levels of heritability 69.83% (UMI 79/936-C1-7-2) to 89.23% (UMI 79/936-C1-3-2) with low genetic advance as percent of mean from 4.20 to 6.71. The mean values for these two characters showed almost similar to recurrent parent 55.40 days and 57.40 days respectively.

The variability parameters *viz.,* PCV 13.28 % (UMI 79/936-C1-3-2) to 15.87% (UMI 79/936-C1-3-4) were found to be moderate for the trait plant height with low level to moderate level of GCV from 7.92% (UMI 79/936-C1-3-2) to 15.87% (UMI 79/936-C1-3-4). Moderate to high level of heritability was found in all the progenies from 33.33% (UMI 79/936-C1-3-2) to 89.23 % (UMI 79/936-C1-3-2).Cob length and Cob diameter showed low to moderate level of PCV and GCV with moderate to high levels of heritability in all the four progenies. Similar findings in maize were also reported by Rafique *et al.* (2004), Abhirami *et al.* (2005), Alake *et al.* (2008) and Reddy *et al.* (2013).

Panwar *et al.* (2013) also reported moderate variability for number of grains per row and cob diameter. All the progenies recorded moderate to high level of PCV for number of rows per cob ranged from 16.98% (UMI 79/936-C1-7-2) to 24.17 % (UMI 79/936-C1-3-4) and moderate levels of GCV from to 10.35% (UMI 79/936-C1-7-2) 18.70 % (UMI 79/936-C1-3-4) with high heritability (Table 1 to 4).

Table.1 Variability parameters observed in BC3F1 Progenies for UMI 79/936-C1-3-2

Traits	Grand Mean			Range								
	P1	**P2**	**BC_3F_1**	**Min.**	**Max.**	**Vp**	**Vg**	**PCV**	**GCV**	**h2**	**GA**	**GA(as percentage on mean)**
Days to 50 per cent tasseling	55.40	62.40	56.08	54.00	58.00	3.40	2.58	3.29	2.86	75.88	2.48	4.42
Days to 50 per cent silking	57.40	64.00	58.44	56.00	61.00	6.50	5.80	4.36	4.12	89.23	3.40	5.82
Plant height (cm)	84.00	102.00	83.54	68.00	104.00	123.00	43.80	13.28	7.92	35.61	7.32	8.76
Ear height (cm)	42.80	49.00	44.64	35.00	57.00	48.60	21.75	15.62	10.45	44.75	4.64	10.40
Cob length	13.30	13.38	11.15	7.30	13.50	4.87	2.44	19.79	14.01	50.08	1.78	15.94
Cob diameter	11.80	11.56	9.97	7.60	12.00	3.45	1.87	18.63	13.71	54.16	1.47	14.72
No.of.rows per cob (cm)	18.80	14.40	12.96	8.00	16.00	7.52	2.62	21.16	12.49	34.84	1.67	12.86
No.of.kernels per row (cm)	19.20	17.00	13.92	8.00	26.00	16.49	11.64	29.18	24.51	70.59	5.86	42.07
Cob weight (g)	55.82	34.94	31.88	17.20	60.28	154.60	53.56	39.00	22.96	34.64	7.78	24.39
Yield per plant (g)	40.68	23.36	21.15	10.00	47.45	146.87	62.17	57.31	37.29	42.33	7.58	35.83
100 Grain weight (g)	19.10	16.92	12.94	12.60	20.35	6.64	3.15	19.91	13.70	47.39	2.03	15.71
Shelling %	71.89	67.02	65.33	54.52	78.72	46.65	15.55	10.45	6.04	33.33	4.64	7.11

Table.2 Variability parameters observed in BC3F1 Progenies for UMI 79/936-C1-3-4

Traits	Grand Mean			Range								
	P1	**P2**	**BC_3F_1**	**Min.**	**Max.**	**Vp**	**Vg**	**PCV**	**GCV**	**h2**	**GA**	**GA(as percentage on mean)**
Days to 50 per cent tasseling	55.40	62.40	56.83	54.00	60.00	4.10	3.28	3.56	3.19	79.98	3.29	5.80
Days to 50 per cent silking	57.40	64.00	59.18	56.00	63.00	5.02	4.32	3.79	3.51	86.06	3.97	6.71
Plant height (cm)	84.00	102.00	89.84	60.00	116.00	282.38	203.18	18.70	15.87	71.95	24.58	27.36
Ear height (cm)	42.80	49.00	47.20	30.00	68.00	78.57	51.72	18.78	15.24	65.83	11.87	25.15
Cob length	13.30	13.38	12.71	7.80	16.70	5.64	3.21	18.69	14.11	56.93	2.74	21.57
Cob diameter	11.80	11.56	11.43	7.40	14.40	2.86	1.28	14.80	9.90	44.73	1.53	13.41
No.of.rows per cob (cm)	18.80	14.40	14.45	10.00	24.00	12.20	7.30	24.17	18.70	59.84	4.25	29.38
No.of.kernels per row (cm)	19.20	17.00	14.00	8.00	23.00	20.26	15.41	32.15	28.04	76.06	5.48	39.14
Cob weight (g)	55.82	34.94	32.06	12.00	78.00	230.21	129.17	47.32	35.45	56.11	13.27	41.38
Yield per plant (g)	40.68	23.36	21.55	8.20	55.00	132.33	47.63	53.39	32.03	35.99	8.29	38.50
100 Grain weight (g)	19.10	16.92	13.45	7.00	20.12	10.27	6.77	23.83	19.35	65.98	4.29	31.90
Shelling %	71.89	67.02	65.99	49.45	85.42	67.67	36.57	12.47	9.16	54.04	9.15	13.87

Table.3 Variability parameters observed in BC3F1 Progenies for UMI 79/936-C1-7-2

Traits	Grand Mean			Range									
	P1	**P2**	**BC_3F_1**	**Min.**	**Max.**	**Vp**	**Vg**	**PCV**	**GCV**	**h2**	**GA**	**GA (as percentage on mean)**
Days to 50 per cent tasseling	55.40	62.40	55.78	54.00	60.00	2.72	1.90	2.96	2.47	69.83	2.34	4.20
Days to 50 per cent silking	57.40	64.00	58.00	56.00	62.00	2.69	1.99	2.83	2.43	74.00	2.50	4.31
Plant height (cm)	84.00	102.00	94.33	68.00	124.00	251.08	171.88	16.80	13.90	68.46	22.35	23.69
Ear height (cm)	42.80	49.00	48.78	34.00	66.00	80.79	53.94	18.43	15.06	66.77	12.36	25.35
Cob length	13.30	13.38	12.30	8.30	16.60	6.27	3.84	20.36	15.93	61.25	3.16	25.69
Cob diameter	11.80	11.56	11.17	7.50	14.60	3.97	2.39	17.84	13.84	60.19	2.47	22.13
No.of.rows per cob (cm)	18.80	14.40	16.44	12.00	22.00	7.79	2.89	16.98	10.35	37.14	2.14	12.99
No.of.kernels per row (cm)	19.20	17.00	17.78	7.00	29.00	24.33	19.48	27.75	24.83	80.07	5.51	30.99
Cob weight (g)	55.82	34.94	43.69	18.00	86.40	287.28	186.24	38.80	31.24	64.83	16.56	37.90
Yield per plant (g)	40.68	23.36	31.35	10.20	60.00	158.58	73.88	40.17	27.42	46.59	12.09	38.55
100 Grain weight (g)	19.10	16.92	16.52	10.10	23.46	17.68	14.19	25.46	22.81	80.24	5.36	32.43
Shelling %	71.89	67.02	71.33	53.33	82.07	50.52	19.42	9.96	6.18	38.44	5.63	7.89

Table.4 Variability parameters observed in BC3F1 Progenies for UMI 79/936-C1-7-7

Traits	Grand Mean			Range								
	P1	**P2**	**BC_3F_1**	**Min.**	**Max.**	**Vp**	**Vg**	**PCV**	**GCV**	**h2**	**GA**	**GA(as percent on mean)**
Days to 50 per cent tasseling	55.40	62.40	55.68	54.00	59.00	2.81	1.99	3.01	2.53	70.82	2.45	4.39
Days to 50 per cent silking	57.40	64.00	57.68	56.00	61.00	2.81	2.11	2.91	2.52	75.09	2.59	4.50
Plant height (cm)	84.00	102.00	94.84	68.00	122.00	223.39	144.19	15.76	12.66	64.55	19.87	20.95
Ear height (cm)	42.80	49.00	49.08	38.00	65.00	70.83	43.98	17.15	13.51	62.09	10.75	21.90
Cob length	13.30	13.38	15.35	8.40	16.60	5.03	2.59	18.15	13.04	51.62	2.38	19.30
Cob diameter	11.80	11.56	13.50	7.70	14.70	4.72	3.14	19.74	16.10	66.49	2.98	27.04
No.of.rows per cob (cm)	18.80	14.40	19.92	10.00	20.00	8.49	3.59	18.31	11.91	42.31	2.54	15.95
No.of.kernels per row (cm)	19.20	17.00	20.20	7.00	25.00	32.38	27.53	34.95	32.23	85.02	9.97	61.21
Cob weight (g)	55.82	34.94	58.50	10.20	52.00	267.05	166.01	40.46	31.90	68.16	20.93	51.81
Yield per plant (g)	40.68	23.36	60.25	10.20	52.00	198.31	113.61	46.85	35.46	57.29	16.62	55.29
100 Grain weight (g)	19.10	16.92	21.20	10.20	24.21	18.63	15.14	26.98	24.32	81.25	7.22	45.15
Shelling %	71.89	67.02	73.10	56.67	85.42	73.78	42.68	11.94	9.08	57.85	10.24	14.22

All the four progenies exhibited high PCV and GCV for cob weight ranged from 38.80 % (UMI 79/936-C1-7-2) to 47.32% (UMI 79/936-C1-3-4) and 22.96% (UMI 79/936-C1-3-2) to 35.45% (UMI 79/936-C1-3-4) respectively. It also showed high heritability ranged from 34.64% (UMI 79/936-C1-3-2) to 68.16% (UMI 79/936-C1-7-7) with high genetic advance. 100 grain weight found to high levels of heritability with high levels genetic advance as percent of mean. Yield per plant recorded high PCV and GCV ranged from 46.59% (UMI 79/936-C1-7-2) to 57.31 % (UMI 79/936-C1-3-2) and 27.42% (UMI79/936-C1-7-2) to 37.29(UMI 79/936-C1-3-2) respectively. It also recorded high heritability from 35.99 % UMI 79/936-C1-3-4 to 57.29% (UMI79/936-C1-7-7) with high genetic advance. Vashishta *et al.*, 2013 observed high to moderate variability for number of grains per row and grain yield per plant.

Among the four progenies UMI 79/936-C1-7-7 showed better *per se* performance for yield contributing characters. It showed highest mean value than the parents for the characters namely cob length (15.35 cm), cob diameter (13.50 cm), number of rows per cob (19.92), number of kernels per rows (20.20), cob weight (58.50g) and yield per plant (60.25g). It also recorded high level of heritability and genetic advance. This is the indication of predominance of additive gene action. This is desirable for selection since these traits are least influenced by the environment. The selection for these traits is likely to accumulate more additive genes leading to further improvement in their agronomic performance. Similar results were obtained by Vashishta *et al.* (2013) and by Bekele and Rao (2014) for grain yield per plant (58.52), plant height (37.09) and ear height.

To conclude that the study revealed that among the four progenies studied the progeny UMI 79/936-C1-7-7 showed better *per se* performance for the yield contributing characters. It also recorded moderate to high variability and high heritability with high genetic advance for cob weight and yield per plant. So the progeny no UMI 79/936-C1-7-7 was identified as best progeny in regards to better biometrical performance. It may serve as basis material for developing single cross maize hybrids resistant to sorghum downy mildew with high yield.

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