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Combining ability studies in Muskmelon (*Cucumis melo* L.)

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ABSTRACT

The parent Hara Madhu in E_1, AMM-01-18 and AMM-02 -26 in E_2 and AMM-01-18, AMM-02-26 and Hara Madhu on pooled basis exhibited positive and significant GCA effects for fruit yield per plant. Thus these three parents appeared to be good general combiners for fruit yield. Out of these parents AMM-01-18 had a good combining ability for fruit yield per plant, number of primary branches, number of fruits per plant, fruit weight, moisture content, total soluble solids, acidity and total soluble sugars on pooled basis. Specific combining ability effects for fruit yield and yield attributing traits revealed significant and positive SCA effects in fourteen crosses for number of primary branches per plant, nine for fruit length, twelve for fruit girth, ten for fruits per plant, eleven for fruit weight, nine for fruit yield per plant, eleven for flesh thickness, nine for moisture content, twenty for total soluble solids, twenty for acidity and fifteen for total soluble sugars data in the desired direction in pooled analysis. However, some crosses like AMM-01-18 x AMM-02-26, Hara Madhu x RM-50 and AMM-01-18 x DM-1 exhibited significant SCA effects for fruit yield per plant over environments along with some of the component traits in different environments.

Key words: GCA, SCA

INTRODUCTION

Muskmelon, *Cucumis melo* L. with diploid chromosome number, 2n = 24 belongs to the family Cucurbitaceae. Persia and the Transcaucasus are believed to be the main centres of origin and development of muskmelon with a secondary centre including the northwest provinces of India and Afghanistan. Although truly wild forms of *Cucumis melo* have not been found, several related wild species have been observed in those regions. The early travellers introduced it to Europe from where it moved the USA. At present, muskmelon is being cultivated throughout the world under both tropical and subtropical climatic conditions.

In breeding high-yielding varieties of crop plant the breeder is often faced with the problem of selecting parents and crosses. Combining ability analysis is one of the powerful tools available, which gives an estimate of combining ability effect and aids in selecting desirable parents and crosses for further exploitation. The common approach of selecting parents on the basis of per se performance does not necessarily lead to fruitful results (Allard, 1960). Selection of the best parents for hybridization has to be based on complete genetic information. Knowledge of combining ability estimates gives information about the genetic architecture of the parents. With this aim in view, the present investigation was undertaken to identify the best combiners among the existing germplasm in 10 x 10 diallel set to facilitate the formulation of a sound breeding programme of this crop.

MATERIAL AND METHODS

Ten varieties of muskmelon, viz., Punjab Sunehri, Pusa Madhuras, AMM- 00-25, AMM- 00-11, AMM- 01-18, DM-1, AMM- 02-26, PMM- 96-20, Hara Madhu and RM-50 were crossed in all possible combinations, excluding reciprocals. The resulting 45 F_1 hybrids alongwith their parents were grown in randomized block design with three replications at a spacing of 150 cm (row to row) and 90 cm (plant to plant) in plots of size 6m x 4.5 m. Observations were taken on 10 selected plants from each plot in two environments created by different sowing dates (E_1=15th October, 2003 and E_2=15th February, 2004). All the recommended cultural practices were followed during experimentation. Observations were recorded on number of the node on which the first female flower appeared, days to first open female flower, number of primary branches per plant, days to first harvest, fruit length (cm), fruit girth (cm), number of fruits per plant, fruit weight (g), fruit yield per plant (kg), flesh thickness (cm), moisture content (%), total soluble solids (TSS %), acidity (%) and total soluble sugars (mg g^{-1}). Data were statistically analysed for the study of combining ability, by method 2, model 1 of Griffing (1956).

Table 1. Parental lines and their source

Variety/Genotype	Source
Punjab Sunehri	PAU, Ludhiana
Pusa Madhuras	IARI, New Delhi
AMM- 00-25	AAU, Anand
AMM- 00-11	AAU, Anand
AMM- 01-18	AAU, Anand
DM-1	IARI, New Delhi
AMM- 02-26	AAU, Anand
PMM- 96-20	Pantnagar
Hara Madhu	PAU, Ludhiana
RN-50	Durgapura

RESULTS AND DISCUSSION

Mean squares due to GCA and SCA were found significant for all the traits across environments except GCA mean square for fruit yield per plant in E_1. These results suggest the importance of both additive and non-additive gene action for different traits studied during the two different seasons. Further, the variance ratio of GCA : SCA indicated that non-additive gene action was greater for all the traits under study. The potence ratio of both the components of genetic variance was below one (unity) for all the characters except fruit girth and moisture content in E_1 which suggests that specific combining ability effects were more pronounced for inheritance of most traits. The predictivity ratio of variance was estimated below 0.5 for all the characters in each environment indicating that variance due to specific combining ability was predominant for genetic control for all the traits.

General combining ability effects for fruit yield and yield components were estimated between the environments as well as over the environments for parents (Table 2). The top three good combiners for fruit yield and yield attributing traits with respect to mean performance in each environment were identified and are presented in Table 3. The consideration of *per se* performance of parents in combination with their GCA effects was reported to provide a better criteria for choice of superior parents in hybridization programs. In the present investigation, *per se* performance of the parents for different characters was generally related to the GCA effects for the number of the node on which first female flower appeared, number of primary branches, days to first harvesting, fruit girth and number of fruits per plant. In muskmelon, fruit yield is a complex trait, hence direct selection for this trait is not usually effective. Several workers (Swamy, 1985; Randhawa and Singh, 1990) have reported that the number of fruits, average fruit weight, number of the node on the main stem, number of primary branches and fruit shape index are the important component traits of fruit yield in muskmelon. These component traits are expected to have greater variability, heritability and a positive association with fruit yield. Selection based on these important traits may be effective in improving this complex trait of fruit yield. General combining ability of parents for the characters studied are presented in Table 2, a perusal of which indicates that none of the parents were good general combiners for all the characters in an individual environment and in pooled analysis. Further, Table 2 revealed that the parents Hara Madhu in $E_{1,}$ AMM-01-18 and AMM-02 -26 in E_2 and AMM-01-18 and AMM-02-26, on pooled basis, exhibited positive and significant GCA effects for fruit yield per plant. Thus, these three parents were observed to be good general combiners for fruit yield. Parent AMM-01-18 was a good combiner not only for fruit yield per plant but also for number of primary branches, number of fruits per plant, fruit weight, moisture content, total soluble solids, acidity and total soluble sugars on pooled basis. Similarly, parent Hara Madhu was also a good combiner for the number of node on which first female flower appeared, days to first harvesting, number of fruits per plant, acidity and total soluble sugars. However, parent AMM-02-26 was a good combiner for fruit yield peer plant but was average or poor combiner for the remaining traits in pooled analysis. In addition to this, parent AMM-00-11 also seems to be a good combiner for days to first open female flower, number of primary branches, total soluble solids, moisture content, acidity and total soluble sugars.

In a cross- pollinated crop like muskmelon, specific combining ability effects are of great importance because they are mostly related to dominance gene effects which could be utilized for the development of hybrid varieties. Moreover, if a cross combination having at least one parent as a good general combiner exhibits high SCA effect in addition to high *per se* performance, it is expected that such a cross combination would throw up desirable transgressive segregants in later generations. In muskmelon, such type of combinations could be utilized for the development of improved cultivars. Further, cross combinations involving

Table 2. Estimates of general combining ability (GCA) effects of parents for various characters in muskmelon

Parent	Number of the node on which first female flower appears			Days to first open female flower			Number of primary branches per plant		
	E_1	E_2	P	E_1	E_2	P	E_1	E_2	P
Punjab Sunehri	0.19 *	-0.26 *	-0.04	0.83 **	-0.75 *	0.04	-0.30 **	-0.11	-0.20 **
Pusa Madhuras	0.06	-0.31 **	-0.12	0.38	-0.60	-0.11	-0.40 **	-0.33 **	-0.37 **
AMM-00-25	-0.20 *	-0.37 **	-0.28 **	-0.60 **	-0.34	-0.47 *	-0.27 **	-0.55 **	-0.41 **
AMM-00-11	-0.21 **	1.14 **	0.46 **	-0.85 **	-0.77 *	-0.81 **	0.14	0.54 **	0.47 **
AMM-01-18	0.04	0.26 *	0.15 *	-0.42 **	1.98 **	0.78 **	0.50 **	0.48 **	0.49 **
DM-1	0.19 *	-0.24 *	-0.02	-0.18	0.92 **	0.37 *	0.25 **	0.36 **	0.31 **
AMM-02-26	0.06	0.34 **	0.20 **	-0.03	1.06 **	0.51 **	-0.04	-0.12	-0.08
PMM-96-20	0.15	-0.38 **	-0.11	-0.02	0.10	0.04	0.09	0.09	0.09
Hara Madhu	-0.01	-0.50 **	-0.25 **	0.71 **	-0.82 *	-0.06	-0.31 **	-0.50 **	-0.40 **
RM-50	-0.28 **	0.31 **	0.02	0.18	-0.79 *	-0.30	0.07	0.13	0.10
SE (g_i) ±	0.08	0.11	0.07	0.20	0.32	0.19	0.09	0.11	0.07
SE ($g_i - g_j$) ±	0.12	0.17	0.10	0.29	0.48	0.28	0.14	0.16	0.10
C.D. *(P=0.05)*	0.16	0.22	0.14	0.39	0.63	0.37	0.18	0.22	0.14
C.D. *(P=0.01)*	0.21	0.28	0.18	0.52	0.83	0.49	0.23	0.28	0.18

Parent	Days to first harvesting			Fruit length			Fruit girth		
	E_1	E_2	P	E_1	E_2	P	E_1	E_2	P
Punjab Sunehri	2.17 **	-0.14	1.02 **	-0.28	-0.59 *	-0.70 **	-1.49 **	-2.45 **	-1.97 **
Pusa Madhuras	0.53	0.26	0.40	0.53 **	-0.49	0.02	2.39 **	-1.54 **	0.42
AMM-00-25	-0.38	-0.61 **	-0.50 *	0.78 **	0.39	0.58 **	0.95 **	1.82 **	1.38 **
AMM-00-11	0.23	0.36 *	0.29	-0.28	0.74 **	0.23	-0.90 **	-0.14	-0.52 *
AMM-01-18	0.03	0.80 **	0.42	0.19	-0.66 *	-0.24	-0.84 **	1.15 **	0.15
DM-1	-0.11	-0.35 *	-0.23	0.47 *	-0.13	0.17	1.31 **	-0.36	0.47 *
AMM-02-26	-0.80	0.02	-0.39	-0.49 **	0.77 **	0.14	-0.60 **	0.81	0.11
PMM-96-20	-1.08 *	-0.45 *	-0.77 **	0.38 *	-0.39	0.00	0.83 **	0.16	0.50 *
Hara Madhu	-1.13 *	-0.15	-0.64 *	-0.33 *	-0.36 *	-0.35 *	-0.57 **	-0.24	-0.40
RM-50	0.53	0.26	0.40	-0.44 *	0.73 **	0.15	-1.07 **	0.80	-0.14
SE (g_i) ±	0.48	0.18	0.25	0.19	0.28	0.17	0.18	0.43	0.23
SE ($g_i - g_j$) ±	0.39	0.27	0.38	0.29	0.42	0.25	0.28	0.65	0.35
C.D. *(P=0.05)*	0.94	0.35	0.49	0.37	0.55	0.33	0.35	0.84	0.45
C.D. *(P=0.01)*	1.24	0.46	0.65	0.49	0.72	0.44	0.46	1.11	0.59

Parent	Number of fruits per plant			Fruit weight			Fruit yield per plant		
	E_1	E_2	P	E_1	E_2	P	E_1	E_2	P
Punjab Sunehri	0.33 *	-0.35 **	-0.01	-47.37 **	-31.29 *	-39.33 **	-0.01	-0.31 **	-0.16 **
Pusa Madhuras	-0.34 *	-0.03	-0.19 **	25.10 *	-36.31 *	-5.60	-0.05	-0.13	-0.09 *
AMM-00-25	-0.43 *	-0.17 *	-0.30 **	18.10	13.80	15.95	-0.07	-0.08	-0.07
AMM-00-11	0.16	-0.10	0.03	-28.38 **	23.80	-2.29	-0.04	-0.02	-0.03
AMM-01-18	0.30	0.10	0.20 *	1.40	51.97 **	26.69 *	0.07	0.23 **	0.15 **
DM-1	-0.08	0.10	0.01	-8.43	-38.42 *	-23.42 *	-0.05	0.01	-0.02
AMM-02-26	-0.21	0.32 **	0.06	-9.51	35.08	12.79	-0.06	0.34 **	0.14 **
PMM-96-20	0.15	-0.04	0.05	-1.95	28.45	13.25	0.06	0.01	0.03
Hara Madhu	0.29	0.23 **	0.26 **	30.62 **	0.69	15.66	0.17 **	0.12	0.14 **
RM-50	-0.17	-0.06	-0.11	20.42	-47.78 **	-13.68	0.00	-0.17 *	-0.09 *
SE (g_i) ±	0.17	0.07	0.09	10.48	18.35	10.57	0.05	0.07	0.04
SE ($g_i - g_j$) ±	0.25	0.11	0.13	15.62	27.36	15.75	0.08	0.11	0.07
C.D. *(P=0.05)*	0.33	0.14	0.18	20.54	35.97	20.72	0.10	0.14	0.08
C.D. *(P=0.01)*	0.44	0.18	0.23	27.04	47.34	27.27	0.13	0.18	0.10

*, ** Significant at 5 and 1 per cent levels, respectively

E_1 = 15th October, 2003 E_2 = 15th February, 2004 P = Pooled

Table 2. contd…

Parent	Flesh thickness			Moisture content			Total soluble solids		
	E_1	E_2	P	E_1	E_2	P	E_1	E_2	P
Punjab Sunehri	0.01	-0.02	-0.01	-0.24	-0.39 **	-0.32 **	-1.51 **	0.15	-0.68 **
Pusa Madhuras	0.08 *	-0.01	0.03	-1.31 **	-0.26 *	-0.79 **	0.78 **	-0.43 **	0.18
AMM-00-25	0.06	-0.01	0.03	0.28	0.01	0.14	0.79 **	-0.34 *	0.23
AMM-00-11	0.06	-0.11 **	-0.03	-0.60 **	-0.14	-0.37 **	0.20	1.23 **	0.72 **
AMM-01-18	-0.04	-0.07 *	-0.05	-0.71 **	-0.19	-0.45 **	0.20	0.35 *	0.27 *
DM-1	0.07	0.10 **	0.08 **	-0.83 **	-0.32 **	-0.58 **	0.77 **	0.26	0.52 **
AMM-02-26	-0.04	0.06 *	0.01	-0.23	0.03	-0.10	0.35	-0.09	0.13
PMM-96-20	0.01	-0.12 **	-0.05	0.85 **	-0.02	0.42 **	-0.16	-0.27 *	-0.22
Hara Madhu	-0.12 **	0.12 **	0.00	1.37 **	0.17	0.77 **	-0.52 *	0.05	-0.23
RM-50	-0.08 *	0.06 *	-0.01	1.43 **	1.11 **	1.27 **	-0.90 **	-0.92 **	-0.91 **
SE (g_i) ±	0.04	0.03	0.03	0.21	0.11	0.12	0.24	0.14	0.14
SE $(g_i - g_j)$ ±	0.06	0.05	0.04	0.31	0.16	0.17	0.36	0.21	0.21
C.D. *(P=0.05)*	0.08	0.06	0.06	0.41	0.22	0.24	0.47	0.27	0.27
C.D. *(P=0.01)*	0.10	0.08	0.08	0.54	0.28	0.31	0.62	0.36	0.36

Parent	Acidity			Total soluble sugar		
	E_1	E_2	P	E_1	E_2	P
Punjab Sunehri	-0.01	-0.02 *	-0.02 **	0.07	0.31 *	0.19 *
Pusa Madhuras	0.00	-0.01	0.00	0.00	0.14	0.07
AMM-00-25	0.02 *	0.02 *	0.02 **	-0.14	-0.19	-0.17 *
AMM-00-11	-0.06 **	-0.04 **	-0.05 **	0.43 **	0.47 **	0.45 **
AMM-01-18	-0.02 *	-0.02 *	-0.02 **	0.21	0.21	0.21 **
DM-1	0.02 *	0.01	0.02 **	-0.22 *	-0.17	-0.20 *
AMM-02-26	0.04 **	0.03 **	0.04 **	-0.24 *	-0.42 **	-0.33 **
PMM-96-20	-0.04 **	-0.03 **	-0.04 **	0.15	0.32 *	0.23 **
Hara Madhu	-0.02 *	-0.02 *	-0.02 **	0.36 **	0.17	0.26 **
RM-50	0.08 **	0.08 **	0.08 **	-0.62 **	-0.83 **	-0.72 **
SE (g_i) ±	0.01	0.01	0.007	0.11	0.13	0.08
SE $(g_i - g_j)$ ±	0.02	0.01	0.01	0.16	0.20	0.13
C.D. *(P=0.05)*	0.02	0.02	0.01	0.22	0.25	0.16
C.D. *(P=0.01)*	0.03	0.03	0.02	0.28	0.34	0.21

*, ** Significant at 5 and 1 per cent levels, respectively

E_1 = 15th October, 2003 E_2 = 15th February, 2004   P = Pooled

good x good combiners and exhibiting significant SCA effects indicate a major role of additive type of gene effects, which are fixable. However, two good general combiners may not necessarily throw up good segregants. Similarly, in the segregating progenies of superior crosses involving both poor general combiners, very little gain is expected from such cross combinations because the high SCA effects obtained may be due to dominance and epistatic gene effects which dissipate the progress towards fixation of heterosis.

A critical study of the GCA effects of the parents for crosses exhibiting significant desirable SCA effects for fruit yield per plant on pooled basis revealed maximum number of elite hybrids to be of good x good, average x average/poor type of combinations (62.5 per cent). In E_1, 60 per cent of the cross combinations registered average x average type of combination, while 50 per cent of the crosses showed average x average type of combination in E_2. Gurav *et al* (2000) also reported that crosses showing significant SCA effects evolved parents with good x good, good x poor and poor x poor combining ability suggesting the presence of additive as well as non-additive gene action in the expression of characters.

Specific combining ability effects for fruit yield and yield attributing traits revealed that fourteen crosses for the number of primary branches per plant, nine for fruit length, twelve for fruit girth, ten for fruit per plant, eleven for fruit weight, nine for fruit yield per plant, eleven for flesh thickness, nine for moisture content, twenty for total soluble solids, twenty for acidity and fifteen for total soluble depicted significant SCA effects in the desired direction in pooled analysis. However, out of these, only eight crossess exhibited significant and positive SCA effects for the number of primary branches per plant, two crosses each for fruit length, fruit girth, fruit yield per plant and flesh

Table 3. Top three parents with respect to their *per se* performance and GCA effects in desirable direction for various traits in muskmelon

Characters	E_1		E_2		P	
	Per se Performance	GCA effects	*Per se* performance	GCA effects	*Per se* performance	GCA effects
Number of node on which first female flower appears	RM- 50 AMM-00-25 Pusa Madhuras	RM- 50 AMM-00-11 AMM-00-25	Punjab Sunehri PMM-96-20 AMM-00-25	Hara Madhu PMM-96-20 AMM-00-25	AMM-00-25 Punjab Sunehri PMM-96-20	AMM-00-25 Hara Madhu Pusa Madhuras
Days to first female flower open	AMM-00-25 Pusa Madhuras Punjab Sunehri	AMM-00-11 AMM-00-25 AMM-01-18	PMM-96-20 Punjab Sunehri AMM-02-26	Hara Madhu RM- 50 AMM-00-11	PMM-96-20 Punjab Sunehri AMM-00-25	AMM-00-11 AMM-00-25 RM- 50
Number of primary branches per plant	AMM-01-18 AMM-00-11 PMM-96-20	AMM-01-18 DM-1	AMM-01-18 AMM-00-11 PMM-96-20	AMM-00-11 AMM-01-18 DM-1	AMM-01-18 AMM-00-11 PMM-96-20	AMM-01-18 AMM-00-11 DM-1
Days to first harvesting	Hara Madhu PMM-96-20 AMM-00-25	Hara Madhu PMM-96-20	PMM-96-20 Punjab Sunehri DM-1	AMM-00-25 PMM-96-20 DM-1	PMM-96-20 Hara Madhu Punjab Sunehri	PMM-96-20 Hara Madhu AMM-00-25
Fruit length	AMM-01-18 Pusa Madhuras DM-1	AMM-00-25 Pusa Madhuras DM-1	RM- 50 DM-1 Hara Madhu	AMM-02-26 AMM-00-11 RM- 50	DM-1 RM- 50 Hara Madhu	AMM-00-25
Fruit girth	Pusa Madhuras DM-1 PMM-96-20	Pusa Madhuras DM-1 PMM-96-20	RM- 50 AMM-00-25 DM-1	AMM-00-25 AMM-01-18	DM-1 Pusa Madhuras RM-50	AMM-00-25 PMM-96-20 DM-1
Number of fruits per plant	AMM-00-11 PMM-96-20 Punjab Sunehri	Punjab Sunehri	DM-1 Hara Madhu Pusa Madhuras	AMM-02-26 Hara Madhu	Pusa Madhuras Punjab Sunehri Hara Madhu	Hara Madhu AMM-01-18
Fruit weight	AMM-01-18 AMM-02-26 PMM-96-20	Hara Madhu Pusa Madhuras	PMM-96-20 DM-1 AMM-01-18	AMM-01-18	AMM-02-26 Pusa Madhuras AMM-00-25	AMM-01-18
Fruit yield per plant	PMM-96-20 Pusa Madhuras Punjab Sunehri	Hara Madhu	DM-1 Hara Madhu Pusa Madhuras	AMM-02-26 AMM-01-18	AMM-02-26 RM- 50 PMM-96-20	AMM-01-18 AMM-02-26 Hara Madhu
Flesh thickness	DM-1 Punjab Sunehri PMM-96-20	Pusa Madhuras	RM- 50 Hara Madhu AMM-02-26	Hara Madhu DM-1 AMM-02-26 RM- 50	Pusa Madhuras AMM-02-26 RM- 50	DM-1
Moisture content	Pusa Madhuras Punjab Sunehri AMM-01-18	Pusa Madhuras DM-1 AMM-01-18	Punjab Sunehri DM-1 AMM-01-18	Punjab Sunehri DM-1 Pusa Madhuras	AMM-00-25 Punjab Sunehri Hara Madhu	Pusa Madhuras DM-1 AMM-01-18
Total soluble solids	DM-1 PMM-96-20 Pusa Madhuras	AMM-00-25 Pusa Madhuras DM-1	Punjab Sunehri Pusa Madhuras PMM-96-20	AMM-00-11 AMM-01-18	AMM-01-18 Hara Madhu PMM-96-20	AMM-00-11 DM-1 AMM-01-18
Acidity	AMM-00-25 PMM-96-20 Pusa Madhuras	AMM-00-11 PMM-96-20 AMM-01-18 Hara Madhu	AMM-00-25 Pusa Madhuras AMM-02-26	AMM-00-11 PMM-96-20 AMM-01-18 Hara Madhu	AMM-01-18 AMM-00-11 AMM-02-26	AMM-00-11 PMM-96-20 AMM-01-18 Hara Madhu
Total soluble sugars	AMM-00-25 Pusa Madhuras AMM-02-26	AMM-00-11 Hara Madhu	AMM-00-25 Pusa Madhuras PMM-96-20	AMM-00-11 PMM-96-20 Punjab Sunehri	AMM-01-18 AMM-00-11 AMM-02-26	AMM-00-11 Hara Madhu PMM-96-20

E_1 = 15th October E_2 = 15th February P = Pooled thickness, five crosses for moisture content, nine for total soluble solids, fourteen for acidity and ten for total soluble sugars in individual environment and when averaged over environments.

The relative ranking of three best crosses over environments on the basis of SCA effects and *per se* performance (Table 4) indicating that crosses exhibiting high SCA effects would not necessarily give either the highest mean values and vice-versa. Further none of the cross combination showed consistently high SCA effects for all the characters over environment. However, some crosses like AMM-01-18 x AMM-02-26, Hara Madhu x RM-50 and AMM-01-18 x DM-1 exhibited significant SCA effects for fruit yield per plant over the environments along with some of the component traits in different environments.

From the perusal of Table 4, it is clear that hybrids Hara Madhu x RM-50 and AMM-01-18 x AMM-02-26 are high yielding. Hence, these two hybrids were identified as potential hybrids for widespread cultivation and commercial exploitation. The hybrid Hara Madhu x RM-50 involved parents with good x poor combiners and hybrid AMM-01-18 x AMM-02-26 involved both parents with good

Table 4. Top three hybrids with respect to their SCA effects in desirable crosses for various traits in muskmelon on pooled basis

Character	*Per se* Performance	SCA effects
Number of the node on which first female flower appears	AMM-01-18 x AMM-02-26	AMM-01-18 x AMM-02-26
	P. Madhuras x Hara Madhu	AMM-00-11 x PMM-96-20
	P. Madhuras x AMM-01-18	P. Madhuras x AMM-00-11
Days to first open female flower	AMM-01-18 x RM-50	AMM-00-11 x RM-50
	DM-1 x Hara Madhu	DM-1 x Hara Madhu
	AMM-00-25 x PMM-96-20	AMM-00-25 x RM-50
Number of primary branches per plant	AMM-00-11 x DM-1	DM-1 x RM-50
	DM-1 x RM-50	P. Madhuras x DM-1
	DM-1 x PMM-96-20	AMM-00-11 x DM-1
Days to first harvesting	AMM-00-25 x DM-1	AMM-00-25 x DM-1
	AMM-00-25 x AMM-02-26	P. Sunehri x P. Madhuras
	AMM-00-25 x AMM-01-18	AMM-00-25 x AMM-01-18
		AMM-00-25 x AMM-02-26
Fruit length	AMM-00-25 x RM-50	AMM-00-25 x RM-50
	AMM-02-26 x RM-50	AMM-02-26 x RM-50
	P. Madhuras x AMM-01-18	P. Sunehri x PMM-96-20
Fruit girth	AMM-00-25 x RM-50	AMM-01-18 x Hara Madhu
	AMM-01-18 x Hara Madhu	AMM-00-25 x RM-50
	AMM-01-18 x DM-1	P. Sunehri x AMM-00-25
Number of fruits per plant	PMM-96-20 x Hara Madhu	PMM-96-20 x Hara Madhu
	AMM-01-18 x Hara Madhu	PMM-96-20 x AMM-01-18
	AMM-01-18 x DM-1	AMM-00-25 x AMM-00-11
Fruit weight	P. Sunehri x AMM-00-11	Hara Madhu x RM-50
	Hara Madhu x RM-50	AMM-01-18 x AMM-02-26
	AMM-00-25 x RM-50	AMM-00-25 x PMM-96-20
Fruit yield per plant	Hara Madhu x RM-50	AMM-01-18 x AMM-02-26
	P. Madhuras x AMM-00-11	Hara Madhu x RM-50
	P. Madhuras x AMM-00-25	AMM-01-18 x DM-1
Flesh thickness	AMM-00-11 x DM-1	AMM-01-18 x PMM-96-20
	P. Madhuras x PMM-96-20	AMM-01-18 x Hara Madhu
	P. Madhuras x AMM-01-18	AMM-00-25 x AMM-00-11
Moisture content	DM-1 x RM-50	AMM-00-11 x DM-1
	P. Sunehri x DM-1	AMM-00-25 x Hara Madhu
	P. Sunehri x AMM-01-18	AMM-00-11 x RM-50
Total soluble solids	P. Madhuras x AMM-00-25	P. Sunehri x AMM-02-26
	PMM-96-20 x RM-50	AMM-00-11 x PMM-96-20
	P. Sunehri x PMM-96-20	AMM-00-25 x Hara Madhu
Acidity	P. Madhuras x Hara Madhu	DM-1 x PMM-96-20
	P. Madhuras x RM-50	AMM-01-18 x DM-1
	PMM-96-20 x RM-50	P. Madhuras x Hara Madhu
Total soluble sugars	P. Madhuras x Hara Madhu	DM-1 x PMM-96-20
	P. Madhuras x AMM-00-25	AMM-01-18 x DM-1
	AMM-00-11 x Hara Madhu	AMM-01-18 x PMM-96-20

combiners for fruit yield per plant indicating the role of additive x additive type of gene action and hence, there is good scope for isolation of high yielding homozygous lines in advanced generations.

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