

HYBRID VIGOR is evident in crosses between two parents when the hybrid offspring exceed either parent, or the average of the two parents, in expression of a character. Hybrid vigor is important in many economic plants, and has been previously reported for earliness and certain fruit characters in muskmelon.

This study conducted in southern California's Imperial Valley involved 10 muskmelon varieties and provided information on levels of hybrid vigor for fruit appearance and quality and for yield and maturity characteristics among biparental crosses. Forty-five crosses were made, consisting of all possible combinations of one muskmelon variety with each other variety. Commercial varieties were represented by Powdery Mildew Resistant (PMR) 45, Hale's Best, Campo, and Sulfur Resistant (SR) 91. Other varieties included were Honey Rock, Spartan Rock, Schoon's Hardshell, Delicious 51, Pride of Wisconsin, and Tip Top. Selection of varieties for incorporation into the study was based on the broad expression of characteristics, particularly fruit characters, available in these varieties.

Hybrids and parent varieties were grown at El Centro from February through July. Seedlings started in the greenhouse were transplanted to the field on February 2. A wide plant spacing of 7 x 7 ft was used so that performance of individual plants could be recorded. Fruit harvest was initiated on May 20, and continued at two- to three-day intervals throughout a 41-day harvest period. Fifteen characteristics were evaluated, including net appearance scored visually (as a combined rating of net density and net thickness) on a scale of 0 to 4, with 4 the best. Soluble solids, representing

CORRECTION: CABBAGE LOOPER CONTROL

Our apologies to the authors for implications in wording of both the title and abstract that effective control of the cabbage looper had been demonstrated by use of the male inhibition technique, as it appeared in the article in the December 1971 CALIFORNIA AGRICULTURE, "The male inhibition technique . . . Cabbage Looper Control by confusing sex pheromone communication." These experiments did not demonstrate an accomplished control system, but rather that control *might* be possible in the future when this technique is more perfected.

HYBRID VIGOR IN

sweetness of the fruit, were measured by extracting juice from ripe fruit tissue and reading the solids percentage directly in a hand refractometer. Records were also made of days from transplanting to first fruit harvested, and total number of fruits per plant, including all harvested fruits plus immature fruits of marketable size remaining on the plants after completion of harvest.

Values from the first three fruits harvested from each of 15 plants of each hybrid and parent variety (three replications of five plants each), or a total of 45 values, were averaged to obtain hybrid and parent performance for net appearance and soluble solids presented in table 1. The maturity and fruit number data (table 2) are averages from 15 plants.

Net appearance

Twelve hybrids were better for net appearance than the best parent in the cross (table 1), with the superior hybrids involving crosses among Campo, Hale's Best, PMR 45 and Schoon's Hardshell. An additional 11 hybrids were better than the midparent, SR 91, a commercial variety, produced three of five crosses which were below the performance of the poorer parent, and these inferior hybrids involved crosses with the three other commercial types. The hybrid values for soluble solids all exceeded the midparent value, except for Hale's Best and PMR 45 crossed to Schoon's. Thirty-five of 45 crosses exceeded the best parent in the cross for this character. Considerable hybrid vigor, therefore, is expressed for soluble solids level in these muskmelon varieties.

Hybrids were generally earlier to produce the first mature fruit (low values in table 2 indicate fewer days from transplant to maturity, which is desirable) with 37 crosses earlier than the early parent in the cross. SR 91, the latest parent to mature its first fruit, in general provided the earliest hybrids. Campo and Hale's Best crossed with PMR 45, recorded delayed fruit maturity compared with parent maturities. Over half of the hybrids (25 of 45) produced higher total fruit numbers per plant than the best parent, and an additional nine crosses exceeded midparent values. Five of nine crosses involving Spartan Rock produced

fewer fruit than the poorer parent involved, although Spartan Rock was one of the highest ranking parents for fruit number. Such instances which are common in hybrid studies, point out the difficulty in predicting hybrid performance based on performance of the parental types.

Hybrid vigor

Hybrid vigor in these muskmelon crosses for the four characters are summarized in table 3, along with additional quality and appearance, and yield and maturity characteristics, measured in this study. Suture appearance was rated on the 0 to 4 scale, with a score of 4 indicating smooth fruit void of sutures; rind thickness measured rind and adjacent green flesh portion of the fruit; shape index represents the ratio of fruit length to fruit width; the other characters are self-explanatory. Average per cent hybrid vigor expressed by the hybrids was calculated from the formula: Average per cent hybrid vigor equals Avg. of hybrids minus Avg. of parents divided by Avg. of parents, multiplied by 100.

Hybrids, on the average, expressed favorable vigor only for per cent soluble solids among the fruit quality and appearance factors. Varieties recording high values for net appearance, however, generally maintained this high value when intercrossed, indicating that desirable net should be fixable in muskmelon varieties. This conclusion is supported by the fact that several varieties available commercially have excellent net appearance. Similar evidence is available for suture appearance, and nonsuture commercial varieties are available. Both rind thickness and shape index in hybrids were greater than in parents, which, although representing positive hybrid vigor, are undesirable.

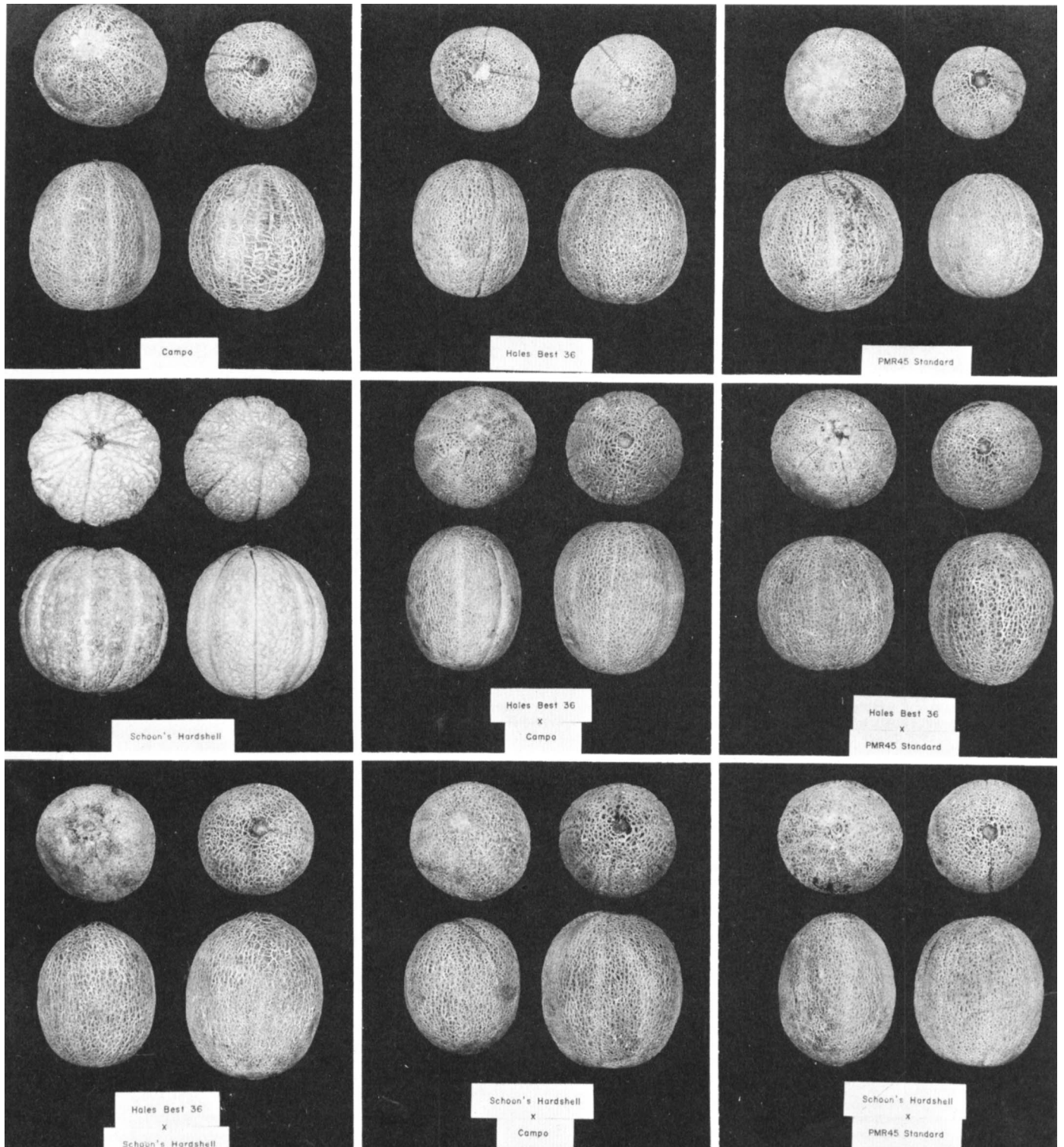
Maturity, yield

Considering maturity and yield characteristics, hybrids performed well, with only a delay in maturity between the first and third fruit harvested, and a lower number and percentage of smaller sized fruits (45 and 36 sizes). Early fruit maturity is desirable, so the delay in maturity of subsequent fruit complicates breeding for concentrated set and once-over

MUSKMELON CROSSES

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Fruits of four muskmelon varieties and five selected F_1 hybrids. Net and suture appearance of these hybrid fruits rate very good to excellent.



Performance muskmelon

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harvest for commercial muskmelon production. The larger fruit size of hybrids would naturally reduce numbers and percentages of smaller sized fruits. Hybrid vigor for average fruit size was not rated as either desirable or undesirable in table 3. An average size of 900 to 1100 grams (36 size) is desirable, but fruit size from this study was expected to be larger than would have resulted from the closer,

more competitive plant spacing common in commercial plantings. Hybrid vigor evident from these muskmelon crosses will continue to be evaluated in this research project on muskmelon breeding.

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TABLE 1. PERFORMANCE OF 45 BIPARENTAL HYBRIDS AND THE 10 PARENT VARIETIES FOR ONE FRUIT APPEARANCE TRAIT (NET, ABOVE DIAGONAL) AND ONE FRUIT QUALITY TRAIT (PER CENT SOLUBLE SOLIDS, BELOW DIAGONAL). VALUES REPRESENT AVERAGE OF 3 FRUITS FROM EACH OF 15 PLANTS GROWN AT EL CENTRO

PER CENT SOLUBLE SOLIDS	MELON NET RATING*	Campo	Del. 51	Hale's Best	Honey Rock	PMR 45	Pride Wisc.	Spart. Rock	SR 91	Schoon's	Tip top
		3.67	0.37	3.67	2.27	3.60	1.53	2.30	3.23	2.13	0.27
Campo	12.5										
Del. 51	13.1	13.8 ¹	1.73	3.80 ¹	2.50	3.77 ¹	2.03	1.93 ³	1.97 ³	3.13 ²	1.67
Hale's Best	12.3	12.7 ¹	13.7 ¹	2.00	2.77 ¹	1.43	1.77 ¹	1.57 ²	2.00 ²	1.83 ²	0.80 ¹
Honey Rock	12.1	13.4 ¹	13.3 ¹	13.1 ¹	2.57	3.83 ¹	2.40	2.73	2.47 ²	3.80 ¹	1.93
PMR 45	12.8	13.3 ¹	14.1 ¹	13.2 ¹	13.2 ¹	2.40	2.20 ²	2.63 ¹	2.27	2.07 ²	1.97 ²
Pride Wisc.	13.6	13.3 ²	13.8 ¹	13.5 ²	14.0 ¹	13.7 ¹	2.27	2.53	2.17 ³	3.80 ¹	2.27 ²
Spart. Rock	13.6	13.2 ²	13.7 ¹	13.5 ²	13.5 ²	13.7 ¹	14.6 ¹	2.27 ²	2.43	2.17 ¹	1.60 ¹
SR 91	8.9	13.3 ¹	13.9 ¹	13.9 ¹	13.4 ¹	13.6 ¹	14.0 ¹	13.9 ¹	2.33	2.43 ¹	1.67 ²
Schoon's	13.1	13.2 ¹	14.1 ¹	12.6	13.2 ¹	12.9	14.1 ¹	14.2 ¹	13.4 ¹	2.30	2.00 ²
Tip Top	12.0	12.8 ¹	13.7 ¹	12.9 ¹	13.2 ¹	13.5 ¹	13.4 ²	12.8 ²	13.0 ¹	12.9 ²	1.23 ²

TABLE 2. PERFORMANCE OF 45 HYBRIDS AND 10 PARENT VARIETIES FOR ONE YIELD TRAIT (TOTAL NUMBER OF FRUIT PER PLANT, ABOVE DIAGONAL) AND ONE MATURITY TRAIT (DAYS FROM TRANSPLANT TO FIRST FRUIT HARVESTED, BELOW DIAGONAL), VALUES ARE AVERAGES FROM 15 PLANTS GROWN AT EL CENTRO

DAYS TO FIRST FRUIT	TOTAL FRUIT NUMBER	Campo	Del. 51	Hale's Best	Honey Rock	PMR 45	Pride Wisc.	Spart. Rock	SR 91	Schoon's	Tip Top
		9.4	8.5	9.2	5.9	8.4	4.6	9.3	9.1	4.1	5.9
Campo	129.4										
Del. 51	123.5	118.9 ¹	9.1 ²	9.5 ¹	8.1 ²	10.5 ¹	6.6	7.4 ³	9.7 ¹	9.5 ¹	9.4 ¹
Hale's Best	124.7	124.9 ²	116.3 ¹	8.9	8.2 ²	10.5 ¹	7.1 ²	6.3 ³	10.7 ¹	9.9 ¹	9.3 ¹
Honey Rock	123.3	123.3 ¹	122.4 ¹	119.7 ¹	7.5	10.3 ¹	9.1 ²	7.5 ²	9.5 ¹	9.6 ¹	7.7 ²
PMR 45	128.1	135.5 ²	114.8 ¹	131.4 ²	114.4 ¹	8.5 ¹	8.4 ¹	6.5	7.5	9.3 ¹	7.8 ¹
Pride Wisc.	129.7	120.0 ¹	122.3 ¹	128.8	120.0 ¹	128.0 ¹	7.7 ²	9.9 ¹	11.3 ¹	9.9 ¹	9.3 ¹
Spart. Rock	126.8	123.6 ¹	123.7 ²	119.9 ¹	116.8 ¹	122.4 ¹	124.4 ¹	5.3	8.5 ²	8.7 ¹	6.5 ¹
SR 91	129.8	120.7 ¹	117.5 ¹	119.3 ¹	121.5 ¹	119.1 ¹	115.7 ¹	7.3 ³	7.3 ³	6.8 ²	5.6 ²
Schoon's	129.3	125.2 ¹	122.7 ¹	128.4	120.3 ¹	128.0 ¹	128.3 ¹	127.5 ²	115.9 ¹	10.5 ¹	9.1 ¹
Tip Top	127.1	121.1 ¹	123.7 ²	121.5 ¹	112.8 ¹	120.7 ¹	126.0 ¹	126.1 ¹	121.0 ¹	125.4 ¹	7.2 ¹

* Melon net rating scored visually as a combined rating of net density and net thickness on a scale of 0 to 4 with 4 the best rating.

¹ Hybrid crosses which exceed best parent in cross.

² Crosses which were better than the midparent or average of two parents.

³ Crosses which were below the low or poor parent.

TABLE 3. SUMMARY OF HYBRID PERFORMANCE FOR 15 TRAITS IN MUSKMELON—NUMBER OF HYBRIDS WHOSE VALUES EXCEEDED HIGH PARENT IN CROSS (>HP), EXCEEDED MIDPARENT (>MP) OR WERE LESS THAN LOW PARENT (<LP) ARE INDICATED FOR EACH TRAIT

Characters evaluated	Number of crosses:			Mean of parents	Mean of hybrids	Avg. % hybrid vigor
	>HP	>MP†	<LP			
Quality and appearance traits:						
Net appearance (0-4 score)	12	23	5	2.31	2.30	- 0.17 -‡
Scruble solids (%)	35	43	0	12.40	13.44	+ 8.39**+
Rind thickness (mm)	6	13	24	2.85	3.26	+ 14.31**-
Suture appearance (0-4)§	5	14	14	2.46	2.25	- 8.40**-
Flesh (%)	5	19	14	44.27	43.81	- 1.04 -
Shape index (length/width)	10	18	17	1.101	1.124	+ 2.10**-
Maturity and yield traits:						
Days to first harvested fruit	37	41	2	127.2	122.1	- 3.99**+
Days—1st to 3rd fruit harvested	8	15	20	9.5	11.7	+ 23.72**-
Avg. wt. 1st 3 fruits (gm)	25	30	6	1244	1428	+ 14.79**
Total wt. fruit/plant (gm)	34	38	3	7791	9456	+ 21.38**+
Total number fruit/plant	25	34	5	7.4	8.5	+ 14.52**+
No. fruit harvested/plant	15	27	9	5.0	6.7	+ 35.27**+
Early fruit harvested (21 day harvest period)	24	29	4	1.6	2.0	+ 27.76**+
No. fruit in 45 and 36 sizes	7	18	17	2.5	2.2	- 13.82 -
% fruit in 45 and 36 sizes	6	14	22	37.8	30.5	- 19.27**-

† Includes >HP crosses.

‡ + and - designates desirable or undesirable direction of average hybrid vigor.

§ 0-4 scale; 4 = smooth fruit void of sutures.

** Differences between parents and hybrids which are significantly different from zero at 1% level of probability.

THE PURPOSE of plant breeding is to combine in a single individual or variety a desirable level of expression of all important traits. This can be difficult to achieve because the various desirable traits are often distributed among different plant types. Population improvement can be accomplished by simultaneous incorporation of several types into a composite population, followed by selection for maximum expression of the various traits within the offspring. Evaluation and selection of parent materials to combine into such a population to permit this accumulation of traits, therefore, becomes important.

Diallel cross

The diallel cross involves all possible two-way crosses among several parents, and provides a method for evaluating parental entries by comparing their performance in combination with each other parent in the diallel. The average performance of a line in hybrid combinations is termed "general combining ability," (GCA) and relates to additive gene action. The performance of specific hybrid crosses, after taking into account the GCA of the two parents, is termed "specific combining ability" (SCA) and measures the dominance deviation from the additive model. Information of GCA and SCA—or the types of gene action influencing various traits—enables the plant breeder both to evaluate parental entries, and to select the best breeding system for maximum character improvement.

A diallel cross was established to evaluate 10 muskmelon varieties for their combining abilities, and to provide a basis for selection of varieties to be incorporated into a breeding population for muskmelon improvement in desert areas. The 10 varieties in the table were crossed in all possible combinations to provide 45 F₁ hybrids. These hybrids, along with the parent varieties, were grown at three locations in southern Cali-