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Muskmelon Quality Characteristics— Their Variability and Interrelationships

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This paper presents statistics related to 14 selected characteristics of muskmelons. The statistics were derived from observations made on melons grown in various production areas of California. The following information is presented:

. . . Mean and range of variation for each of the 14 characteristics (table 2).

. . . Coefficients of variation, standard deviations, and F values of the characteristics, from which the number of melons required for adequate sampling may be estimated (table 2).

. . . The correlation between responses of any two characteristics to variation in location (table 3).

. . . The correspondence of each characteristic with a hypothetical group of factors deduced by factor analysis from the correlations between all characteristics (table 4).

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INTRODUCTION

THE JUDGMENT of fruit quality in the muskmelon or cantaloupe (*Cucumis melo* L.) must be based on a number of fruit characteristics. A study of quality therefore becomes a quantitative study of these characters. By common report, quality can vary appreciably from one production site to another. With the ultimate objective of understanding the relationships between environment and muskmelon quality, we undertook in 1962 a survey of melons grown in different locations in California, having as our immediate objectives:

(a) the development of quantitative measurements or ratings for important quality characteristics;

(b) observation of the range within which each characteristic may vary when melons are selected from different growing situations;

(c) determination of correlations, if any, between melon characteristics.

Initially, the primary problem was the detection of quality variations of the type reported by growers and shippers. The variations in question do not affect the grading of melons according to standards set by the United States Department of Agriculture, but allegedly affect the acceptability of melons on the market. Logically, then, we would be considering variations which are normal physiological responses, occurring under apparently or generally favorable cultural conditions. We would not be considering defects such as sunburn or severe absence of netting, which are apt to result from obviously poor growing conditions or disease situations. We felt that justification for research and anticipation of success in relating quality to environment depended on establishing the reality of these reported variations by quantitative means. To permit concentration on the primary problem, observations made for the purpose of detecting causal relationships were relegated to future work. This was a decisive point in formulating the sampling procedure. Attention in 1962 was centered, not on samples representative of all melons produced at each of the 24 sites, but on samples representing the melons of U. S. #1 quality produced at each site—those which would appear on the market. Observations on the cultivar PMR 45 were preferred.

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SAMPLING METHOD

A limited section of each field was selected for sampling. The sample was expected to represent a particular site of fairly uniform character. About 60 fruits were picked for each site.

All samples were picked before 10 a.m., except at Site 23, where the sample was taken after noon. Very large or small-sized melons were not taken. The melons were at full-slip, firm to the touch, and free from any defects that would eliminate them from U. S. #1 grade. It was assumed, on the basis of experience, that the sample melons were not more than a day past inception of the full-slip stage, i.e., complete and easy abscission of the stem from the fruit.

Melons were taken to a laboratory within two hours. The best 30 out of the 60 full-slip melons were selected on the basis of firmness, minimum color change, and general appearance, as judged from net development, suture netting, and size of ground spot.

Recorded information on the sites is given in table 1 and indicates that the fields differed in ways that might conceivably influence melon quality. Sites 3 to 8 were located in one experimental area, being treatment plots of a nitrogen-irrigation experiment (Flocker *et al.,* 1962), representing combinations of three levels of soil moisture and three levels of applied nitrogen. All samples were of the variety PMR 45 except those at Site 1, which were SR 91, and at Sites 23 and 24, which were PMR 450.

DEFINITIONS AND MEASUREMENTS OF INDIVIDUAL CHARACTERISTICS

Table 2 presents the average measurements or ratings for 14 characters of muskmelons from each of the 24 sites. This table conveys the principal results of the report and requires only a few supplementary remarks about each character.

Ground-spot diameter is the average of the widest and narrowest diameters of the ground spot, measured in centimeters. This character varied widely between sites. The range represented in table 2 was sufficient to greatly affect the appearance of the melons.

Net height, as given in table 2, is a visual judgment of the degree to which the net is elevated above the melon surface. Although significant differences between sites are recorded for both net height and net tightness, it cannot be said that representative melons from any of the sites had a poor appearance on the basis of net development.

Net tightness describes the lateral development or spread of net strands. This was judged by estimating the average width of the enclosed areas between the net strands. In accordance with the rating shown in the table, the greater the development of net strands, the higher the recorded value. Since this measurement has reference to a standard unit of length, it is probably more reproducible than the rating for net height.

Melon color ratings shown in table 2 are based on the color of the areas between the net strands, sometimes called the background color. Color of the net was also rated. These latter ratings, not given in the table, were highly correlated with background color. The data indicate that melons at initiation of full-slip at some sites were more highly colored than melons at the same stage at other sites.

Unnetted suture width was rated by estimating the average width of the unnetted portion of the sutures. This characteristic varied widely between sites, and markedly affected melon appearance.

TABLE 1

LOCATION AND DESCRIPTION OF SITES FROM WHICH EXPERIMENTAL MUSKMELON FRUITS WERE OBTAINED

Site	County	Approx. latitude	Soil series	Soil texture*	Location from trough of valley	Source of irrigation water	Harvest date
1............	Tulare	36.2	Madera	l	East	Sierra, canal	8/7
2............	Yolo	38.3	Yolo	fsl	West	Well	8/2
3............	Fresno I_3N_3†	36.2	Panoche	cl	West	Well	7/25—30
4............	Fresno I_2N_3	36.2	Panoche	cl	West	Well	7/25—30
5............	Fresno I_1N_3	36.2	Panoche	cl	West	Well	7/25—30
6............	Fresno I_2N_2	36.2	Panoche	cl	West	Well	7/25—30
7............	Fresno I_3N_1	36.2	Panoche	cl	West	Well	7/25—30
8............	Fresno I_2N_1	36.2	Panoche	cl	West	Well	7/25—30
9............	Stanislaus	37.3	Pleasanton	gcl	West	Delta, canal	8/1
10............	Merced	36.9	Lost Hills	cl	West	Delta, canal	7/31
11............	Merced	37.0	Sorrento	l	West	Delta, canal	7/13
12............	Merced	37.1	Merced	c	West	Delta, canal	7/13
13............	Kings	36.0	Panoche	fsl	West	Well	7/9
14............	Kern	35.2	Traver	fsl	East	Well	7/2
15............	Kern	35.2	Cajon	fs	East	Well	7/2
16............	Kern	35.2	Cajon	fs	East	Well	7/3
17............	Fresno	36.5	Panoche	l	West	Well	7/5
18............	Kings	36.0	Panoche	fsl	West	Well	7/6
19............	Tulare	35.5	Hesperia	sl	East	Well	7/5
20............	Fresno	36.1	Panoche	l	West	Well	7/6
21............	Fresno	36.2	Panoche	fsl	West	Well	7/11
22............	Fresno	36.2	Panoche	l	West	Well	7/10
23............	Imperial	32.5	Holtville	cl	NW of Holtville	Colorado River	5/26
24............	Imperial	32.4	Superstition	gs	N of Mt. Signal	Colorado River	5/26

* l = loam, c = clay, s = sandy, fs = fine sandy, g = gravelly.
† I_1, I_2, I_3 = 7, 3, 0.5 bars maximum soil-moisture tension respectively; N_1, N_2, N_3 = 30, 80, 130 pounds of nitrogen per acre.

Size is represented in table 2 by the melon cross diameter. The widest cross diameter was located for this measurement. Longitudinal diameter, not given in the table, may be calculated from the cross diameter and the ratio of length to cross diameter. As a general rule, size 45 melons fall between 11 and 12 cm in cross diameter, size 36 melons between 12 and 13 cm, and size 27 between 13 and 14 cm (Little *et al.*, 1961).

Ratio of melon length to cross diameter (shape). The range of ratios in table 2 is sufficient to alter the melon shape conspicuously. Supplementary observations show that the low value indicated for the ratio of length to cross diameter for Site 23 is not attributable to the difference in variety (PMR 450).

Net toughness is a judgment of how well the net resisted scuffing when a knife blade, with the top held forward at an angle of about 60° above the horizontal, was scraped three times on a portion of the fruit surface. This was recorded for three areas on the surface, the ground spot being omitted. A serious attempt was made by the Department of Agricultural Engineering to instrument this measurement. The experience indicates that reproducibility might be gained by instrumentation, but variability would not be reduced. Melon ratings often varied from minimum to maximum ratings on different areas of the same melon. Wiant (1938) has described the consequence of scuffing on the keeping quality of cantaloupe. The influence of net toughness on the final market quality has yet to be determined.

Melon firmness was measured by an instrument developed by the Department of Agricultural Engineering. This instrument measures the depression of the melon under a dead weight applied for a specified length of time. The force was applied to the melon surface midway between stem and blossom ends and about 90° from the ground-spot center. The larger the value in table 2, the

TABLE 2

AVERAGE MEASUREMENTS OR RATINGS FOR 14 CHARACTERISTICS OF MUSKMELONS FROM 24 SITES

Site	Ground-spot diam.	Net height*	Net tightness†	Color‡	Unnetted suture width§	Cross diam.	Length: cross diam. ratio	Net toughness¶	Melon firmness‖	Cavity size	Flesh thickness	Flesh thickness: cavity diam. ratio	Flesh firmness	Soluble solids concentration
	cm					*cm*	*cm/cm*			*cm*	*cm*	*cm/cm*	*lb/cm²*	*per cent*
1..........	4.8	2.5	1.6	2.1	3.8	13.5	1.12	1.2	0.60	6.1	3.7	0.61	7.5	10.8
2..........	4.7	2.3	1.7	1.6	4.1	14.0	1.12	1.5	0.69	6.0	4.0	0.70	7.0	11.2
3..........	3.5	2.4	1.8	2.4	3.4	13.2	1.09	1.9	0.63	5.7	3.8	0.66	8.0	13.2
4..........	2.6	2.1	2.0	2.5	3.9	13.2	1.12	2.0	0.56	5.9	3.7	0.63	7.7	12.5
5..........	2.6	2.2	1.8	2.8	3.0	12.6	1.06	1.8	0.58	5.4	3.6	0.68	7.2	12.0
6..........	3.4	2.2	1.8	2.6	2.9	13.1	1.06	1.8	0.58	5.9	3.6	0.62	7.5	13.3
7..........	3.8	2.2	1.8	2.8	2.6	12.8	1.07	2.0	0.59	5.8	3.5	0.60	7.0	12.6
8..........	3.7	2.2	1.8	2.5	3.3	13.0	1.07	2.2	0.59	6.0	3.5	0.58	7.0	12.4
9..........	1.5	2.8	2.0	2.4	3.3	13.9	1.06	1.4	0.66	6.5	3.7	0.58	6.5	12.4
10..........	3.7	2.3	1.7	1.8	2.9	13.8	1.08	1.6	0.67	6.1	3.9	0.64	6.9	12.0
11..........	4.6	2.3	1.6	1.9	2.3	11.2	1.01	1.7	0.52	5.4	2.9	0.55	4.8	14.2
12..........	4.9	2.1	1.8	1.8	1.8	11.9	1.00	1.5	0.52	5.6	3.1	0.57	5.7	13.0
13..........	6.0	2.0	1.9	2.2	2.8	12.3	1.12	1.4	0.62	5.5	3.4	0.63	7.1	12.7
14..........	1.9	1.8	1.2	2.2	...	12.9	1.12	1.9	0.59	6.0	3.5	0.58	6.4	12.3
15..........	5.3	2.4	1.7	2.0	2.8	12.6	1.10	1.9	0.62	5.9	3.4	0.57	6.7	10.7
16..........	3.3	2.6	1.5	1.5	1.9	12.1	1.12	2.1	0.59	5.6	3.3	0.59	6.2	10.4
17..........	3.3	2.8	2.0	1.9	1.8	12.7	1.07	1.5	0.60	6.1	3.3	0.55	6.5	12.2
18..........	4.1	2.3	1.3	1.7	1.8	11.6	1.13	1.7	0.67	5.1	3.2	0.64	7.4	11.3
19..........	1.6	2.2	1.9	2.4	2.0	11.7	1.07	1.6	0.61	5.5	3.1	0.56	7.5	12.7
20..........	4.6	2.1	1.3	2.4	2.2	11.9	1.09	1.9	0.50	5.2	3.3	0.64	5.1	11.3
21..........	2.1	2.6	1.8	2.6	2.5	12.2	1.07	1.8	0.52	5.4	3.4	0.64	7.1	13.7
22..........	6.1	2.3	1.6	1.8	2.8	12.5	1.10	1.2	0.56	5.2	3.7	0.71	...	13.1
23..........	0.2	2.7	2.4	2.1	3.0	14.2	0.93	1.9	0.48	6.3	3.9	0.62	6.5	14.2
24..........	2.2	2.5	1.8	2.3	3.3	13.0	1.06	1.9	0.55	5.5	3.8	0.69	5.8	10.0
Mean......	3.70	2.33	1.74	2.20	2.76	12.67	1.08	1.72	.60	5.74	3.47	.61	6.82	12.28
LSD .05...	1.3	.3	.3	.3	.4	.4	.03	.2	.10	.3	.2	.06	1.0	.6
σ^2..........	6.44	.317	.240	.400	.660	.564	.004	.227	.035	.28	.097	.012	3.89	1.52
C..........	68	24	28	29	29	6	6	28	31	9	9	18	29	10
F**........	6.69	5.86	6.75	12.02	21.97	34.26	9.53	9.02	2.47	14.77	22.34	5.60	4.69	19.39

* 1 = low, 2 = med., 3 = high.

† Diameter of area between net strands: 1/16 in. = 3; 1/16 to 1/8 in. = 2; larger than 1/8 in. = 1.

‡ Background color: Dark green = 1; light green = 2; yellow = 3.

§ Sutures completely netted = 1; most sutures completely netted = 2; average unnetted strip 3 mm wide or less = 3; average unnetted strip 3 to 6 mm wide = 4; average unnetted strip greater than 6 mm wide = 5.

¶ Net easily scuffed = 1; med. = 2; resistant = 3.

‖ The values represent firmness by the quantity (1 − D) where D is the total depression in centimeters at the end of 60 seconds.

** F value for error due to differences between fields. Numerator and denominator degrees of freedom are at least 19 and 580 respectively.

firmer the melon. By subjective judgment, most—if not all—of the sample melons in the survey would have been rated as hard melons. To determine the function of the depression with weight, a 5-kilogram weight was applied for 30 seconds, then immediately another 5 kilograms were added and applied for 30 seconds more. In all these tests, as well as in other preliminary tests using up to 20 kilograms of weight, the function was invariably linear.

It is difficult to believe that the slight variations in firmness shown in table 2 represent the pronounced field-to-field variations reported by growers and shippers. The term "firmness" as used in the trade does not seem to be well defined. To some it appears to mean overall firmness; to others, firmness of flesh; and to still others, a "firm" melon may mean a healthy melon that will maintain its quality during shipment.

In the survey samples, all melons were fairly comparable. They were of approximately the same maturity, were picked early in the morning, handled gently, and tested soon after picking. If larger differences in firmness are evident in commercial pickings, they may arise, not during development in the field but from differences in maturity between fields or harvests, differences in time of day when melons are picked, differences in handling from field to shed, or perhaps from differences in pathogen content which do not become manifest until some time after picking.

Cavity size values, given in table 2, represent the equatorial width of the cavity when the melon is cut lengthwise, i.e., through both ends and the ground spot. Cavity length, not included in the table, was closely associated with cavity width and melon shape.

Flesh thickness is the difference (divided by two) between the cavity diameter and the outside melon cross diameter. Thus, although called flesh thickness, this measurement includes the thickness of the rind. The measurement given is the equatorial flesh thickness and is typically greater than the flesh thickness at blossom or stem ends.

Ratio of flesh thickness to cavity diameter is an important relationship, since it is an index to the yield of flesh per given size melon. It is expressed as a decimal fraction in table 2. The differences shown in the table are sufficient to cause appreciable differences in the appearance of melons when cut open.

Flesh firmness was measured by a Ballauf pressure fruit-tester, which measures the force in pounds necessary to crush the flesh. The pressure nib was $\frac{7}{16}$ inch in diameter (about one cm^2 in area), and the instrument range was from zero to ten pounds. The nib was pressed, to the depth of a shield affixed to the base of the nib, on the cross section of the flesh of a halved melon. Two measurements were made per melon.

Concentration of soluble solids, calibrated as grams of sucrose per 100 cc of solution, was measured by a hand refractometer, using unfiltered juice. Separate readings were made of juice from top and bottom halves of each melon, longitudinally halved (cf. Scott and MacGillivray, 1940), using equatorial segments. Samples taken in this way were believed to be representative of the fruit.

VARIANCE OF THE CHARACTERISTICS

Significant differences between sites are to be found in each character. It may be seen from table 2 that the variances (σ^2) of the different characters are far from uniform as assessed by the coefficient of variation (C) or the F values. Some characters vary so greatly among melons from the same site that differences between means must be quite large to be significant. In this category are ground-spot size, external firmness, scuff resistance (net toughness), net height, net tightness, background color, and flesh firmness. Physical dimensions and concentration of soluble solids have surprisingly low coefficients of variation and correspondingly high F values, indicating that, for detection of significant differences in these characters, samples need contain only a relatively few individuals.

INTERRELATIONSHIPS AMONG CHARACTERISTICS

Table 3 presents the correlation coefficients for 14 characters of melons from 20 sites. Sites 14 and 22 were not represented by a complete set of data and were not included in the correlation analysis. Because fruit firmness of melons for Sites 23 and 24 was determined with an improvised instrument, these sites also were not included in the correlation analysis. On graphic analogues of these relationships, however, the omitted values are not divergent from the main regressions of values.

A coefficient of plus or minus 0.43 is necessary for significance at the 5 per cent level; 0.51 is necessary for significance at the 1 per cent level. Should a coefficient be 0.43, however, only 18 per cent of the variation in one character can be said to be associated with the variation in the other character. This is the square of the correlation coefficient, i.e., the coefficient of determination. Thus, while a coefficient of 0.43 indicates a significant relationship between two variables, the association is not so complete that one variable can be predicted reliably from knowledge of the other.

Twenty-three of the 91 possible relationships were significant at the 5 per cent level, fifteen of these being significant at the 1 per cent level. Of these, correlations between lineal dimensions such as size, cavity diameter, and flesh thickness are to be expected. Such relationships, however, may vary with variety (Hoffman, 1939).

The high correlation of unnetted suture width with melon size is of immediate interest, since growers would like to reduce width of unnetted sutures. Evidently this character depends greatly on melon size, at least within the PMR 45 variety.

On the basis of the single correlations, the concentration of soluble solids is not as closely correlated with external characters as is commonly thought. A more complex relationship is discussed under the section on Factor Analysis. The concentration of soluble solids possesses a significant relationship to net tightness and an even stronger one to ratio of melon length to cross diameter.

The size of the cavity is of importance in the market. Of itself, it appears to be largely a function of melon size. The ratio of flesh thickness to cavity diameter is probably of importance in making judgments of quality. This was found to vary considerably among sites and was not related to melon size.

Because there are 91 possible relationships among the 14 characters, each cannot be discussed separately. The table itself may serve as reference should interest arise concerning particular relationships.

THE FACTOR ANALYSIS

Scatter diagrams indicated that the relationships between the characters were essentially linear. Thus, a factor analysis (Cattell, 1952; Hoyle and Baker, 1961, Yule and Kendall, 1948) of the correlation matrix (table 3) was carried out to five factors. The coefficients for the five factors for each character are presented in table 4. The values of h^2 (maximum h^2 is unity) indicate that many of the characters are almost completely determined for the five factors. The original correlation matrix (table 3) reveals some relation-

Table 3

CORRELATION COEFFICIENTS FOR RESPONSE OF 14 MUSKMELON CHARACTERISTICS TO LOCATION

Site	Ground-spot diam.	Net height	Net tightness	Color	Unnetted suture width	Cross diam.	Length: cross diam. ratio	Net toughness	Melon firmness	Cavity size	Flesh thickness	Flesh thickness: cavity diam. ratio	Flesh firmness	Soluble solids concentration
Ground-spot diam.		—.399	—.408	—.431	.001	—.136	.152	—.175	—.014	—.174	—.103	.056	—.296	—.250
Net height	—.399		.134	—.224	—.065	.248	.033	—.208	.230	.450	.096	—.265	—.023	—.164
Net tightness	—.408	.134		.403	.295	.391	—.259	—.160	.089	.556	.243	—.211	.363	.465
Color	—.431	—.224	.403		.254	.105	—.192	.299	—.322	—.010	.151	.129	.334	.434
Unnetted suture width	.001	—.065	.295	.254		.795	.344	—.072	.338	.546	.827	.493	.477	—.082
Cross diam.	—.136	.248	.391	.105	.795		.285	—.186	.563	.833	.939	.374	.467	—.212
Length: cross diam. ratio (shape)	.152	.033	—.259	—.192	.344	.285		.041	.500	.017	.425	.460	.503	—.666
Net toughness	—.175	—.208	—.160	.299	—.072	—.186	.041		—.292	—.249	—.074	.036	.002	.007
Melon firmness	—.014	.230	.089	—.322	.338	.563	.500	—.292		.439	.552	.276	.512	—.390
Cavity size	—.174	.450	.556	—.010	.546	.833	.017	—.249	.439		.600	—.191	.220	—.119
Flesh thickness	—.103	.096	.243	.151	.827	.939	.425	—.074	.552	.600		.650	.561	—.236
Flesh thickness: cavity diam. ratio	.056	—.265	—.211	.129	.493	.374	.460	.036	.276	—.191	.650		.410	—.167
Flesh firmness	—.296	—.023	.363	.334	.477	.467	.503	.002	.512	.220	.561	.410		—.043
Soluble solids concentration	—.250	—.164	.465	.434	—.082	—.212	—.666	.007	—.390	—.119	—.236	—.167	—.043	

TABLE 4

FACTORS AND COEFFICIENTS OF DETERMINATION FOR 14 VARIABLES RELATING TO CANTALOUPE QUALITY

Factor	F_1	F_2	F_3	F_4	F_5	h^2
Ground-spot diam.	—.262	.560	—.301	—.143	—.262	.562
Net height	.270	—.312	—.307	—.286	.355	.472
Net tightness	.388	—.618	—.064	.276	—.374	.753
Color	.118	—.362	.586	.399	—.261	.715
Unnetted sutures	.768	.094	.321	—.356	—.385	.977
Size	.937	—.096	—.131	—.092	—.046	.914
Length: cross diam. ratio	.472	.647	.120	—.175	—.041	.689
Net toughness	—.144	—.048	.514	.003	.084	.294
Melon firmness	.641	.330	—.367	—.023	—.058	.659
Cavity size	.703	—.432	—.401	—.302	—.181	.965
Flesh thickness	.926	.175	.099	.095	.095	.915
Flesh thickness: cavity diam. ratio	.418	.589	.420	.170	.108	.739
Flesh firmness	.683	.104	.259	.279	—.239	.679
Soluble solids concentration	—.235	—.563	—.068	.734	.069	.920

ships between the 14 variables. The factor analysis demonstrates that there is an underlying structure to this matrix; i.e., there are more subtle relationships within this group of characters than is brought to light by the single correlations considered individually. An important exception is net toughness, shown to have a very low h^2 value, indicating that it is a unique character determined by factors distinct from those which decide the other characters. Similarly, ground-spot size and net height tend to vary independently of the remaining characters.

The high h^2 for concentration of soluble solids indicates that it is fairly well established by factors determining the other characters. This is of interest, since the concentration of soluble solids has been established as a measure of the eating quality of cantaloupes (Chace *et al.*, 1924). On the basis of correlations in the last column of table 3, four variables were selected to determine how well the concentration of soluble solids could be predicted in terms of external characters alone. These were net tightness, background color, shape, and firmness. A comparison of the actual values of concentrations of soluble solids with estimated values is given in figure 1. Practically all estimated values were within one refractometer per cent reading of the actual. The derived regression equation is:

$$Y_e = 25.9 + 1.32\,N + 0.52\,C - 14.90\,R - 1.71\,F$$

Y_e is the predicted value for the concentration of soluble solids, N is the net tightness, C is the background color, R is the ratio of melon length to cross diameter, and F is the overall firmness. The multiple regression coefficient is 0.766, which is highly significant and a substantial improvement over the zero order coefficient of –0.666 for the correlation between concentration of soluble solids and the ratio of melon length to cross diameter alone.

DISCUSSION

For the proper interpretation of the values of table 3, it is most important to consider the generic basis for the field-to-field variations in muskmelon quality and their interrelationships. The correlation coefficients of table 3 were calculated from the mean values of 30 melons from each field. The F values and coefficients of variation for most of the characteristics (table 2) indicate the large variability which existed even within these rather carefully selected

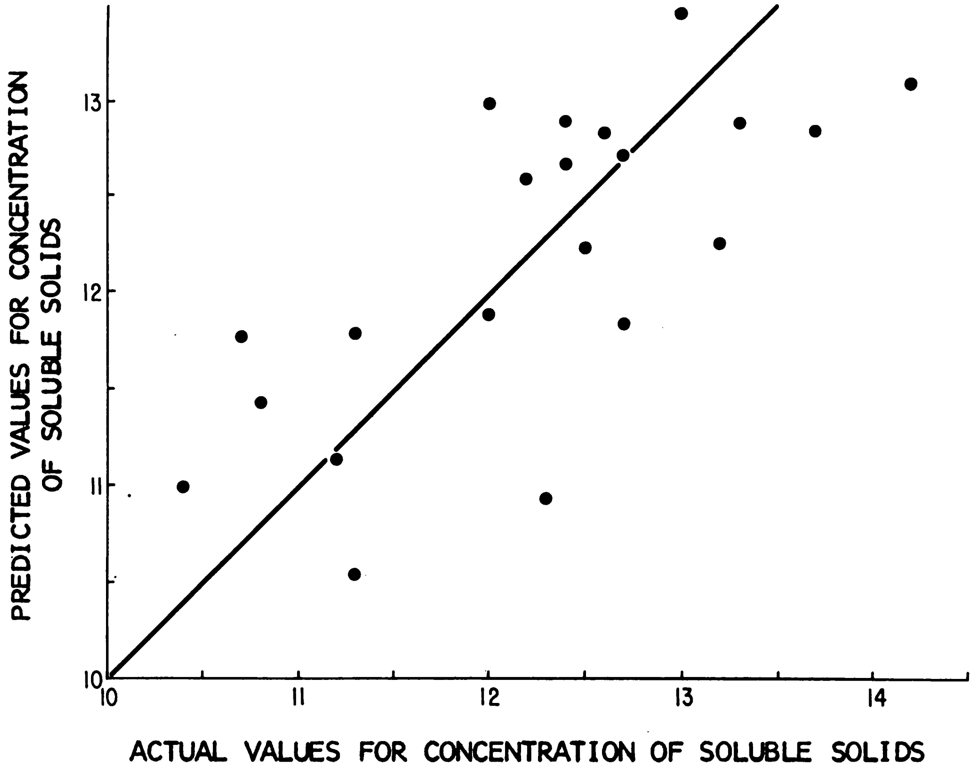

Figure 1. Predictability of the concentration of soluble solids on the basis of multiple-regression equation involving net tightness, melon color, shape, and firmness of fruits from 21 sites.

sample groups. If attempts are made to draw correlations within each sample group of 30 melons, the characteristics are found to be independent of one another, with the exception of the measurements of physical dimensions. At each location, therefore, the population was heavily heterogeneous, and we cannot say of the melons at any one location, for example, that large sutures are associated with large melons, or sweetness with oblateness, nor can we predict the concentration of soluble solids from four external characters by the formula herein developed.

It must be concluded, then, that the correlation coefficients of table 3 are expressions of correlated responses to environmental variables and not of genetic correlations. The coefficients permit only the statement, for example, that whatever condition caused melons to be more globular at one field caused them also to have a higher concentration of soluble solids. This is quite different from saying that, in any given lot of melons, the more globular individuals will have a higher concentration of soluble solids. Such a statement cannot be made on the basis of this analysis.

With this distinction made, the preliminary opinion may be advanced that the five factors detected by the factor analysis logically are to be associated with environmental factors rather than with genetically based linkages. When these variances are more precisely assigned, we may anticipate from the results of the factor analysis that the number of characters to be observed may be safely reduced with an expectation of increasing experimental efficiency.

An additional use of the factor analysis as a diagnostic tool is illustrated by its isolation of net toughness, ground spot, and net height as unique factors, indicating to the investigator who is studying such characters that he must be alert for sources of variance distinct from those affecting most other characters.

The fact that the correlations were elicited by a variety of environmental conditions, together with the unity of the correlation matrix despite genetic variability and the subjectivity of many character ratings, provides some basis for believing that the table of correlations (table 3) has a considerable degree of universality for this variety of muskmelon.

It is obvious that the underlying relations between most of the quality characters are neither simple nor always positive. It is evident that a field which produces muskmelon fruits showing a high level in one character will not automatically produce melons with a high level of all quality characters. Limitations to quality improvement by cultural means may be seen by studying the coefficients of table 3. For example, it will be noted that as the ratio of fruit length to cross diameter decreases, the concentration of soluble solids tends to increase. This could be a desirable relationship from the commercial point of view. As the melons become rounder, however, the ratio of flesh thickness to cavity diameter tends to decrease. This would be an undesirable development if pronounced, and at present is to be remedied only by melon breeding. In this case, the prospects appear favorable (Hoffman, 1939).

The fact that a close relationship does not exist between a number of characters may be fortunate. The lack of correlation between melon size and the concentration of soluble solids, for example, indicates that cultural practices to reduce size and related suture width may be attempted without danger of decreasing concentration of soluble solids.

SUMMARY

Detailed observations were made in 1962 on muskmelon fruits selected from 24 sites in California. Fourteen characteristics of melon quality have been described by ratings or measurements, and the means of these tabulated for each location. Averages, standard-error estimates, coefficients of variation, and F values are presented for each characteristic.

Also presented is a table of correlation coefficients for the characteristics as they varied between fields. We may conclude that the significant correlations of the table are expressions of correlated responses to environmental influence. By means of a factor analysis, it appears that the table of correlations can be fairly well reconstructed on the basis of five factors.

At the conclusion of the discussion, examples have been provided to demonstrate how a knowledge of character interrelationships may be used in formulating experimental policy or commercial practice.

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