also wash the leaf or slide surface, using as little solvent as possible. Then place the tube in boiling water to evaporate the ether, making certain that no trace of ether remains. As no bumping occurs, it is practicable to treat a number of tubes together.

Nitration. Add to the tube 3 to 4 ml. of freshly prepared nitration mixture consisting of equal volumes of fuming nitric acid and concentrated sulfuric acid. Immerse in boiling water; 2.5 minutes after brown fumes have begun to evolve, remove and cool in a beaker of water. (The authors have found that nitration is almost complete in 2.5 minutes. More accurate results could perhaps be obtained in 10 minutes, but they prefer not to use a longer period, owing to more drastic attack on the nitro compound.) Wash the mixture into a 40-ml. stoppered test tube containing 10 ml of distilled water, using three 2-ml. amounts of water. Cool the tube in a beaker of cold water.

Extraction. Add 10 ml. of benzene and shake vigorously for 30 seconds. Then remove 1 ml. of the benzene layer with a pipet. This apparent waste of potential sensitivity is incurred in the interests of quick operation, as the benzene layer tends to contain emulsion. Greater sensitivity can be obtained by using a smaller volume of benzene for extraction, but the method may then be slower. Carbon tetrachloride has been found unsuitable as an extracting solvent. Chloroform extracts the color, but rapid fading occurs.

Color Reaction. The benzene extract can, if necessary, be left for 24 hours before the color reaction is carried out provided the tube containing it is securely stoppered. Place the 1 ml. of benzene solution in a clean dry test tube of standard diameter (ca. 5 × $^{5}/_{8}$ inch) and add from a buret 3 ml. of a mixture of isopropylamine and benzene in the proportions of 1 to 3 by volume. Shake gently and compare the yellow color formed against tubes of yellow color solutions of potassium dichromate and a blank tube containing the benzene isopropylamine mixture. If the impurities mixed with the DDT deposit, such as oils and chlorophyll, give a yellow tint to the benzene extraction, replace the blank of isopropylamine benzene mixture with the unused portion of the layer.

Estimation

Color estimation should be carried out within 2 hours of development. The potassium dichromate standards are first calibrated against the colors produced from known quantities of DDT. A pale yellow can be distinguished with as little as 0.05 mg. of DDT, and differences of 0.1 mg. can readily be distinguished.

Ten color standards covering the range 0.05 to 1 mg. are usually sufficient. If quantities in excess of 1 mg. are to be estimated, the color can be diluted a known number of times with benzene to bring the color down to the scale being used. The color standards should be numbered to give a straight-line relationship with DDT.

Acknowledgment

Thanks are due to the directors of Pest Control, Ltd., for permission to publish.

Literature Cited

(1) Alessandrini, World Health Office, *Bull.* **2**, 629 (1950).
(2) Schechter, M. S., *et al.*, *Ind. Eng. Chem. Anal. Ed.*, **17**, 704 (1945); *Anal. Chem.*, **19**, 51 (1947).

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SUGAR BEET EVALUATION

Determining Respiration Rate and Sampling For Chemical Analysis of Sugar Beets

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METHODS OF HANDLING and storing sugar beets have been rapidly improved during the past decade. The mechanical harvester has brought about direct delivery of the crop after lifting, thereby eliminating exposure of the beets to frost, sun, and wind before piling. This, plus greater use of forced ventilation of storage piles, has done much to reduce storage losses by providing a better storage environment within the pile. Further improvement seems to be divided into two separate approaches: improvements in harvester and piler efficiency and more effective control of the environment within the pile and on its surface exposures; and improvement of the beet itself, to reduce respiration rate and susceptibility to attack by fungi.

The first approach can be best accomplished by engineers, machinery manufacturers, and agricultural departments of the sugar companies who design, make, and use or supervise the use of the equipment and have direct control over the large and expensive installations.

Improving the beet itself has been studied very little in modern breeding methods. The old method, used by all sugar-beet breeders, of selecting superior mother beets or stecklings in the fall, storing until the following spring, and replanting for seed production, has eliminated most lines or individuals that were extremely susceptible to attack by fungi. This has greatly improved resistance to spoilage, but individual differences are still evident within commercial varieties and some inbred lines are extremely susceptible to spoilage. Gaskill (*1*) has shown by progeny tests that greater resistance to attack by certain fungi can be bred into lines of beets.

Very little work has been done to breed beets for low respiration rate. This has been partly due to the lack of a rapid method of sampling and measuring respiration rate and of making chemical analyses on an individual beet basis without impairing the subsequent growth of the beet. Nelson and Oldemeyer (*2*) reported studies on sliced pieces of uniform thickness from the tail section of the beet; respiration rates ranged from about 150 to 300 mg. of carbon dioxide per kg. of beets per hour at 20° C. The present report describes a sampling technique, a method of measuring respiration rate, and preparation of diffusate for chemical analysis without undue in-

A new sampling tool makes it possible to obtain pressed juice for refractometric determination of dry substance of sugar beets in one quick operation with little injury to the beets. Another tool gives a clean 1-inch plug cut through the beet. The plug may be used for morphological observations, respiration measurements, and chemical analysis. A convenient respiration technique, somewhat similar to that described by Nelson and Oldemeyer, is used. A slight modification of the colorimetric Stanek-Pavlas method for "harmful nitrogen" gives results that correlate well with total and acid-soluble nitrogen in fresh beets. Other accessory equipment for the rapid evaluation of mother beets for breeding purposes is described. All possible correlations (*r* values) between the different measurements of widely different varieties of beets have been calculated by means of the IBM punch-card method. Correlation coefficients between the different measurements were very dissimilar for red garden beets, compared with sugar beets and mangels.

jury of the beet for subsequent growth. This method is patterned somewhat after that described by Nelson and Oldemeyer, except that the sample is in the form of a cylinder. The respiration rates on the samples here reported are only about one-third those of the sliced tissue samples used by Nelson and Oldemeyer, owing to the reduced surface area of the samples.

The wide variations among individual beets within commercial varieties probably result from both heredity and cultural environment. Most commercial varieties can be considered as a mixture of related types because of the strong tendency of the beet to cross-fertilize in the seed field. Sugar beets are also highly competitive plants with regard to space allotment in the field. A small delay in germination or early development causes a large difference in growth. The magnitude of these differences, both genetic and environmental, can be seen by the mean average values of 25 beets of each of 12 varieties grown on plots of equal size under normal competitive environment. Most beets smaller than 600 grams were discarded. Average value for all varieties and average percentage difference or variation between the highest and lowest individuals of each variety were observed to be: weight 1050 grams, variation 224%; sugar percentage 14.22, variation 61%; respiration rate 73.3 mg. of carbon dioxide per kg. per hour, variation 83%; amino nitrogen as glutamine 0.42%, variation 553%; sodium 800 p.p.m., variation 308%; and potassium 4313 p.p.m., variation 81%. Because of these wide variations, effective selection within a heterogeneous population is possible, but it requires testing a large number of individuals, grown under normal field competition, and saving only the best for further breeding work. Progeny tests made possible by utilizing special self-fertile types of beets permit still further genetic control.

Sampling Equipment and Technique

The most rapid and convenient test for quality of sugar beets is that for soluble dry substance by means of the Abbe refractometer. The usual procedure has been to drill a hole in the beet and press a drop of juice from the macerated tissue through muslin cloth on the prism of the refractometer. The dry substance percentage is read directly on the special scale of the instrument.

A new conically shaped tip, shown in Figure 1, allows the juice to be pressed from the macerated tissue while still within the beet and caught in a plastic spoon for transfer to the refractometer prism.

A $^1/_4$-inch brass brazing rod is made cone-shaped and split with a hack saw. Two washers are forced on as shown and a piece of hack-saw blade is soldered in place. The blade is ground slightly lower on the cutting side to ensure maceration rather than cutting of tissue. A second washer prevents juice from draining into chuck of drill. The drill should be operated in a tilted position at about 200 to 400 r.p.m. The beet is drilled to within about $^1/_4$ inch of the first washer; then with the drill stopped, further pressure expresses the juice, which is caught in a plastic spoon.

The tip does not penetrate as deeply as the drills previously used, no cloth filter is necessary, and sampling requires much less time. After a little experience six people have tested more than 150 beets per hour, including cleaning one side of the beet, sampling, reading dry substance, and recording the values on both beet and paper, as well as numbering and selecting the choice beets. Cleaning the beets proved to be the bottleneck of the operation. If the beets are washed previously, the testing can be speeded up with one less person, the laboratory is kept cleaner, and there is less damage to the refractometer prism. Probably 50 to 70% of the beets of poorer quality should be eliminated by this rapid and simple test. The remaining beets are saved for further tests.

From each of the selected beets a smooth, cylindrical piece of tissue is then cut by means of the apparatus shown in Figure 2, by placing the small hole in the beet made by the dry substance sampling tip over a small faucet washer on the rubber anvil, forcing the handle down, and quickly raising it. An adjustable stop is provided for the handle to prevent the cutting tube from being damaged by severe contact with the rubber anvil. The stationary guide inside the cutter tube guides the cutter tube through the beet and also forces the cut cylinder from the tube as the handle is raised. The cut cylinder is then easily pushed from the beet.

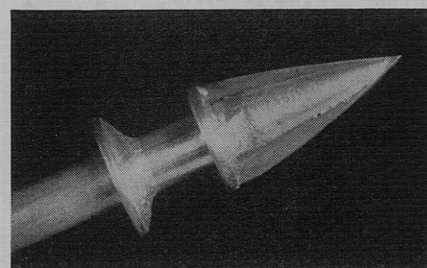

Figure 1. Improved juice extractor for use with Abbe refractometer

A piece of tissue, slightly in excess of 10 grams, is cut from the cylinder of tissue by the double-bladed instrument shown in Figure 2. The remainder of the cylinder can be placed in the groove of the single-knife instrument, shown in Figure 2, and a piece weighing slightly more than 26 grams cut off. The two pieces of tissue are lightly impaled on stainless steel wires protruding from trays which hold the samples in numerical order. Three people can weigh, number, record, and sample 56 beets in about 30 minutes. The two samples are protected from undue loss of moisture

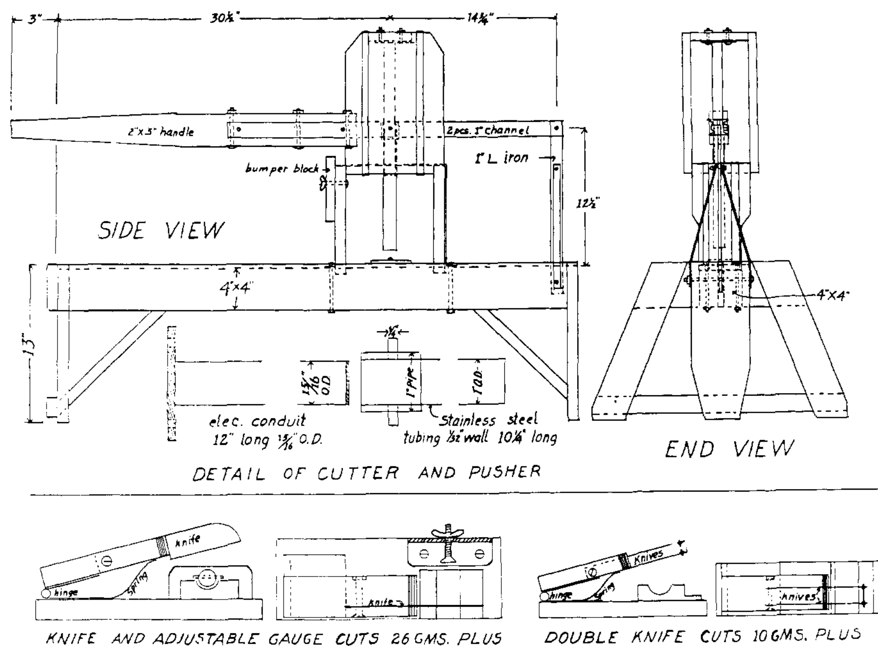

Figure 2. Apparatus to cut cylinder of tissue from beet

until they are adjusted to weight for respiration rate measurement or disintegration for chemical analysis.

The cylinders of tissue may also be used for study of the vascular ring structure of the beets.

Measurement of Respiration Rate

The samples cut by the double-bladed knife are adjusted to 10 grams and lightly impaled on stainless steel wires soldered to a stainless steel tray, and washed with water at 45° C. (three changes of water during 3 minutes). They are then washed in water at the temperature of the respiration measurement (usually 20° C.) for 15 minutes, blotted with a towel, and stored in a closed humid chamber for 3 hours before the respiration test is started. (The periods and temperatures given are probably not critical, but have given good results. Any procedure adopted should be consistently followed).

The respiration apparatus shown in Figure 3 has 58 units, two of which are reserved for checks (without tissue). Each unit consists of a wide-mouthed bottle 3.5 inches high and 2 inches in outside diameter closed with a No. 9 one-hole rubber stopper. The stopper is fitted with a piece of bent stainless steel wire to hold the tissue and is connected to the oxygen manifold through semicapillary glass tubing, rubber tubing, and a small piece of copper tubing soldered into the $^1/_2$-inch pipe. The oxygen manifold is fastened to a 1 × 4.5 inch board that extends the full length of the tilting platform. The base of the tilting platform is made of $^1/_8$-inch Masonite and extends 3.5 inches on each side of the center supporting board. The base is reinforced with 0.5 × 1.5 inch slats spaced about 2 feet apart. The tilting platform is supported by the oxygen manifold pipe that fits into saddle bearings at each end of the tilting platform. The lever arm that operates the tilting platform extends below its base and is operated by a $^1/_8$-inch steel rod connected to a wooden wheel on a small speed-reducing gearbox. The gearbox is v-belt-driven by a small electric motor (about 0.1 hp.). The gearbox and motor assembly are bolted to the supporting platform through slotted holes to provide for easy adjustment to obtain uniform tilting of the platform. The amplitude of tilt is adjusted by having a series of holes in the wooden wheel through which the connecting rod is inserted. The unit described is operated at about 22 cycles per minute. This rate can be varied by changing pulleys on the gearbox and motor.

The tilting platform is about 94.5 inches long and about 5 inches higher on one end than the other to prevent "dead centering" of the marbles on one side of the bottles. Marbles 0.75 inch in diameter keep rolling much better than smaller ones.

In operation, a tissue sample is placed on each of several of the stainless steel L-shaped supports that extend through the rubber stoppers. Five milliliters of 0.35 N barium hydroxide are added to each bottle, containing a marble, and the bottle is immediately fitted to the rubber stopper, so that this connection is tight and the bottle rests level on the tilting platform. This procedure is repeated until all samples are in place. A weather balloon is loosely filled with pure oxygen and connected to the manifold. The opposite end of the manifold is left open. A lighted match or cigarette held by the open end indicates when all the air is swept from the manifold. The manifold is closed and the operation started. Twenty hours after the first samples are placed in position, the apparatus is stopped and the excess barium hydroxide in each bottle is rapidly titrated with 0.11 N hydrochloric acid, using phenolphthalein indicator. The respiration rate is then calculated by simply subtracting the milliliters of hydrochloric acid used for each sample from the milliliters of hydrochloric acid used for the check samples (containing no tissue) and multiplying by 10. The respiration rate is recorded as milligrams of carbon dioxide per kilogram of beets per hour. These values are about 5.5 times the rate of respiration of whole beets, averaging 1 kg. each.

Duplicate samples taken from opposite sides of the same beets and treated according to the method outlined occasionally vary as much as 10%. Unwashed samples are less consistent. Correlation coefficients between duplicate washed samples usually ranged between $r = 0.85$ and $r = 0.95$. Unwashed samples sometimes gave values as low as $r = 0.70$. Respiratory

Figure 3. Respiration Apparatus

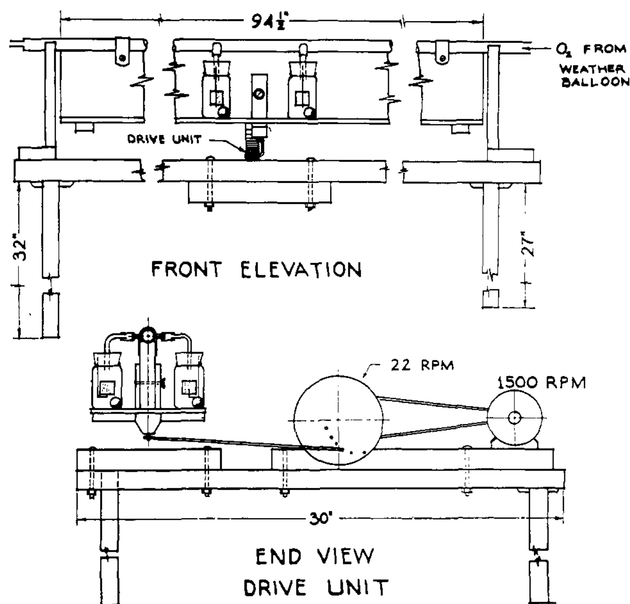

Table I. Average Weight, Respiration Rate, and Chemical Analysis of Beets from Gallinat Plot, 1952

Variety	No. of Beets	Weight, Grams	Sugar, %	Amino[a] N, %	Na, P.P.M.	Resp., Mg. CO_2/Kg./Hr.	K, P.P.M.
Commercial							
US 75	25	1305	13.10	0.294	1171	55.4	4608
US 35/2	25	1241	14.99	0.340	575	71.4	4189
US 22/3	25	1080	14.52	0.229	823	59.7	4441
US 56/2	25	1049	13.64	0.269	1174	67.7	3542
Inbreds							
SL 9046A (low)	25	1451	13.54	0.576	1053	60.7	3941
SL 9046A (N)	25	1021	13.49	0.408	876	74.7	4153
SL 9019 (low)	25	1453	15.78	0.278	503	82.3	4238
SL 9019 (N)	25	1022	15.92	0.293	401	87.2	4177
SL 904 (low)	11	1597	13.86	0.134	754	59.5	4645
SL 904 (N)	25	1134	14.51	0.603	440	125.6	4359
Polyploids							
SL 9985 4*n*	25	1310	13.75	0.174	1012	61.5	4301
SL 1953 4*n*	25	1646	12.94	0.270	802	70.3	4995
Red beets							
SL 7334, Lutz Green Leaf	25	1183	8.69	0.583	1412	61.7	4240
SL 1308, Detroit Dark Red	14	456	5.58	1.021	2227	52.8	4672
Mangels							
SL 8315	25	1153	7.31	0.348	1363	65.1	4255
SL 8344	25	1364	11.59	0.378	1247	52.7	3943
Half-sugar beet							
SL 8318	25	1440	9.64	0.330	1377	58.2	4755

[a] As glutamine. True amino N is only 0.09589 times figures given.

enzymes in the cut surfaces, or sugar that might interfere with gaseous exchange in the surface, may be responsible for the less consistent results with unwashed samples.

Chemical Analysis

A weighed 26-gram piece of the cut cylinder of tissue is sliced into a Waring Blendor equipped with well-sharpened knives, 177 ml. of distilled water added, the machine run for 1 minute, and the mixture poured into a Monel metal sugar cup. About 0.7 gram of Dr. Horne's dry lead acetate (dibasic) is added and the mixture is shaken. After about 30 minutes the sample is again shaken and filtered. About 18 ml. of the filtrate is saved in a plastic-stoppered, 20-ml. bottle for amino nitrogen, sodium, and potassium determinations and the remainder is used for sugar determination by polarization.

Amino Nitrogen as Glutamine

Ten milliliters of the clear filtrate is pipetted into a 25-ml. test tube and 1 ml. of Stanek-Pavlas (*3*) reagent (10 grams of cupric nitrate trihydrate plus 250 grams of sodium acetate trihydrate per liter) added. (Better results were obtained at high nitrogen concentrations by increasing the cupric nitrate to 15 grams per liter). The solutions are mixed by inverting two or three times and the per cent transmittance in a standard 10-mm. cell at 620 mμ is determined with a spectrophotometer or photocolorimeter, using distilled water as a 100% transmittance reference standard. The percentage of "amino nitrogen as glutamine" on beets is read from a decade table, prepared from a series of standard glutamine solutions (glutamic acid can be used as a standard but is less soluble, although less expensive). Any lead carbonate that precipitates and clouds the filtrate may result in high values and should be guarded against. For this reason all sample bottles were well filled and capped to reduce contamination with atmospheric carbon dioxide. The determinations should be run promptly after filtration, for the same reason.

Although the method outlined is not so accurate as the Kjeldahl method, it is very fast and well correlated with results for total nitrogen and soluble, nonprotein nitrogen in the diffusate from fresh beets, as determined by the Kjeldahl method.

Correlation coefficients, calculated on more than 30 fresh-beet samples determined by three methods in 1943, gave calculated r values as follows:

% total N *vs.* amino N as % glutamine	$r = +0.967$
% total N *vs.* % soluble nonprotein N	$r = +0.990$
% soluble nonprotein N *vs.* % amino N as glutamine	$r = +0.970$

The samples analyzed varied in nitrogen content as follows:

Total N (Kjeldahl)	0.105 to 0.256%
Soluble nonprotein nitrogen (Kjeldahl)	0.045 to 0.188%
Amino N as glutamine (colorimetric)	0.07 to 0.65%

The method is probably useful to indicate the relative nitrogen content of fresh beets in routine or selection work.

Sodium and Potassium

Sodium and potassium are very rapidly determined on the remainder of the sample in the 20-ml. vial by means of the flame spectrophotometer. If the 5-ml. sample cups are coated with Beckman Desicote, practically all of the previous sample can be removed by shaking, thus speeding up the determinations.

The conversion of all spectrophotometer transmittance readings to percentage or parts per million values is greatly facilitated by preparing decade tables for each kind of determination.

Decade tables may be prepared as follows: The concentration for each percentage point of transmittance is carefully read from the standardization curve plotted on log log paper. This curve should be nearly a straight line. These values are then calculated to the equivalent parts per million or percentage on beets, taking into consideration the dilution factor used in making the diffusate. If 0.5N diffusate is used, the factor for parts per million on beets will be 200/26 times the concentration of the standardizing solution. These expanded values will contain larger errors due to the expansion of the values as read from the curves, especially at the higher concentrations. Errors in reading the standard curve may be reduced by making about three overlapping curves on the same sheet of log log paper. If the log scale is repeated on each axis, one curve can represent from 10 to 1000 p.p.m., the second from 1 to 100 p.p.m., and the third from 0.1 to about 7 p.p.m. in the standard solutions. Errors in the expanded values may be reduced by plotting a limited part of the data at a time on large sheets of linear cross-section paper. Values for tenths or two-tenths increments of transmittance readings are filled in linearly between successive percentage transmittance values.

Table II. Correlation Between Various Factors in Sugar Beets, Red Beets, and Mangels

Variety	Weight					Sugar				N			Na		Resp.
	Sugar	N	Na	Resp.	K	N	Na	Resp.	K	Na	Resp.	K	Resp.	K	K
1952															
US 75	−0.302	+0.255	+0.046	+0.018	+0.871	+0.059	−0.806	+0.233	−0.649	−0.337	+0.126	+0.691	−0.136	+0.137	−0.256
US 35/2	−0.074	+0.292	−0.054	−0.158	+0.484	+0.108	−0.787	+0.100	−0.379	−0.044	−0.071	+0.397	−0.102	+0.367	−0.085
US 22/3	−0.524	−0.006	+0.643	+0.352	+0.232	−0.089	−0.711	+0.158	−0.360	−0.394	+0.152	+0.180	−0.015	+0.281	+0.089
US 56/2	−0.382	−0.199	+0.424	−0.068	+0.318	−0.477	−0.850	−0.009	−0.722	+0.431	+0.119	+0.413	+0.091	+0.626	−0.169
1952 inbreds															
SL 9046A (low)	−0.098	−0.165	+0.390	+0.077	+0.529	−0.328	−0.223	+0.262	+0.094	−0.049	−0.223	+0.050	−0.172	+0.315	−0.157
(N)	+0.018	+0.216	+0.070	+0.215	+0.482	+0.044	−0.630	−0.406	−0.382	+0.162	−0.124	+0.177	−0.003	+0.564	+0.044
SL 9019 (low)	−0.572	+0.482	+0.642	−0.058	+0.497	−0.425	−0.818	+0.341	−0.619	+0.251	−0.010	+0.339	−0.256	+0.646	+0.100
(N)	−0.346	+0.189	+0.417	+0.092	+0.300	−0.545	−0.693	+0.446	−0.327	+0.299	−0.088	+0.321	−0.074	+0.271	−0.164
SL 904 (low)	−0.570	+0.033	+0.471	+0.651	+0.097	+0.125	−0.720	−0.494	−0.660	−0.425	+0.089	+0.209	+0.082	+0.471	+0.116
(N)	−0.375	−0.131	−0.426	−0.145	+0.081	−0.342	−0.855	+0.260	−0.427	+0.212	+0.232	+0.526	−0.286	+0.410	+0.352
1952 4*n*															
SL 9985	−0.308	+0.378	+0.256	+0.266	+0.384	−0.282	−0.727	+0.053	−0.416	+0.296	+0.176	+0.358	−0.037	+0.141	+0.232
SL 1953	−0.165	+0.142	+0.228	−0.051	+0.518	−0.057	−0.786	+0.194	−0.422	−0.204	+0.542	+0.292	−0.401	+0.501	−0.251
1952 red beets															
SL 7334 (Lutz)	−0.305	−0.334	+0.440	−0.118	+0.148	−0.175	−0.701	+0.291	−0.335	−0.134	+0.103	+0.559	−0.208	+0.020	+0.186
SL 1308 (DD Red)	+0.448	−0.064	−0.410	−0.066	−0.224	−0.145	−0.708	−0.080	−0.243	+0.047	+0.318	+0.303	+0.319	+0.132	+0.730
1952 mangels															
SL 8315	+0.060	+0.032	−0.142	−0.166	+0.158	−0.143	−0.569	+0.353	−0.368	+0.032	−0.104	+0.295	+0.052	+0.153	−0.268
SL 8344	−0.317	+0.583	+0.328	−0.031	+0.277	−0.248	−0.261	+0.422	−0.300	+0.179	+0.233	+0.166	−0.224	+0.155	−0.109
SL 8318 (half-S.)	−0.338	−0.048	+0.043	−0.150	−0.134	−0.238	−0.490	+0.104	−0.216	+0.146	−0.077	+0.227	−0.036	+0.354	+0.407

With the aid of such a table the transmittance values can be converted very rapidly to parts per million or percentage on beets. A standard solution should be run every five or ten determinations, to make sure that the atomizer burner is feeding at a constant rate.

If the transmittance reading of the standard solution is in error by more than 1 or 2%, the capillary tube of the atomizer burner should be cleaned. Slight errors may be corrected by adjusting the slit width and rerunning the samples back to the previous standard.

Preliminary Data And Calculated *r* Values

Some correlation coefficients (*r* values) were calculated on data obtained from a wide variety of beets harvested in 1952. Although the number of beets (usually 25) of any one variety was small, the range in type of beets was very broad and included commercial varieties, inbreds, red beets, mangels, and a cross between a sugar beet and a mangel. This (shotgun) approach was used first to determine how the genetic differences affected correlation values between the different measurements. Large average differences in weight, respiration rate, and chemical composition were observed in the varieties studied (Table I). The inbreds that were selected for low respiration rate (low) produced progenies that were consistently lower in respiration rate than the original varieties (N) from which they were selected, indicating that progress in such selections can be expected. The large difference between SL 904 (low) and SL 904 (N) should be minimized because of the small number of beets of SL 904 (low). The average sugar content of the progeny from selected beets with a low respiration rate held up well, considering that they were much larger beets.

Correlation coefficients (*r* values) between all measurements determined on the same beets as shown in Table I are given in Table II. The numbers of individual beets studied from each variety were rather low. *r* values smaller than about 0.2 are probably not significant. There was a fairly consistent negative correlation between weight and sugar, except in the Detroit Dark Red table beet, which showed a surprisingly strong positive correlation. Weight and sodium content were positively correlated in most varieties, except in the Detroit Dark Red table beet and SL 904 N. Weight and potassium content were consistently positively correlated, with the usual exception. Sugar and amino nitrogen were negatively correlated, with no significant exceptions. Sugar and sodium content were negatively correlated in all cases. This is probably the strongest and most significant *r* value studied thus far. Selections made for low sodium content have yielded progeny much lower in sodium content. Respiration rate was, in general, positively correlated with sugar content in previous studies with whole beets.

Further studies using larger numbers of individual beets of each variety should yield more interesting data regarding genetic linkages in *Beta vulgaris* L.

Acknowledgment

Statistical calculations were made using IBM punch-card equipment, under the supervision of G. K. Ryser, Agricultural Research Service, Field Crops Research Branch, U. S. Department of Agriculture.

Literature Cited

(1) Gaskill, J. O., *Proc. Am. Soc. Sugar Beet Technol.*, **1952,** 396–9.

(2) Nelson, R. T., and Oldemeyer, R. K., *Ibid.*, **1952,** 400–6.

(3) Stanek, V., and Pavlas, P., *Z. Zuckerind. Cechoslovak. Rep.*, **59** (14), 129–41 (1934); abstract in *Facts About Sugar*, **30,** 67 (February 1935).

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