Report
Hop Analyses
1937--1938
by
D. D. Hill

Hop. 36

## Introduction

Funds for the project on evaluation of hops were provided by the 1937 Legislature. The first work attempted was on the 1937 crop. Work on these samples was extended into 1938 and completed at that time.

The evaluation studies on hops were divided into physical analyses and chemical analyses. The scope of the work and the results accomplished are included in a progress report made to the Director's Office in the fall of 1938. This report is included herein, following immediately after Table 2.

## Source of Material

Samples for the hop evaluation project were obtained from two hop firms in Salem, the T. A. Livesley Company and the Pacific Hop Growers, Inc. The farms from which these samples came, together with a brief description of them, are given in Tables 1 and 2.

## Table 1

## Hop Samples Furnished by T. A. Livesley Co., Salem, 1957

| No. of Samples | Sample Number | Bales | Name of Grower | Description |
|---|---|---|---|---|
| 5 | 1 | 55 | Thomas Rabie (Yakimas) | Good, medium greenish |
| 1 | 2 | 74 | E. C. Davidson | Good, medium, greenish, yellow |
| 1 | 3 | 75 | Geo. Rosich | Choice, yellow |
| 1 | 4 | 58 | Homer Marquam | Medium, greenish |
| 1 | 5 | 72 | Mrs. Etta Kehoe | Medium, greenish |
| 1 | 6 | 55 | Rude Berning | Good, medium, greenish |
| 1 | 7 | 25 | Ed Wanner | Good, medium, greenish, yellow |
| 1 | 8 | 72 | Gossler & Oberson (fuggles) | Good,medium,greenish,yellow |
| 3 | 9 | 33 | Bert Ebner | Poor, greenish, yellow |
| 3 | 10 | 65 | Mrs. Lena Fessler | Good,medium,greenish,dirty picked |
| 3 | 11 | 31 | C. E. Geelan | Good,medium,greenish,seedless type mottled |
| 1 | 12 | 37 | Roy Michaels | Poor, greenish, yellow |
| 2 | 13 | 62 | Martin Schneider | Good,medium,yellow,dirty picked |
| 1 | 14 | 45 | Butte Creek Orchards | Re-dried |
| 1 | 15 | 56 | Ray Martin | Good, medium, greenish |
| 1 | 16 | 14 | Sam Fawver (fuggles) | Poor, greenish |
| 2 | 17 | 78 | Robin Day (fuggles) | Good,medium,greenish,yellow |
| 2 | 18 | 60 | Albert Mikkelson | Good,medium,greenish,dirty picked |
| 1 | 19 | 132 | Wm. Middleton | Choice, yellow |
| 1 | 20 | 74 | W. L. Murray & Son | Choice, greenish, yellow |
| 2 | 21 | 165 | Carl Goshie | Good, medium, greenish |
| 1 | 22 | 31 | Keber & Mortensen | Good, medium, greenish |
| 1 | 23 | 55 | Alvin Thompson | Poor, greenish |
| 1 | 24 | 53 | J. N. Gooding | Medium, greenish, yellow |
| 1 | 25 | 43 | Anderson Bros. | Good, medium, greenish |
| 1 | 26 | 17 | Harold Satern | Good,medium,greenish,yellow |
| 1 | 27 | 62 | Henry Annen | Poor,greenish,semi-seedless, dirty picked |
| 2 | 28 | 67 | Harold Satern | Poor,greenish,yellow,dirty picked |
| 3 | 29 | 78 | C. Christe | Good, medium, greenish |
| 2 | 30 | 36 | A. C. Locke | Medium, greenish, dirty picked |
| 3 | 31 | 124 | Arthur Goffin | Medium,greenish,yellow,dirty picked |
| 2 | 32 | 51 | Leo Buyserie | Good, medium, yellow |
| 2 | 33 | 25 | Glen Hastings | Medium, greenish, dirty picked |
| 1 | 34 | 83 | C. H. Lorenze | Good, medium, greenish |
| 1 | 35 | 19 | Rohwein Bros. (fuggles) | Poor, medium, greenish, dull, dirty picked |
| 4 | 36 | 516 | Ben Hilton (DL1,DL2) | Medium, good, dull, mottled |
| 4 | 37 | 328 | Ben Hilton (HE1,HE2) | Poor, yellow |
| 2 | 38 | 60 | W. A. Turnidge | Good, medium, yellow |
| 1 | 39 | 460 | Fook Chung | Poor, greenish |
| 1 | 40 | 249 | Hartley & Hadley | Poor, greenish |
| 1 | 41 | 84 | Albert Egan | Medium, greenish, yellow |
| 2 | 42 | 150 | Willamette Hop Co. | Poor, yellow |
| 2 | 43 | 30 | M. Smith | Poor,medium,red,dirty picked |
| 2 | 44 | 124 | Jerman & Chittenden | Good, medium, greenish |

Table 1 (Con.)

| No. of Samples | Sample Number | Bales | Name of Grower | Description |
|---|---|---|---|---|
| 2 | 45 | 101 | R. H. Corbett & Jones | Medium,greenish,yellow,dirty picked |
| 1 | 46 | 88 | Bert Jerman | Good, medium, greenish |
| 1 | 47 | 112 | V. O. Kelley | Good,medium,greenish,yellow |
| 1 | 48 | 35 | Ed Loose | Good,medium,yellow, red tint |
| 2 | 49 | 57 | Martin Westendorf | Medium, good, dirty picked |
| 1 | 50 | 94 | Hobart Mitchel | Good, medium, greenish, yellow |
| 2 | 51 | 58 | Lelek & Co. | Medium, greenish, yellow, dirty picked |
| 1 | 52 | 20 | John Stenger | Poor, medium, greenish, yellow, dirty picked, red tint |
| 1 | 53 | 51 | M. Smith | Medium, greenish, yellow, red tint, dirty picked |
| 1 | 54 | 209 | D. C. Minto | Good, Medium, greenish |
| 2 | 55 | 99 | Collins & Collins | Poor, greenish, yellow |
| 1 | 56 | 270 | Dave Titus (fuggles) | Good, medium, greenish, yellow |
| 1 | 57 | 91 | Collins & Collins (fuggles) | Poor, greenish |
| 2 | 58 | 129 | Collins & Collins | No. 1 sample is poor, greenish<br>No. 2 sample is good, medium, greenish, yellow |
| 2 | 59 | 265 | Collins & Collins | Good, medium, greenish |
| 2 | 60 | 272 | D. P. McCarthy | Medium, greenish |
| 1 | 61 | 66 | S. A. Varble | Medium, greenish |
| 2 | 62 | 128 | Robin Day | Medium, greenish, yellow |
| 2 | 63 | 108 | Fred Viesko | Good, medium, greenish |
| 2 | 64 | 179 | Fred Viesko | Good, medium, greenish |
| 2 | 65 | 141 | Bert Jones | Medium, greenish |
| 2 | 66 | 394 | Ross Wood and Hugh Nelson | Sample No. 1 good, medium, greenish<br>Sample No. 2 medium, greenish, yellow |
| 1 | 67 | 21 | R. Newenschwander | Medium, yellow, red tint |
| 1 | 68 | 15 | W. Newenschwander | Medium, greenish, dirty picked |
| 2 | 69 | 62 | Frank Buckley | Good, medium, greenish |
| 1 | 70 | 30 | O. Smith | Good, medium, yellow |
| 2 | 71 | 62 | Bill Annen | Poor, medium, dull, greenish, dirty picked |
| 1 | 72 | 27 | Guy Chapman | Medium, greenish, yellow |
| 2 | 73 | 36 | Otto Lucht | Medium, greenish, yellow, dirty picked |
| 1 | 74 | 39 | Roth & Roth | Good, medium, greenish, yellow |

Table 2

Hop Samples Obtained from Pacific Hop Grower, Inc., 1937 Crop

| Sample Number | Bales | Name of Grower | Description - variety |
|---|---|---|---|
| 1 | 1000 | C. L. Ross | Sacramentos |
| 2 | 25 | Albert Sather | Fuggles |
| 3 | 151 | Ben Eppers | Fuggles |
| 8 | 26 | Oscar Satern | |
| 9 | 44 | John Gafte | |
| 12 | 15 | Oswald Johnson | |
| 14 | x20 | John Jacobs | Fuggles |
| 15 | 10 | Henry Humpert | Fuggles |
| 16 | x 50 | Ray Morley | Fuggles |
| 20 | 39 | P. C. Magness | |
| 25 | 16 | Chas. Swartout | |
| 26 | 71 | Ken Williams | Fuggles |
| 27 | 65 | C. Messenger | Fuggles |
| 30 | 72 | Etta Kehoe | Early Clusters |
| 31 | 32 | Willamette Hop Co. | Early Clusters |
| 32 | x250 | Linn & Linn | |
| 33 | 250 | Mission Bottom Hop Co. | |
| 34 | 68 | V. O. Kelley | |
| 36 | 300 | John Morley | |
| 37 | x100 | Geo. Elton | |
| 38 | x20 | Joe Zies | |
| 40 | 35 | Frank Poepping | |
| 42 | 54 | John Morley | Fuggles |
| 43 | 17 | Harold Satern | |
| 44 | 12 | John Moe | |
| 45 | x100 | Oscar Overland | |
| 47 | 14 | Paul Dettwyler | |
| 48 | 13 | Gil Bentson | Fuggles |
| 49 | 35 | Mike Zies | |
| 50 | 27 | Otto Dahl | |
| 51 | 22 | Adolph Hari | Fuggles |
| 52 | x300 | C. G. Hiltibrand | |
| 53 | 116 | Downing & Stutesman | |
| 54 | 116 | Fook Chung Co. | |
| 58 | 42 | Ed Harnsberger | |
| 62 | 79 | Robin D. Day | Early Clusters |
| 63 | 336 | F. E. Needham | Fuggles |
| 64 | 45 | Wm. Geiger | |
| 65 | 43 | Henry Johnson | Late Clusters |
| 66 | 65 | Morley & DeLang | Early Clusters |
| 68 | x60 | Emil Loe | Late Clusters |
| 73 | 28 | Harold McKay | |

Table 2 (Con.)

| Sample Number | Bales | Name of Grower | Description - variety |
|---|---|---|---|
| 75 | 19 | Harold McKay | |
| 79 | 38 | P. C. Magness | |
| 80 | x175 | Vinton & Loop | |
| 81 | 15 | T. W. Beamish | |
| 82 | 49 | Lena Kuenzi | |
| 83 | x30 | Holman Bros. | |
| 84 | 27 | Joe Zies | |
| 87 | 72 | Gosler & Oberson | Fuggles |
| 88 | 358 | Virgil De Coster | Fuggles |
| 89 | 44 | Sloper Bros. | |
| 97 | x500 | F. E. Needham | |
| 98 | 9 | Nick Krebs | |
| 148 | 40 | J. D. Lofgren | |
| 156 | 345 | A. M. Jerman | |
| 157 | 388 | Sloper Bros. | |
| 158 | 225 | Sloper & Son | |
| 159 | 125 | Greer & Reese | Sacramentos |
| 160 | 218 | Aman & Harbison | |
| 162 | 125 | Oscar Satern | |
| 163 | 43 | Geo. Wood | |
| 166 | 51 | Wenger Bros. | |
| 167 | 32 | John Overland | |
| 168 | 40 | Turner & Vaughn | |
| 169 | 68 | Gaffke | |
| 170 | 20 | R. Davidson | |
| 171 | 9 | Albert Sather | |
| 172 | 150 | Lee Quan | |
| 174 | 134 | Downing & Stutesman | |
| 175 | 136 | Hedges Estate | |
| 176 | 80 | W. Porterfield | |
| 185 | 68 | A. Schar | |
| 187 | 81 | Oscar Smith | |
| 188 | 53 | J. N. Gooding | |
| 189 | 5 | Tegland | |
| 190 | 37 | Eric Larson | |
| 191 | 18 | Ben Funrue | |
| 192 | 22 | Art Brenden | |
| 193 | 13 | Otto Anderson | |
| 194 | 47 | Lovelin | |
| 195 | 136 | Chas. Walker | |
| 196 | 60 | A. E. Jergeson | |
| 197 | 70 | Gaffke | |
| 198 | 270 | Dave Titus | |
| 199 | x150 | Hugh Smith | |
| 200 | 125 | Homer Gouley | Early Clusters |

Table 2 (Con.)

| Sample Number | Bales | Name of Grower | Description - variety |
|---|---|---|---|
| 201 | | Homer Gouley | Late Clusters |
| 202 | x180 | E. A. Miller | |
| 203 | 288 | L. Lachmund | |
| 207 | 128 | Robin Day | Late Clusters |
| 208 | 150 | Wm. Nicholson | |
| 209 | 38 | P. C. Magnus | Late Clusters |
| 214 | 18 | Fred Vieske | |
| 215 | 27 | L. S. Christofferson | Fuggles |
| 216 | 222 | L. S. Christofferson | |
| 217 | 50 | Christofferson & Sandgathe | |
| 218 | 231 | Frank Needham | |
| 219 | 17 | Frank Needham | |
| 220 | 104 | Brown Island | |
| 221 | 32 | Brown Island | |
| 228 | 44 | J. S. Gilkey | |
| 232 | 45 | Ivan Branton | |
| 233 | 35 | Ernest Schneider | |
| 235 | Idaho | Roger Batt | Early Clusters |
| 241 | 53 | Chas. Feller | |
| 242 | 48 | Chas. Feller | Early Clusters |
| 243 | 98 | Chas. Feller | |
| 247 | 72 | A. Nusom | |
| 249 | 58 | Glenn Hiltibrand | |
| 550 A | 199 | Mrs. Weston | |
| 550 $B_5$ | " | " | |
| 251 | 66 | S. A. Varble | |
| 252 | 140 | E. A. Miller | |
| 253 | 43 | L. E. Stafford | |
| 265 | 68 | Allen Drescher | |
| 266 | 81 | John Brunner | |
| 281 | 90 | Ben Shepard | |
| 284 | 48 | H. G. Lucht | |
| 292 | 99 | James Feller | |
| 301 | 310 | V. O. Kelley | |
| 317 | 56 | Ray Martin | |
| 319 | 109 | A. E. Feller | |
| 320 | 91 | A. E. Feller | |
| 332 | 180 | Cooper & Fawver | Fuggles |
| 339 | 54 | Carl Kirk | |
| 356 | 56 | Hattie Hovenden | |
| 360 | 25 | D. G. Robertson | |
| 374 | 325 | Lee Hing | |
| 396 | 70 | Jake Wanner | Seedless |
| 403 | 78 | Hattie Hovenden | |
| 406 | 85 | F. E. Maxfield | |
| 410 | 55 | Chas. Chikuo | |
| 454 | 18 | R. Stadeli | |

Table 2 (Con.)

| Sample Number | Bales | Name of Grower | Description - variety |
|---|---|---|---|
| 455 | 11 | R. Stadeli | |
| 459 | 181 | Helmer Jacobson | |
| 468 | 105 | B. Belair | Yakimas |
| 485 | 46 | Frank Hein | |
| 495 | 34 | Joe Jacobs | |
| 502 | 150 | Willamette Hop Co. | |
| 503 | 36 | Otto Lucht | |
| 506 | 91 | Fred Kaser | |
| 507 | 86 | Fred Kaser | |
| 510 | 28 | Fred Kaser | |
| 512 | 55 | Ralph DeSart | |
| 513 | 52 | Ralph DeSart | |
| 516 | 50 | Schutz Bros. | |
| 519 | 94 | Collins & Collins | Fuggles |
| 521 | 60 | John Beck | |
| 546 | 29 | John Wolf | |
| 547 | 77 | Wm. Nicholson | |
| 552 | 59 | Ross Wood | 1935 Fuggles |
| 566 | 14 | Oral Egan | |
| 587 | 94 | Fred Stadeli | |
| 609 | 119 | Eric Larson | |
| 610 | 118 | O. J. Schlottman | |
| 611 | 66 | O. J. Schlottman | |
| 619 | 53 | Joe Faulhaber | |

# A PROGRESS REPORT OF THE STATE PROJECT

# "THE EVALUATION OF HOPS"

by

D. D. Hill & D. E. Bullis

## Introduction

At the 1937 session of the State Legislature, an appropriation was approved for the study of problems of particular interest to the hop industry. One such problem is the determination of hop quality. It was thought that information would prove to be valuable not only to the research program but also to those engaged in production and marketing of hops.

Under this project, an attempt has been undertaken to determine what factors, physical and chemical, enter into the estimation of hop quality, which at present is determined solely by casual inspection of certain physical characteristics.

The project has been divided into three portions, the first of which deals with a study of the physical factors relating to hop quality; the second deals with a study of the chemical factors which may have a bearing on hop quality; and the third deals with the relationship between the first two. The study of physical factors was conducted by D. D. Hill of the Farm Crops Department, and the chemical studies were made by D. E. Bullis of the Department of Agricultural Chemistry.

# A STUDY OF PHYSICAL FACTORS RELATING TO HOP QUALITY

As a starting point in the study of physical factors relating to hop quality, it was necessary to ascertain what the factors were that should be studied. This was done by contacting hop growers, dealers, brewers, and others interested in the production, marketing and consumption of the crop. The factors gathered in this way represented a wide range in ideas which often were not in very close agreement. It was apparent that such factors as were being used to evaluate hop quality represented opinions only of those interested in the buying or selling of hops. Many of the factors used were not susceptible of accurate measurement, or, if they were susceptible of measurement, were not being measured accurately. Furthermore, there appeared to be wide variations in opinion as to the exact relationship of many of the physical factors to the intrinsic value of the hop in commercial uses.

The factors which appeared to be of interest to those engaged in marketing and which at the same time appeared to be susceptible of measurement were: (1) percentage of seed, (2) color, (3) percentage of foreign material, (4) maturity, (5) condition of the hops. It was recognized in the beginning that these factors did not include all the possible ones and that they probably included some which had little or no value.

The second problem in this connection was in the development of technique necessary to measure the physical qualities accurately. For the most part, little or no information was available to serve as a guide. Therefore, it was necessary to make many determinations which were purely experimental in nature and which had to be repeated many times in order to test the accuracy of the method.

Samples for these studies were collected through the cooperation of the Pacific Hop Growers, Incorporated, and the T. A. Livesley Company, both of Salem, Oregon. Both of these firms supplied the investigators with adequate samples from their stock of samples. In addition they furnished the name of the grower, the description of the variety in certain cases, as well as the total amount of the crop. Altogether some 300 samples of hops from the 1937 crop were gathered for physical analysis. These samples were kept in air tight cans, stored in the cold room at the Poultry Building, at a temperature of from 34° to 36° F.

Certain difficulties were encountered in handling, storing and working on such a large number of samples. Adequate research laboratories for this purpose are not available, hence it became necessary to move material from the storage area to an instructional laboratory for actual analysis. Furthermore, it was necessary to carry on the analytical work at a time when laboratory instruction was not being given. Future work could be facilitated by more adequate research laboratory space.

Results.

1. Seed weight. The percentage by weight of seed is recognized generally as important in evaluating hops. The low seed content of many foreign hops is usually pointed out as one of the reasons why this class of material brings a better price on the market. In order to determine seed percentage without an exorbitant cost, it was necessary to develop a new method. The only prescribed method is that of the U. S. Department of Agriculture, which requires heating at a given temperature for six hours and followed by the actual separation of the seed from the hop cones.

By washing the sample in methyl alcohol and drying in an oven the time required in preparing the sample for analysis was reduced from six hours to ten minutes. Repeated comparisons of the two methods indicate only a slightly lower accuracy by the alcohol method.

The percentage of seed was found to vary widely. Samples with as low as one per cent of seed were found, as well as samples with as high as 25 per cent. The average seed content ranged from 6 to 12 per cent.

Determination of seed weight by counting a given area. An attempt was made to determine the seed weight by counting the number of seeds in a given area on the cut surface of a sample. The area used was 2.25 square inches and an average of five counts was made on each sample. When the counts were converted to seed weight by the use of an appropriate factor, certain wide variations were found. It was then discovered that the seed weights varied with the maturity, and that maturity could be ascertained by the amount of dark seeds. The samples were classified into three groups according to the percentage of dark seeds. An attempt was then made to classify the samples according to the maturity of the seeds and to use three different factors based on maturity. It was found that while the average seed weight of a number of samples determined by count agreed closely with the average obtained by the alcohol extraction method, the individual variations were great enough to prevent the use of this method on individual samples. It would appear that if seed weight is to be determined, the most practical method is to use the alcohol extraction method.

2. Foreign Material. Foreign material was determined by analysis of a given weight of sample. The percentage by weight of foreign material varied from less than one per cent to more than 15%. This foreign material

is mostly leaves and stems, resulting from poor picking. As the leaves and stems have no value in the brewing process, the presence of such material definitely lowers the hop quality. Foreign material can be determined easily--include in stands general appearance--sales.

3. Color. The color of these 300 samples was determined on the Munsell color machine, which has been developed to determine color in a wide variety of agricultural products. The color machine has been developed to measure color in three different ways; hue, value and chroma. Hue is the quality by which one color is distinguished from another. Value is the quality by which a light color is distinguished from a dark one, and chroma is the quality by which a strong color is distinguished from a weak one. The color tests show rather wide ranges in hue and chroma but relatively small ranges in value. By the use of this apparatus it is possible to determine color value quickly and accurately.

It is difficult, however, to tie color values to any intrinsic value in the hop itself. The hop trade appears to have widely varying ideas about the importance of color, as well as the actual color of the best quality hops. As color values are affected by the practice of using sulfur in curing, it becomes more and more difficult to indicate that a definite color value represents a given quality. The tentative conclusion is reached that color values are more apparent than real. Undoubtedly color will affect the market value of hops in so far as a buyer has a preference for a certain color. It is difficult to establish that color is related to quality except when the color values are destroyed due to disease, insect damage, or over-ripeness and immaturity. It should be possible to work out definite color values to associate with these factors. Generally hops with a high

hue value tend to be immature, while those with a low chroma value tend to be hops which are over-ripe and affected by disease or insect pests.

4. Condition. The condition of the hop cone was found to vary within wide limits. In every sample determinations were made of the percentage of broken cones in the sample. The analyses show very few samples in which the percentage of whole cones exceed 50 per cent. Approximately one-half of the samples will show 25 per cent whole cones or less and many of them will have as little as 10 per cent. As the broken cones may often be inferior to whole cones, due to over-drying, loss of lupulin, etc., there appears to be ample opportunity to improve quality by improvement in drying and handling methods.

An attempt was made to evaluate the condition and amount of lupulin. It was difficult to evaluate these differences accurately by physical examination. Possibly this was due to the fact that the test was not made until the hops had been in storage for a considerable period. It is believed that further attempts should be made along this line but that these should be done while the hops are still fresh and before the character of the lupulin has changed.

An attempt was made to obtain attachments to the Heppenstall moisture meter in order to determine moisture content of the dried hops. Sometime previously the Tagliabue Company had developed an attachment for this purpose. Upon contacting this company it was found that such attachments were not now available, nor were they contemplating the manufacture of any such unit at this time. Because of the difficulty of storing hops and in obtaining the air-tight containers in which to store them at the beginning of these studies no attempts were made at moisture determinations on the 1937 crop.

## CHEMICAL FACTORS CONCERNED WITH QUALITY IN HOPS

In order better to understand the functions of chemistry in the determination of hop quality, it is desirable to review briefly the purposes of hops in brewing and to discuss the constituents of hops which are important in the brewing process and some of the chemical reactions to which they are subject.

The functions of hops in brewing are at least three-fold. The essential oils present in hops provide the aromatic flavor, the soft resins provide the mild bitterness characteristic of beer, and they also exert an antiseptic action against certain bacteria which are responsible for undesirable lactic types of fermentation and "off flavors." Hop tannins also aid in the coagulation of certain protein-like substances, which if not removed cause cloudiness in the finished beer.

Of these constituents, the resins are probably the most important and at the same time, the most susceptible to injury and deterioration through improper methods of drying and storage.

Hop resins comprise three different groups of closely related compounds. Two of them are termed soft resins and are named "alpha" and "beta" resins, and are of especial interest to the brewer. The third is a hard resin called "gamma resin," which is useless in brewing, but which is, nevertheless, important to the brewer in that it is formed at the expense of the valuable soft resins through processes of oxidation.

Of the two soft resins, the "alpha" resin is the more important since it is considered to be three times as potent antiseptically and about four times as high in its brewing value as an equivalent amount of the "beta" resin.

The term "preservative value" is frequently used to express the value of the combined soft resins in a hop sample. In the value so computed the "beta" resin is given one third the value of a corresponding amount of "alpha" resin. The expression used for calculating the preservative value is commonly written as $10(A + \frac{B}{3})$.

Through natural oxidation and aging, the "alpha" resin is converted to less valuable "beta" resin, and the "beta" resin in turn to the "gamma" or hard resin. The content of soft resins and the rapidity of these changes depends in great measure on the manner in which the crop is harvested, dried and stored.

For maximum soft resin content, the crop should be allowed to mature fully before harvest as the resins increase most rapidly in the late stages of cone development.

Drying should be carefully controlled because high temperatures induce rapid oxidation of the soft resins to hard resins. Degree of dryness is also significant because if overdried the cones are easily broken and the resin-bearing lupulin lost in handling. If under-dried, heating and bacterial deterioration take place after baling.

Storage is a factor in quality that is too often neglected. It has been shown beyond doubt that the natural oxidation changes of the soft resins may be slowed down by storage of hops at low temperatures, and most breweries maintain temperatures near 32°F. for hop storage. On the other hand, high temperatures accelerate the deterioration and hops so stored in hot warehouses may depreciate rapidly in brewing value.

With this brief explanation of the purpose of hops in brewing, of the chemical changes to which the constituents of hops are susceptible and

of the conditions which influence these changes, the function of chemical analysis in setting up standards of quality may better be understood.

Only by chemical analysis can the resin content be accurately determined, and thus one of the most important factors in the evaluation of hops ascertained. Several chemical methods have been devised for the resins determination. Probably the most accurate of these are the methods that have been worked out by English chemists, who for many years have been carrying on hop investigations financed by grants from the Institute of Brewing. Although time-consuming in operation, these methods of analysis were selected as best suited for the chemical phases of the hop evaluation project, but for routine work such as might be involved in hop grading, a much simpler and more rapid approximate method of resin estimation must be devised. By the above mentioned method, about two samples per day can be analyzed, which is far too slow a procedure for adoption in a grading system.

Of the approximate three hundred crop samples collected for the first year's work on this project, time allotted to the chemical phase of the work permitted the analysis of 103 samples for "alpha," "beta" and "gamma" resins and moisture content. The data from these analyses serve two purposes; first, as a means of studying the variation or range in resin values that may normally be expected in samples of one variety or between varieties, and second, for use in determining what correlation, if any, exists between chemical analysis and the various physical factors which are now commonly used in grading hops.

The correlation of physical and chemical data will be discussed later in this report. A short discussion of the variation in resin content and preservative value noted in the samples analyzed follows:

Fourteen samples of Fuggles hops were tested, and the range for moisture, resin, and preservative values were as follows: Moisture, 5.36% to 7.48%; alpha resin, 4.48% to 6.36%; beta resin, 8.74% to 11.94%; hard resin, 1.08% to 1.49%; preservative value, 79.6 to 98.9.

Eighty-two samples of Late Clusters hops showed a range for moisture of 4.56% to 8.08%; alpha resin, 4.52% to 8.50%; beta resin, from 6.84% to 13.47%; hard resin, from .83% to 1.88%; and preservative value, 80.9 to 117.4.

Four Early Clusters hop samples gave moisture 6.12% to 7.56%; alpha resin, 5.74% to 6.73%; beta resin, 10.21% to 10.82%; hard resin, 1.34% to 1.51%; and preservative value, 91.9 to 102.7.

The distribution of the above samples within the range indicated for the various resin contents is shown in the following tables:

Fuggles (14 samples)

| A Resin Content | 4.00-4.50% | 4.51-5.00% | 5.01-5.50% | 5.51-6.00% | 6.01-6.50% |
|---|---|---|---|---|---|
| No. Samples | 1 | 2 | 5 | 5 | 1 |

| B Resin Content | 8.50-9.00% | 9.01-9.50% | 9.51-10.00% | 10.01-10.50% | 10.51-11.00% | 11.01-11.50% | 11.51-12.00% |
|---|---|---|---|---|---|---|---|
| No. Samples | 2 | 3 | 0 | 4 | 2 | 2 | 1 |

| Hard Resin Content | 1.00-1.10% | 1.11-1.20% | 1.21-1.30% | 1.31-1.40% | 1.41-1.50% |
|---|---|---|---|---|---|
| No. Samples | 2 | 5 | 3 | 2 | 2 |

| Preservative Value | 75-80 | 81-85 | 86-90 | 91-95 | 96-100 |
|---|---|---|---|---|---|
| No. Samples | 2 | 3 | 5 | 3 | 1 |

For the Late Cluster Lots the distribution is indicated below:

Late Clusters (82 samples)

| A Resin Content | 4.50-5.00% | 5.01-5.50% | 5.51-6.00% | 6.01-6.50% | 6.51-7.00% | 7.01-7.50% | 7.51-8.00% | 8.01-8.50% |
|---|---|---|---|---|---|---|---|---|
| No. Samples | 4 | 6 | 16 | 21 | 22 | 7 | 5 | 1 |

| B Resin Content | 6.00-7.00% | 7.01-8.00% | 8.01-9.00% | 9.01-10.00% | 10.01-11.00% | 11.01-12.00% | 12.01-13.00% | 13.01-14.00% |
|---|---|---|---|---|---|---|---|---|
| No. Samples | 1 | 1 | 1 | 11 | 30 | 28 | 9 | 1 |

| Hard Resin Content | .80-1.00% | 1.01-1.10% | 1.11-1.20% | 1.21-1.30% | 1.31-1.40% | 1.41-1.50% | 1.51-1.60% | 1.61-1.70% | 1.71-1.90% |
|---|---|---|---|---|---|---|---|---|---|
| No. Samples | 4 | 12 | 25 | 18 | 13 | 2 | 2 | 3 | 3 |

| Preservative Value | 80-85 | 86-90 | 91-95 | 96-100 | 101-105 | 106-110 | 111-115 | 116-120 |
|---|---|---|---|---|---|---|---|---|
| No. Samples | 2 | 8 | 15 | 16 | 20 | 15 | 5 | 1 |

Because of the very few samples of the Early Clusters hops examined, there are no distribution tables included.

From the tables for Fuggles, it may be seen that an average sample of the 1937 crop tested about 5.50% alpha resin, 10.00% beta resin, 1.20% hard resin and had a preservative value of approximately 85 to 90.

For Late Cluster hops, the approximate average values are: alpha resin, 6.50%; beta resin, 11.50%; hard resin, 1.20%; and preservative value about 100.

These average values compare very favorably with those available for crops previous to 1937. This fact is all the more striking when it is remembered that when judged by the commonly employed physical standards the 1937 crop was considered to be of very inferior quality due to downy mildew, mold and insect injuries. Chemical analyses, however, appear to show that such injuries to the physical appearance of the crop have in no way affected the resins content and such the brewing value of such hops.

## RELATION OF PHYSICAL TO CHEMICAL FACTORS

The variation in the prices paid in a given year is usually a reflection of the variations in physical characteristics. The intrinsic value of hops appears to be related largely to the chemical constituents. Therefore, when hops are purchased on the basis of physical characteristics, and if the price paid reflects the actual value of the hops, there should be a reasonably close correlation between the physical and chemical characteristics. In order to determine the extent of such relationships, correlation studies of the physical and chemical factors were undertaken. In all cases, the percentage of soft resins was taken as the chemical character of most importance.

Correlation coefficients were computed to show the relationship between the amount of soft resins and the following physical characters: percentage of seeds, maturity of seed, foreign material, color (both hue and chroma values). These correlation studies failed to show a single

correlation coefficient of any statistical significance. This naturally raised the question as to (1) whether hops are bought under a false set of values, (2) whether the physical characters were measured accurately, or (3) whether the proper physical characters were studied. It is entirely likely that the answer may be found in all three possibilities. In this connection, it should be pointed out that the hops studied in these investigations were produced in an abnormal season. There was a considerable mildew infection throughout the season, and this was followed by heavy damage from red spider, aphids, and consequent mold during the harvest period. In the opinion of most producers and dealers contacted, the quality of the 1937 crop was much below average. Possibly these abnormal conditions have upset the relationships which may normally exist between the physical characters and the chemical constituents. In order for any definite conclusions to be drawn, the studies should be continued on the 1938 crop which appears to be above average in quality.

## CONCLUSIONS

While it is premature to consider the development of grades and standards on the basis of one year's investigations of an abnormal crop, certain conclusions may be drawn at this time:

(1) Certain physical characters are used so generally under present marketing conditions that they must be included under any set of standards which may eventually be developed. Many of these such as color, percentage seeds and foreign material are susceptible of measurement in a manner which would be entirely practical from an inspection standpoint.

(2) The apparent lack of relationship between physical and chemical characters emphasizes the necessity for the development of a simple, rapid, and reasonably accurate method of determining the amount of soft resins, if this important indication of quality is to be used in grading or in influencing price.

## ABSTRACT

The project on "Evaluation of hop quality" was divided into two parts. One part dealt with the physical factors, the other with chemical determinations.

Physical examination was made of approximately 300 samples from the 1937 crop. Determination of seed weight, seed maturity, color, foreign material, and condition of cones was included. A new method of determining seed weight was developed which reduced the time of preparing the sample from six hours to a few minutes. The physical condition of the 1937 crop was considerably below normal, due to mildew, insect, and mold damage.

Chemical determinations were made on 103 samples to ascertain the percentage of both soft and hard resins. The results show the resin content to compare favorably with that obtained in other seasons, even though the physical condition was considered below normal.

A study of the relation of physical and chemical factors failed to show any significant correlation. The tentative conclusion is reached that, despite the lack of correlation, the use of physical factors by the trade necessitates further study and measurement of them. The further conclusion is reached that some rapid and accurate method for the determination of resins is necessary if adequate grade standards for hops are to be formed.

## Physical Analyses of Hops

In attempting studies on physical condition of hops, it was necessary to develop methods and technique. Hop growers and dealers emphasize certain points in connection with hop quality, but without exception these points are a matter of estimation rather than of measurement. After studying this matter for some time it was decided to concentrate physical studies on the following points: percentage of seed, percentage of leaves and stems, percentage of strigs (the central axis of the hop cone), color and general condition. The development of methods for determination of seeds presented the most difficult problem. The problem and the development of methods of seed analysis are given in the following article which was prepared by C. G. Monroe and D. D. Hill for publication in the Journal of the American Society of Agronomy:

### METHODS FOR DETERMINING THE PERCENTAGE OF SEEDS, STRIGS, STEMS, AND LEAVES IN COMMERCIAL HOPS

*C. G. Monroe and D. D. Hill

The seeds, strigs, stems, and leaves in commercial hops add little to the brewing value. Brewers generally consider seedless hops to be superior to seeded hops as the seeds are believed to impart undesirable flavors and odors to the brewed beverages. All of these materials add useless weight to the hops.

Brewmasters and hop dealers have made it a practice to estimate roughly the amount of impurities in a given sample. If analyses are necessary, the stems and leaves can be picked from the sample and the percentage determined accurately. The stickiness of the lupulin which covers the base of the bracts of the hop cone and the enclosed seed makes accurate physical analysis of this factor difficult. Lupulin also interferes with accurate determination of strigs.

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Published as Technical Paper No. 312 with the approval of the Director of the Oregon Experiment Station. Contribution of the Department of Farm Crops.

At the request of the Oregon hop industry, experiments were initiated by the Oregon Experiment Station to study the physical and chemical properties of commercial hops. In this study it was necessary to determine accurately the percentage of seeds in a given sample. A comprehensive review of the literature on the subject revealed only two methods that had been used to accomplish this objective. Epstein and Hubbard(1) suggested a method in which the seeds were plucked from the cones by hand and the lupulin removed from the seeds by rubbing between the thumb and index finger. When the fingers became oily they were dipped in 50 per cent alcohol and wiped clean. About two hours were required to determine the seed content of a 10-gram sample, which according to Epstein and Hubbard was the smallest sample that would give representative results. Rabak (2) offered a more practical method by which 20-gram samples were heated to 105° C. for six hours to destroy the stickiness of the lupulin so that the hops could be threshed by pulverizing between the palms of the hands and the seeds then screened out. This method limits the output of a commercial laboratory to the capacity of its ovens.

## Materials and Methods

An experiment was set up for the purpose of developing a more practical method for arriving at seed percentages. Three lots of hops appearing to vary in seed content were selected. Ten-gram samples from each of these lots were subjected to two types of treatments to destroy the lupulin. In one treatment the samples were exposed to various temperatures for one to six hours; in the other they were dipped in alcohol and then dried. From this experiment, the following methods were selected as the most promising: heating at 105° C. for six hours, heating at 115°C. for two hours, and the alcohol-solvent method.

A second experiment was set up to determine the comparative accuracy of these three methods. From each of five different lots of commercial hops, three sets of five 20-gram samples were selected to be treated by each of the three methods. The samples were taken from hop bales and accurately weighed to 20 grams. All stems, leaves, and portions of leaves more than 1/4 inch in diameter were picked out and weighed to .01 gram, and the percentage determined. In the first experiment it had been found that it was more practical to separate the stems and leaves before heating or dipping in alcohol, as the leaves were less likely to be broken and therefore more easily removed. The samples to be heated were placed in covered soil cans and heated in a thermostatically controlled electric oven in which the temperature would be controlled with an accuracy of ± 2° C.

(1) Dr. S. S. Epstein and Dr. W. S. Hubbard, The American Brewer, June, 1936.

(2) Rabak, F., Relation of Seeds, Leaves, and Stems to the Quality of Hops and Malt Beverages. Printed and distributed by Materials Improvement Committee, Master Brewers' Association of America.

The individual samples for the alcohol solvent method were placed on two-foot squares of muslin or cheesecloth, and immersed in a quart bowl of methyl alcohol for one minute. The excess alcohol was pressed by hand from the sample and retained for further use. Rubber coated gloves were used to protect the operator's hands from the staining effect of the alcohol and lupulin.

The cloth containing the hops was next spread out to dry on a screen over a steam radiator. Breaking up the cones and stirring them occasionally speeded up the drying process. Twenty to thirty minutes were required for drying.

Identical methods of threshing were used for all treatments. The cones were pulverized between the palms of the hands, and the chaff separated from the seeds and strigs, or central stems of the cones, with a laboratory fanning mill. The seeds were readily separated by screening out the larger strigs, then placing the seeds and remaining strigs on an incline and manipulating in such a manner that the seeds rolled off while the irregularly shaped strigs do not. The seeds and strigs were weighed separately and their percentages by weight determined. The weight per 1000 seeds was determined for each treatment.

## Experiment Results

Results of the preliminary trials are shown in Table I. This experiment indicates that heating at higher temperatures for shorter periods of time is comparable to the six-hour treatment at 105° C., and that the alcohol-solvent method compares favorably with the heat treatments. The variations in seed percentages, though small, indicated that the 10-gram samples were too small.

## Table I

### Comparison of Methods of Seed Determination: Preliminary Trial

| Treatment | Lot 45A % Seeds | Lot 45A Condition* | Lot 37 % Seeds | Lot 37 Condition | Lot 51 % Seeds | Lot 51 Condition |
|---|---|---|---|---|---|---|
| Heat, 105°C. | | | | | | |
| " 1 hr. | 9.2 | Slightly sticky | 11.2 | Slightly sticky | 19.0 | Sticky |
| " " 2 hrs. | 6.5 | OK | 11.8 | OK | 16.5 | Slightly sticky |
| " " 3 hrs. | 7.6 | OK | 8.9 | OK | 16.1 | " " |
| " " 4 hrs. | 7.3 | OK | 12.0 | OK | 16.5 | " " |
| " " 5 hrs. | 7.4 | OK | 10.1 | OK | 17.0 | OK |
| " " 6 hrs. | 7.1 | OK, Cones brown | 11.1 | OK | 17.7 | OK |
| Alcohol solvent | 8.3 | OK | 11.5 | OK | 17.2 | OK |
| " " | 6.9 | OK | 11.1 | OK | 17.9 | OK |
| " " | 7.0 | OK | 9.9 | OK | 17.5 | OK |
| " " | 8.0 | OK | 11.5 | OK | 18.9 | OK |
| " " | 6.8 | OK | 10.8 | OK | 18.2 | OK |
| Ave. | 7.4 | | 11.0 | | 17.9 | |
| **P.E. ± | .254 | | .287 | | .203 | |
| P.E. % | 3.45 | | 2.61 | | 1.13 | |

### Trials at Higher Temperatures with Lot 45A

| No. | 115° C., 2 hrs. % Seeds | 115° C., 2 hrs. Condition | 120° C., 2 hrs. % Seeds | 120° C., 2 hrs. Condition | 120° C., 1 hr. % Seeds | 120° C., 1 hr. Condition |
|---|---|---|---|---|---|---|
| 1 | 8.2 | OK | 8.6 | OK, Tobacco brown | 8.1 | Slightly sticky |
| 2 | 7.2 | OK | 8.0 | OK " " | 7.3 | OK |
| 3 | 8.8 | OK | 8.0 | OK " " | 9.2 | Slightly sticky |

*Condition refers to the condition of the sample for threshing.
**Probable error computed by Peter's formula.

Individual percentages of seeds and strigs with averages for each sample and each treatment are shown in Table II. The data obtained from all three methods show comparable results, although the percentage of error from the two-hour heat treatment is slightly higher than from the other two methods.

TABLE II

Comparison of Methods of Seed Determination: Final Experiment

| | Lot 27A | | Lot 51A | | Lot 44 | | Lot 49A | | Lot 8A | |
|---|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | % | % |
| No. | Strigs | Seeds | Strigs | Seeds | Strigs | Seeds | Strigs | Seeds | Strigs | Seeds |
| **Alcohol-Solvent Method** | | | | | | | | | | |
| 1 | 8.6 | 4.0 | 8.5 | 7.7 | 8.0 | 8.6 | 8.9 | 15.0 | 7.6 | 19.7 |
| 2 | 7.3 | 3.9 | 9.9 | 7.9 | 8.0 | 9.0 | 8.9 | 15.4 | 8.5 | 20.8 |
| 3 | 7.4 | 4.1 | 10.2 | 8.4 | 8.3 | 8.1 | 9.2 | 15.5 | 8.4 | 20.3 |
| 4 | 8.7 | 4.1 | 9.7 | 7.8 | 7.4 | 10.3 | 9.0 | 15.5 | 8.9 | 20.0 |
| 5 | 8.3 | 3.8 | 10.2 | 8.1 | 7.9 | 10.1 | 9.6 | 16.3 | 7.7 | 21.3 |
| Ave. | 8.1 | 4.0 | 9.7 | 8.0 | 7.9 | 9.2 | 9.1 | 15.5 | 8.2 | 20.4 |
| P.E. ± | .237 | .042 | .203 | .093 | .093 | .330 | .093 | .118 | .194 | .211 |
| P.E. % | 2.93 | 1.05 | 2.09 | 1.16 | 1.18 | 3.59 | 1.02 | 0.76 | 2.37 | 1.03 |
| 1000 seed wt. | 3.92 g | | 4.23 g | | 3.64 g | | 4.10 g | | 3.27 g | |
| **Heat at 115° C. for Two Hours** | | | | | | | | | | |
| 1 | 7.8 | 4.1 | 9.1 | 8.9 | 7.5 | 8.0 | 7.5 | 15.0 | 9.0 | 22.0 |
| 2 | 8.5 | 3.8 | 8.0 | 8.0 | 7.2 | 9.0 | 5.1 | 13.2 | 8.2 | 19.8 |
| 3 | 8.1 | 4.6 | 7.8 | 9.5 | 7.4 | 8.7 | 8.2 | 15.5 | 7.1 | 20.6 |
| 4 | 8.1 | 3.8 | 6.5 | 8.2 | 5.0 | 10.1 | 6.5 | 15.8 | 8.8 | 21.4 |
| 5 | 8.4 | 4.2 | 7.5 | 7.5 | 6.0 | 8.4 | 6.7 | 16.1 | 7.8 | 19.0 |
| Ave. | 8.2 | 4.1 | 7.8 | 8.4 | 6.6 | 8.8 | 6.8 | 15.1 | 8.2 | 20.6 |
| P.E. ± | .093 | .101 | .262 | .262 | .380 | .237 | .355 | .346 | .245 | .389 |
| P.E. % | 1.13 | 2.46 | 3.36 | 3.12 | 5.76 | 2.69 | 5.22 | 2.29 | 2.99 | 1.89 |
| 1000 seed wt. | 3.70 g | | 4.44 g | | 3.70 g | | 4.30 g | | 3.14 g | |
| **Heat at 105° C. for Six Hours** | | | | | | | | | | |
| 1 | 7.1 | 4.0 | 9.2 | 8.1 | 5.0 | 8.3 | 5.6 | 13.3 | 7.5 | 20.6 |
| 2 | 6.7 | 3.8 | 7.2 | 8.0 | 4.8 | 8.4 | 7.0 | 13.2 | 7.4 | 19.7 |
| 3 | 8.2 | 4.4 | 8.6 | 8.2 | 5.3 | 9.5 | 7.4 | 13.6 | 7.1 | 19.4 |
| 4 | 8.3 | 4.8 | 8.0 | 7.4 | 6.6 | 9.4 | 6.1 | 13.7 | 7.4 | 19.0 |
| 5 | 8.0 | 3.9 | 8.4 | 8.1 | 7.5 | 8.5 | 7.2 | 14.2 | 7.0 | 19.9 |
| Ave. | 7.7 | 4.2 | 8.3 | 8.0 | 5.8 | 8.8 | 6.7 | 13.6 | 7.3 | 19.7 |
| P.E. ± | .253 | .144 | .228 | .084 | .406 | .211 | .270 | .118 | .076 | .177 |
| P.E. % | 3.28 | 3.43 | 2.75 | 1.05 | 7.00 | 2.40 | 4.03 | 0.87 | 1.04 | 0.90 |
| 1000 seed wt. | 3.93 g | | 4.36 g | | 3.74 g | | 4.08 g | | 3.36 g | |

For convenience, the averages from Table II are summarized in Table III.

Table III

Summary of Table II

Comparison of the Averages of the Three Methods

| | Alcohol Solvent | | | Heat, 115° C., 2 hrs. | | | Heat, 105° C., 6 hrs. | | |
|---|---|---|---|---|---|---|---|---|---|
| Average | % by wt. | % P.E. | 1000 Seed wt. | % by wt. | % P.E. | 1000 Seed wt. | % by wt. | % P.E. | 1000 Seed wt. |
| Seeds | 11.4 | 1.52 | 3.85 g | 11.4 | 2.49 | 3.86 g | 10.9 | 1.73 | 3.89 g |
| Strigs | 8.6 | 1.92 | | 7.5 | 3.69 | | 7.2 | 3.62 | |

Discussion

The percentage of probable error indicates the variations within each of the different methods, part of which is the result of variations in sampling. The low percentage of error in all cases indicates that all of these methods are reasonably accurate.

Results of the heat trials indicate that the two-hour method at 115° C. is as accurate as the six-hour method at 105° C. One advantage of the former is that it will enable a laboratory to analyze four times its oven capacity in an eight-hour day. Where oven space is the limiting factor, this is a decided advantage over the six-hour method.

The alcohol-solvent method gave results comparable to those obtained from the heat treatments. The determination of strigs by this method appeared to be slightly more accurate, as indicated by a lower probable error. An important advantage of the method is that no oven is required, and the work can be done wherever facilities are available for drying. In the opinion of the senior author, who conducted most of the actual trials, samples treated with alcohol threshed more easily and were more satisfactory to handle. Heating appeared to cause parts of the bracts to adhere to the seeds, thus interfering in threshing.

The alcohol-solvent method was adopted by the Oregon Experiment Station. It was used on approximately 1000 samples from more than 300 different lots of commercial hops and gave satisfactory results. Results were entirely satisfactory. Experience shows that one man can determine the percentages of stems, leaves, seeds, and strigs of twenty-five 20-gram samples in one eight hour day, using only three pints of methyl alcohol.

Summary and Conclusions

To determine accurately the percentage of seeds in commercial hops, the lupulin must be removed. Lupulin is the sticky, yellow material which adheres to the seeds and the bases of the bracts making accurate separation difficult.

Methyl alcohol used as a solvent appears to be the most satisfactory method of those tried. The short time and the small amount of equipment and materials required, the simplicity of the method, and its accuracy are definite advantages. This method is definitely more accurate for determining percentages of strigs than the heat methods, which tend to cause the strigs to become so brittle that they break and are lost in threshing.

Heating two hours at 115° C. appears to be as satisfactory as heating six hours at 105° C.

Twenty-gram samples are easy to handle, and according to the probable errors obtained they are sufficiently accurate to be dependable.

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In addition to the development of the methods reported above, an attempt was made to determine seed weight by counting the number of seeds in a given area. Therefore, seed counts were made on an area of 2.25 square inches on the face of each sample. These counts were then converted into seed weights by means of the factor that was developed. In addition, as it became apparent that seed varied in weight, an attempt was made to classify them as to color, as it was found that seed weights and seed colors were related.

Stems and leaves were determined by picking out the stems and leaves by hand from a given sample, normally 20 grams. At the same time, counts were made as to the condition and sizes of the hop cones. The percentages of whole and broken cones were noted for each sample.

No consideration normally is given to the percentage of strigs or central axis of the hop cone. It was found in these studies that this percentage varied rather widely and it appeared that this appearance might be a useful figure in evaluation.

Color of the hop samples was determined by means of the Munsell color machine. Color determinations were made on all samples which were of

sufficient size to make a color reading possible. Color is reported in terms of hue, chroma and brilliance.

Results of the physical analyses are given in Tables 3 and 4. The following is offered in explanation of the various characters indicated in this table. The count refers to the number of seed found in 2.25 square inches of surface on the face of the sample. These include the individual counts as well as the average. The seed weight in grams is given, the percentage by weight and the estimate as to the percentage of dark-colored, medium-colored and light-colored seed showing in the cut surface. The percentage of seed calculated from the count is that determined in accordance with the factors determined for the varying percentages of dark and light-colored seed. The percentage of leaves and stems is shown in a separate column. The cones are indicated as per cent whole and per cent broken and the size is classified as small, medium or large. The percentage of strigs (the central axis of the cone) is that determined from actual weight. Finally, the color is given for part of the samples under the headings of hue, chroma and brilliance.

The factors shown in Tables 3 and 4 indicate wide variations between samples. Data on foreign material and strigs are shown in Table 5 and in Fig. 1. These show, for example, that approximately 9 per cent of the total samples had 1 per cent by weight of foreign material and approximately 1 per cent of the samples had 12 per cent by weight of foregin material. For the majority of the samples the foreign material content ranged from 2 per cent to 8 per cent. The percentage of strigs was somewhat higher than that for foreign material. In approximately 80 per cent of the samples the percentage of strigs ranged from 5 to 10 per cent, inclusive.

The distribution of samples in relation to seed weight is shown in Table 6 and in Fig. 2. This shows a somewhat wider distribution than was found for either foreign material or for strigs. For example, 10.64 per cent of the samples had seed weights varying to 1 to 5 per cent, 14.34 per cent of the samples had seed weights ranging from 16 to 25 per cent, three-fourths of the samples had seed weights which ranged from 6 to 15 per cent inclusive. This wide range in percentage of seed represents a variation in quality that normally is not measured by present methods of evaluation.

Table 3

ANALYSES OF HOP SAMPLES OBTAINED FROM PACIFIC HOP GROWER, INC. 1937

B - BISHOP

| No. | Count 1 | 2 | 3 | 4 | 5 | Ave. | Seeds Gram | % | Dark Est.% | Med. by | Light count | % of seeds calculated from counts | % Stems, Leaves | Cones % Whole | Brk'n | Size | Per cent Strigs | Color Hue | Chroma | Brilliance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7 | 11 | 6 | 5 | 6 | 7.2 | 1.18 | 5.9 | 60 | 30 | 10 | 6.91 | 8.35 | 28. | 63.7 | M | 5.75 | | | |
| 2 | | | | | | 10.2 | 3.15 | 15.75 | 60 | 10 | 30 | 9.79 | 3.62 | 17.2 | 79.78 | M | 8.75 | | | |
| 3 | | | | | | 17. | 2.58 | 12.9 | 10 | 40 | 50 | V. Sm. seeds | 7. | 7.75 | 85.25 | S | 7.35 | | | |
| 8 | 17 | 14 | 19 | 14 | 15 | 15.8 | 1.6 | 8. | 60 | 10 | 30 | 15.17 | 4.73 | 26.1 | 69.17 | M | 6.5 | 7.91 | 3.44 | 5.63 |
| 9 | | | | | | 12.8 | 2.83 | 14.15 | 50 | 20 | 30 | 12.29 | 4.8 | 17.55 | 77.65 | M | 6.8 | | | |
| 12 | 4 | 7 | 7 | 1 | 2 | 3.6 | .45 | 2.25 | 50 | 20 | 30 | 3.45 L. seeds | 5.7 | 42.5 | 51.7 | M | | 8.00 | 4.00 | 5.88 |
| 14 | | | | | | 11.6 | 3.55 | 17.75 | 60 | 30 | 10 | 11.13 | 1.75 | 14. | 84.25 | SM | 6.5 | 7.80 | 4.00 | 5.88 |
| 15 | | | | | | 15.8 | 1.64 | 8.2 | 30 | 40 | 30 | 13.90 | 3.55 | 6.15 | 90.35 | SM | 7.85 | 8.65 | 2.96 | 5.28 |
| 16 | | | | | | 8.2 | 1.63 | 8.15 | 60 | 30 | 10 | 7.87 | 5.4 | 16.9 | 77.7 | SM | 6.3 | | | |
| 20 | | | | | | 6.2 | 1.96 | 9.8 | 60 | 20 | 20 | 5.95 | 5. | 36.1 | 58.9 | L | 9. | | | |
| 25 | | | | | | 2.6 | 1.38 | 6.9 | 50 | 30 | 20 | 2.50 | 4.87 | 48.75 | 46.38 | ML | 9. | 7.68 | 4.48 | 6.35 |
| 26 | | | | | | 8.6 | 3.12 | 15.6 | | | | | 5.5 | 14.85 | 79.65 | S | 7. | | | |
| 27 | | | | | | 14.8 | 3.55 | 17.75 | 80 | 10 | 10 | 16.43 | 3.2 | 18.4 | 78.4 | SM | 6.5 | | | |
| 30 | | | | | | 9. | 2.13 | 10.65 | 60 | 30 | 10 | 8.64 | 3.62 | 15.67 | 80.71 | M | 8.75 | 6.38 | 3.76 | 5.63 |
| 31 | | | | | | 5.8 | 2.22 | 11.1 | 70 | 15 | 15 | 6.44 | 4.85 | 43. | 52.15 | ML | 6.8 | 8.73 | 4.40 | 6.08 |
| 32 | 6 | 4 | 6 | 5 | 9 | 6. | 2.62 | 13.1 | 65 | 25 | 10 | 5.76 | 1.75 | 38.15 | 60.1 | LM | 7.2 | | | |
| 33 | | | | | | 16.4 | 3.38 | 16.9 | 45 | 20 | 35 | 15.74 | 6. | 26. | 68. | M | 7.5 | | | |
| 34 | | | | | | 15.6 | 3.47 | 17.35 | 90 | 5 | 5 | 17.32 | 4.1 | 19.5 | 76.4 | SM | 6.5 | | | |
| 36 | | | | | | 5. | 1.77 | 8.85 | 30 | 30 | 40 | 4.40 | 7.35 | 39.7 | 52.95 | M | 7.4 | | | |
| 37 | 7 | 9 | 5 | 5 | 5 | 6.2 | 2.22 | 11.10 | 40 | 40 | 20 | 5.95 L. seeds | 4.25 | 41.5 | 54.25 | M | 7.5 | 8.37 | 4.08 | 6.12 |
| 38 | | | | | | 2.2 | .47 | 2.35 | 40 | 40 | 20 | 2.11 | 12.65 | 37.7 | 49.65 | S | 5.85 | | | |
| 40 | | | | | | 2. | .7 | 3.5 | 40 | 20 | 40 | 1.92 | 5.4 | 32.75 | 61.85 | M | 6.6 | | | |
| 42 | | | | | | 16. | 3.47 | 17.35 | 70 | 20 | 10 | 15.36 | 8.4 | 58.1 | 33.5 | SM | 8 | | | |
| 43 | | | | | | 10. | 3.4 | 17. | 60 | 20 | 20 | 9.60 | 4.95 | 41.6 | 54.84 | M | 8.85 | 6.81 | 3.76 | 5.76 |
| 44 | 6 | 3 | 6 | 4 | 3 | 4.4 | 1. | 5. | 40 | 30 | 30 | 4.22 | 5.8 | 41.45 | 52.75 | M | 7.5 | | | |
| 45 | 4 | 2 | 5 | 3 | 6 | 4.6 | 1.2 | 6. | 40 | 40 | 20 | 4.42 | 11.5 | 38.25 | 50.25 | M | 7.35 | 7.00 | 3.20 | 5.40 |
| 47 | 4 | 1 | 5 | 4 | 2 | 3.2 | .44 | 2.2 | 50 | 40 | 10 | 3.07 | 2.3 | 25.45 | 72.25 | SM | 7.1 | | | |

Table 3 (cont.)

| No. | Count 1 | 2 | 3 | 4 | 5 | Ave. | Seeds Gram | % | Dark Est.% | Med. by count | Light | % of seeds calculated from counts | % Stems, Leaves | Cones % Whole | Brk'n | Size | Per cent Strigs | Color Hue | Chroma | Brilliance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48 | 11 | 10 | 12 | 10 | 11 | 10.8 | 2.35 | 11.75 | 60 | 20 | 20 | 10.37 | 4.55 | 35.45 | 60. | SM | 7.3 | 6.59 | 3.28 | 5.46 |
| 49 | 4 | 8 | 4 | 5 | 8 | 5.8 | 2.33 | 11.65 | 40 | 30 | 30 | 5.57 | 4. | 38.7 | 57.3 | ML | 8.3 | | | |
| 50 | 4 | 5 | 6 | 7 | 3 | 5. | 1.45 | 7.25 | 30 | 20 | 50 | 4.40 | 6.45 | 28.25 | 65.3 | M | 9.4 | 6.43 | 3.44 | 5.54 |
| 51 | 8 | 19 | 16 | 21 | 17 | 16.2 | 3.75 | 18.75 | 80 | 10 | 10 | 17.98 | 3.12 | 29. | 67.88 | LM | 8. | 7.32 | 4.48 | 6.12 |
| 52 | 8 | 10 | 10 | 6 | 8 | 8.4 | 2.5 | 12.5 | 30 | 40 | 30 | 7.39 | 1.92 | 11.1 | 86.98 | M | 9.4 | 6.67 | 3.36 | 5.67 |
| 53 | 13 | 17 | 13 | 18 | 19 | 16. | 3.78 | 18.9 | 30 | 40 | 30 | 14.08 | 4.15 | 24.85 | 71. | SM | 5.65 | | | |
| 54 | 7 | 8 | 9 | 8 | 7 | 7.8 | 1.25 | 6.25 | 50 | 20 | 30 | 7.49 | 4.4 | 33.2 | 63.4 | ML | 7.15 | 7.20 | 4.00 | 6.00 |
| 58 | 21 | 14 | 21 | 25 | 17 | 19.4 | 3.27 | 16.35 | 30 | 20 | 50 | 17.07 | 2. | 13.25 | 84.75 | M | 7.35 | | | |
| 62 | 8 | 3 | 8 | 6 | 8 | 6.6 | 2.8 | 14. | 80 | 10 | 10 | 7.32 | 5. | 63.55 | 31.45 | L | 8.1 | 7.20 | 4.00 | 6.17 |
| 63 | 13 | 14 | 23 | 9 | 13 | 14.4 | 4.07 | 20.35 | 80 | 10 | 10 | 15.98 | 2.3 | 40.85 | 56.85 | ML | 8.15 | | | |
| 64 | 8 | 6 | 11 | 8 | 5 | 7.6 | 2.19 | 10.95 | 80 | 10 | 10 | 8.44 | 6.35 | 16.25 | 77.45 | SM | 8.85 | 7.38 | 3.36 | 5.63 |
| 65 | 6 | 7 | 11 | 9 | 5 | 7.6 | 1.74 | 8.7 | 70 | 20 | 10 | 8.44 | 8. | 16.1 | 75.9 | M | 10.5 | | | |
| 66 | 5 | 3 | 4 | 3 | 3 | 3.6 | 2.09 | 10.45 | 80 | 10 | 10 | 4.00 | 7.1 | 34. | 58.9 | M | 10.65 | 5.72 | 3.76 | 5.72 |
| 68 | 6 | 7 | 11 | 10 | 8 | 8.4 | 2.15 | 10.75 | 60 | 10 | 30 | 8.06 | 5. | 24.6 | 70.4 | SM | 10.15 | | | |
| 73 | 7 | 8 | 4 | 12 | 5 | 7.2 | 1.78 | 8.9 | 80 | 10 | 10 | 7.99 | 2.4 | 22.85 | 75.75 | SM | 7.85 | 7.45 | 3.76 | 5.91 |
| 75 | 3 | 7 | 5 | 8 | 9 | 6.4 | 2.2 | 11. | 50 | 30 | 20 | 6.14 | 3. | 14.15 | 82.85 | ML | 8.85 | 7.96 | 4.40 | 6.08 |
| 79 | 3 | 4 | 7 | 7 | 9 | 6 | 1.73 | 8.65 | 50 | 20 | 30 | 5.76 | 7.8 | 18.85 | 73.35 | M | 9.1 | 6.46 | 3.84 | 5.88 |
| 80 | 7 | 3 | 13 | 4 | 6 | 6.6 | 3.04 | 15.2 | 70 | 10 | 20 | 7.33 | 1.6 | 46.7 | 51.7 | M | 8.5 | | | |
| 81 | 3 | 3 | 3 | 3 | 3 | 3 | 7 | 3.5 | 40 | 40 | 20 | 2.88 | 6.1 | 35. | 58.9 | SM | 8.65 | 6.59 | 3.52 | 5.58 |
| 82 | | | | | | | | | | | | | | | | | | | | |
| 83 | 5 | 13 | 8 | 5 | 12 | 8.6 | 2.38 | 11.9 | 60 | 20 | 20 | 8.25 | 5.1 | 16.5 | 78.65 | SM | 10.55 | | | |
| 83A | 7 | 9 | 12 | 12 | 10 | 10 | 1.61 | 8.05 | 30 | 50 | 20 | 9.60 | 11.25 | 18.5 | 70.25 | SM | 10.15 | | | |
| 84 | 1 | 1 | 6 | 3 | 4 | 3 | 1.2 | 6. | | | | | 8.6 | 39. | 52.4 | SM | 10.5 | | | |
| 87 | 14 | 16 | 25 | 20 | 17 | 18.4 | 3.86 | 19.3 | 80 | 10 | 10 | 20.4 | 1.4 | 13. | 85.6 | ML | 10.25 | 7.44 | 3.44 | 5.67 |
| 88 | 27 | 17 | 30 | 20 | 28 | 24.4 | 2.92 | 14.6 | 20 | 30 | 50 | 21.47 | 5.6 | 25.5 | 68.9 | ML | 8.3 | | | |
| 89 | 14 | 6 | 17 | 7 | 10 | 10.8 | 2.62 | 13.1 | 70 | 20 | 10 | 11.99 | 2. | 19.75 | 78.25 | M | 8.75 | 6.89 | 3.60 | 5.76 |
| 97 | 7 | 3 | 7 | 5 | 5 | 5.4 | 2.33 | 11.65 | 60 | 20 | 20 | 5.18 | 4.1 | 27.5 | 68.4 | ML | 10.1 | | | |
| 98 | 5 | 11 | 12 | 6 | 7 | 8.2 | 2. | 10.00 | 40 | 10 | 50 | 7.87 | 7. | 9. | 84. | SM | 12.3 | 6.09 | 3.68 | 5.72 |
| 148 | 12 | 10 | 8 | 9 | 8 | 9.4 | 2.27 | 11.35 | 80 | 10 | 10 | 10.43 | 6.5 | 44. | 49.5 | M | 11.15 | | | |
| 156 | 9 | 11 | 6 | 5 | 9 | 8 | 1.95 | 9.75 | 70 | 20 | 10 | 8.88 | 4.4 | 37. | 58.6 | ML | 8.5 | 6.67 | 3.52 | 5.80 |
| 157 | 9 | 9 | 8 | 17 | 9 | 10.4 | 2.34 | 11.7 | 70 | 10 | 20 | 11.54 | 5.75 | 38.6 | 55.65 | ML | 8.4 | | | |
| 158 | 6 | 5 | 7 | 9 | 7 | 6.8 | 2.32 | 11.6 | 80 | 5 | 15 | 7.55 | 4.6 | 14.78 | 80.65 | SM | 7.9 | 6.98 | 3.44 | 5.92 |
| 159 | 7 | 5 | 6 | 3 | 8 | 5.8 | 1.23 | 6.15 | 60 | 20 | 20 | 5.57 | 6.15 | 21.35 | 72.5 | SM | 7.7 | 7.62 | 3.36 | 5.46 |
| 160 | 5 | 2 | 3 | 4 | 3 | 3.4 | 1.13 | 5.65 | 60 | 30 | 10 | 3.26 | 5.5 | 44.5 | 50. | SM | 9.05 | 8.29 | 3.28 | 5.46 |
| 162 | 4 | 6 | 5 | 5 | 3 | 4.6 | 2. | 10. | 80 | 10 | 10 | 5.1 | 4.55 | 15.7 | 79.75 | M | 8. | | | |

Table 3 (cont.)

| No. | Count 1 | 2 | 3 | 4 | 5 | Ave. | Seeds Gram | % | Dark Est.% | Med. by count | Light | % of seeds calculated from counts | % Stems, Leaves | Cones % Whole | Brk'n | Size | Per cent Strigs | Color Hue | Chro-ma | Brilliance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 163 | 5 | 7 | 7 | 5 | 4 | 5.6 | 2.58 | 12.9 | 80 | 10 | 10 | 6.22 | 3.1 | 25.8 | 71.1 | | 8.1 | 7.11 | 3.60 | 5.67 |
| 166 | 4 | 3 | 9 | 4 | 6 | 5.2 | 2.1 | 10.5 | 80 | 10 | 10 | 5.77 | 7. | 19.5 | 73.5 | M | 7.25 | 7.09 | 4.40 | 6.28 |
| 167 | 6 | 3 | 6 | 9 | 8 | 6.4 | 1.44 | 7.2 | 60 | 10 | 30 | 6.14 | 7.85 | 31.65 | 60.5 | M | 8.6 | 7.00 | 4.00 | 6.00 |
| 168 | 4 | 2 | 6 | 1 | 5 | 3.6 | .9 | 4.5 | 80 | 0 | 20 | 4.00 | 7.6 | 43.65 | 48.75 | ML | 8.65 | 6.33 | 3.92 | 6.08 |
| 169 | 0 | 7 | 8 | 4 | 4 | 4.6 | 1.8 | 9. | 60 | 10 | 30 | 4.42 | 9.5 | 27.5 | 63. | ML | 8.5 | | | |
| 170 | 3 | 4 | 7 | 7 | 10 | 6.2 | 2.37 | 11.85 | 70 | 20 | 10 | 6.88 | 3.8 | 33.8 | 62.4 | M | 8.9 | | | |
| 171 | 4 | 6 | 6 | 4 | 6 | 5.2 | 1.47 | 7.35 | 50 | 40 | 10 | 4.99 | 3.25 | 7.1 | 89.65 | S | 10. | | | |
| 172 | 5 | 3 | 2 | 3 | 2 | 3.0 | .78 | 3.9 | 20 | 30 | 50 | 2.64 | 6.25 | 14. | 79.86 | M | 7.85 | | | |
| 174 | 10 | 8 | 8 | 10 | 13 | 9.8 | | | 60 | 20 | 20 | 9.41 | | | | | | 6.17 | 3.76 | 5.88 |
| 175 | 3 | 4 | 5 | 7 | 9 | 5.6 | 2.4 | 12. | 30 | 40 | 30 | 4.93 | 1.25 | 28.6 | 70.15 | M | 9.5 | | | |
| 176 | 12 | 14 | 16 | 7 | 17 | 13.2 | 2.5 | 12.5 | 70 | 10 | 20 | 14.65 | 5.75 | 45 | 49.25 | M | 9. | 6.60 | 4.00 | 6.12 |
| 185 | 1 | 4 | 2 | 3 | 1 | 2.2 | .52 | 2.6 | 70 | 15 | 15 | 2.44 | 11.35 | 28.75 | 59.9 | | 6.35 | | | |
| 187 | 16 | 9 | 20 | 23 | 12 | 16 | 2.7 | 13.5 | 60 | 20 | 20 | 15.36 | 3.75 | 37.5 | 59. | M | 7.5 | 6.80 | 4.00 | 6.08 |
| 188 | 4 | 4 | 9 | 7 | 9 | 6.6 | 1.24 | 6.2 | 30 | 40 | 30 | 5.81 | 2.37 | 8.5 | 89.13 | M | 4.7 | 5.51 | 3.92 | 6.00 |
| 189 | 8 | 4 | 8 | 6 | 10 | 7.2 | 1.22 | 6.1 | 70 | 10 | 20 | 7.99 | 7.5 | 20.25 | 72.25 | S | 5.7 | 5.56 | 3.60 | 5.67 |
| 190 | | | | | | 6.32 | 1.48 | 7.4 | | | | | 11.84 | 38.6 | 49.56 | M | 6.1 | | | |
| 191 | 3 | 1 | 3 | 8 | 4 | 3.8 | 1.85 | 9.25 | 75 | 5 | 20 | 4.22 | 7.3 | 27.4 | 65.3 | | 7.9 | 5.64 | 3.12 | 5.22 |
| 192 | 2 | 5 | 2 | 4 | 4 | 3.4 | .67 | 3.35 | 40 | 30 | 30 | 3.26 | 5.8 | 35.5 | 58.7 | | 4.7 | | | |
| 193 | 3 | 3 | 4 | 2 | 2 | 2.8 | .68 | 3.4 | 60 | 10 | 30 | L. seeds 2.69 | 5.2 | 29.3 | 65.5 | | 5.5 | 7.27 | 3.52 | 5.50 |
| 194 | 7 | 3 | 2 | 3 | 6 | 4.2 | .84 | 4.2 | 70 | 15 | 15 | L. seeds 4.66 | 4.25 | 43.5 | 52.25 | SM | 6.7 | | | |
| 195 | 7 | 5 | 8 | 7 | 15 | 8.4 | 2.9 | 14.5 | 70 | 20 | 10 | 9.32 | 7.75 | 21.9 | 70.35 | M | 6.4 | 6.98 | 3.44 | 5.63 |
| 196 | 8 | 10 | 13 | 10 | 16 | 11.4 | 4.3 | 21.5 | 60 | 20 | 20 | 10.94 | 7.65 | 34.35 | 58. | S | 6.65 | | | |
| 197 | 14 | 9 | 8 | 10 | 15 | 11.2 | 2.02 | 10.1 | 10 | 20 | 70 | 9.86 | 10. | 10.2 | 79.8 | | 1.12 | 7.84 | 4.08 | 5.96 |
| 198 | 27 | 18 | 27 | 20 | 23 | 22.4 | 2.94 | 14.7 | 10 | 30 | 60 | 19.71 | 2.5 | 9.2 | 88.3 | M | 10.55 | 8.16 | 3.92 | 5.84 |
| 199 | 12 | 6 | 10 | 9 | 6 | 8.6 | 1.97 | 9.85 | 20 | 60 | 20 | 7.57 | 2.5 | 20.3 | 77.2 | M | 11. | 7.24 | 4.64 | 6.38 |
| 200 | 10 | 9 | 4 | 14 | 5 | 8.5 | 3.67 | 18.35 | 60 | 20 | 20 | 8.16 | 5.3 | 19. | 75.7 | M | 10.75 | 6.85 | 4.32 | 6.08 |
| 201 | 9 | 2 | 11 | 6 | 11 | 7.8 | 1.32 | 6.6 | 60 | 10 | 30 | 7.49 | 2.55 | 7.5 | 89.95 | MS | 5.65 | 6.74 | 3.68 | 5.88 |
| 202 | 6 | 14 | 15 | 14 | 12 | 12.2 | 1.42 | 7.1 | 80 | 10 | 10 | 13.54 | 3. | 24.5 | 72.5 | | | | | |
| 203 | 28 | 26 | 35 | 23 | 19 | 26.2 | 5.00 | 25.00 | 80 | 10 | 10 | 29.08 | 1.75 | 22.25 | 76. | M | 7.25 | 6.28 | 3.44 | 5.63 |
| 207 | 9 | 12 | 14 | 13 | 8 | 10.8 | 2.45 | 12.25 | 75 | 10 | 15 | 11.99 | 5. | 20. | 75 | M | 13.1 | 6.53 | 3.92 | 5.92 |
| 208 | 11 | 5 | 13 | 11 | 10 | 10 | 2.35 | 11.75 | 80 | 10 | 10 | 11.10 | 6.25 | 31.9 | 61.6 | L | 9.25 | 5.96 | 3.76 | 5.80 |
| 209 | 15 | 16 | 12 | 13 | 13 | 13.8 | 1.7 | 8.5 | 30 | 60 | 10 | 12.14 | 5. | 17. | 78. | ML | 7. | | | |
| 213 | 3 | 9 | 11 | 7 | 10 | 8. | 2.2 | 11 | 75 | 15 | 10 | 8.88 | 2. | 19.5 | 78.5 | S | 9.15 | 6.28 | 3.44 | 5.63 |
| 215 | 25 | 25 | 27 | 17 | 25 | 23.8 | 4. | 20. | 70 | 20 | 10 | 26.42 | 1.25 | 17. | 81.75 | M | 10 | | | |
| 216 | 18 | 16 | 11 | 11 | 10 | 13.2 | 2.75 | 13.75 | 50 | 10 | 40 | 12.67 | 5. | 23. | 72. | ML | 10.75 | 7.45 | 3.76 | 5.84 |
| 217 | 14 | 5 | 11 | 5 | 11 | 9.2 | 2.47 | 12.35 | 50 | 10 | 40 | 8.83 | 2.75 | 34.2 | 63.05 | M | 8.5 | | | |
| 218 | 10 | 7 | 13 | 9 | 12 | 10.2 | 3. | 15. | 80 | 10 | 10 | 11.32 | 2.25 | 28.38 | 69.37 | M | 11. | 6.51 | 3.44 | 5.54 |

Table 3 (cont.)

| No. | Count 1 | 2 | 3 | 4 | 5 | Ave. | Seeds Gram | % | Dark Est.% | Med. | Light by count | % of seeds calculated from counts | % Stems, Leaves | Cones % Whole | Brk'n | Size | Per cent Strigs | Color Hue | Chroma | Brilliance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 219 | 12 | 15 | 15 | 12 | 9 | 12.6 | 1.55 | 7.75 | 30 | 40 | 30 | 11.09 | 4.75 | 17.25 | 78. | S | 10.8 | | | |
| 220 | 15 | 14 | 15 | 13 | 11 | 13.6 | 3.45 | 17.25 | 70 | 10 | 20 | 15.09 | 2.63 | 23.25 | 74.12 | ML | 8.6 | 5.68 | 3.52 | 5.63 |
| 221 | 14 | 12 | 12 | 13 | 17 | 13.6 | | | 80 | 10 | 10 | 15.09 | | | | | | | | |
| 228 | 7 | 8 | 9 | 12 | 6 | 8.4 | 2.62 | 13.1 | 80 | 10 | 10 | 9.32 | 4.38 | 9.38 | 86.24 | SM | 12.55 | 7.00 | 4.00 | 5.96 |
| 232 | 6 | 7 | 7 | 0 | 3 | 4.6 | 1.32 | 6.6 | 70 | 20 | 10 | 5.10 | 6.25 | 28.5 | 65.25 | S | 12.5 | | | |
| 233 | 4 | 3 | 3 | 5 | 5 | 4. | 1.19 | 5.95 | 60 | 10 | 30 | 3.84 | 10.75 | 29.6 | 59.65 | M | 9.75 | 6.67 | 3.36 | 5.46 |
| 235 | 5 | 8 | 6 | 5 | 4 | 5.6 | 1.25 | 6.25 | 70 | 20 | 10 | 6.22 | 3.5 | 72.0 | 24.5 | L | 8.2 | 8.67 | 3.60 | 5.67 |
| 241 | 15 | 8 | 13 | 18 | 14 | 11.6 | 2.45 | 12.25 | 80 | 10 | 10 | 12.88 | 6.25 | 47.05 | 46.7 | M | 7.25 | 5.83 | 3.84 | 5.88 |
| 242 | 10 | 11 | 3 | 10 | 5 | 7.8 | 1.76 | 8.8 | 40 | 30 | 30 | 7.49 | 7. | 32.5 | 60.5 | MS | 8.65 | 6.96 | 3.68 | 5.88 |
| 243 | 28 | 25 | 30 | 21 | 19 | 24.6 | 3.98 | 19.9 | 60 | 30 | 10 | 23.61 | 5.5 | 30.35 | 64.15 | | 8.6 | | | |
| 247 | 12 | 22 | 13 | 17 | 20 | 16.8 | 3.03 | 15.15 | 30 | 50 | 20 | 14.78 | 6.25 | 30. | 63.75 | M | 7.75 | 6.30 | 3.68 | 5.84 |
| 249 | 8 | 9 | 14 | 12 | 7 | 10. | 2.09 | 10.45 | 20 | 40 | 40 | 8.88 | 6. | 38. | 56. | SM | 7.7 | 5.61 | 3.28 | 5.46 |
| 251 | 12 | 8 | 11 | 10 | 13 | 10.8 | 2.38 | 11.9 | 60 | 30 | 10 | 10.37 | 5. | 22.5 | 72.5 | M | 8.65 | 6.28 | 3.44 | 5.84 |
| 252 | 16 | 16 | 22 | 14 | 5 | 12.6 | 2.6 | 13. | 45 | 45 | 10 | 12.10 | 4. | 28.7 | 67.3 | M | 7.25 | | | |
| 253 | 10 | 7 | 13 | 19 | 13 | 10.4 | 2.1 | 10.5 | 70 | 15 | 15 | 11.54 | 1. | 59. | 40. | S | 8.35 | 7.65 | 4. | 5.92 |
| 265 | 4 | 4 | 9 | 4 | 2 | 4.6 | 1.15 | 5.75 | 60 | 30 | 10 | 4.42 | 12.5 | 28.1 | 59.4 | M | 7.9 | | | |
| 266 | 11 | 9 | 3 | 10 | 7 | 8. | 1.8 | 9. | 10 | 60 | 30 | 7.04 | 6. | 59. | 35. | L | 9.55 | 7.78 | 4.32 | 5.88 |
| 281 | 6 | 2 | 4 | 6 | 4 | 4.4 | .98 | 4.9 | 70 | 20 | 10 | 4.68 | 5.9 | 48.65 | 45.45 | M | 7.4 | | | |
| 284 | 10 | 15 | 7 | 7 | 10 | 9.8 | 1.55 | 7.75 | 10 | 30 | 60 | 8.62 | 14.8 | 41.5 | 44.7 | L | 9.25 | 6.17 | 3.76 | 5.88 |
| 292 | 16 | 14 | 12 | 9 | 16 | 13.4 | 2.52 | 12.6 | 40 | 30 | 30 | 12.86 | 5.25 | 50.47 | 44.28 | LM | 4.85 | 6.25 | 3.84 | 5.84 |
| 301 | 17 | 7 | 11 | 13 | 16 | 12.8 | 3.14 | 15.7 | 60 | 30 | 10 | 12.29 | 6. | 34. | 60. | MS | 7.15 | 7.04 | 3.52 | 5.94 |
| 317 | 11 | 8 | 8 | 10 | 8 | 9. | 2. | 10. | 80 | 10 | 10 | 9.99 | 8.9 | 22.5 | 68.6 | M | 5.65 | 7.11 | 3.60 | 5.76 |
| 319 | 13 | 6 | 7 | 4 | 10 | 8. | 2.7 | 13.5 | 60 | 20 | 20 | 7.68 | 8.6 | 20.7 | 70.7 | S | 8.1 | | | |
| 320 | | | | | | 4.8 | 1.92 | 9.6 | 80 | 10 | 10 | 5.33 | 10. | 41.5 | 48.5 | M | 8.85 | 6.25 | 3.20 | 5.46 |
| 332 | 36 | 28 | 38 | 23 | 18 | 28.6 | 3.71 | 18.55 | 70 | 10 | 20 | S. seeds 31.74 | 2.5 | 26. | 71.5 | MS | 7.9 | | | |
| 339 | 9 | 16 | 9 | 18 | 12 | 13. | 2.53 | 12.65 | 70 | 20 | 10 | 14.43 | 5.4 | 23.85 | 70.75 | ML | 6.5 | | | |
| 356 | 12 | 14 | 7 | 10 | 6 | 9.8 | 1.53 | 7.65 | 75 | 10 | 15 | 10.88 | 3.75 | 50 | 46.25 | M | 8.7 | 7.96 | 3.52 | 5.76 |
| 360 | 7 | 7 | 14 | 12 | 6 | 9.2 | 1.82 | 9.1 | 80 | 10 | 10 | 10.21 | 2.53 | 26.6 | 70.87 | M | 6.65 | 6.19 | 3.36 | 5.67 |
| 374 | 18 | 10 | 10 | 6 | 15 | 11.8 | 2.9 | 14.5 | 80 | 15 | 5 | 13.10 | 8 | 45 | 47 | S | 7 | | | |
| 396 | 2 | 1 | 2 | 3 | 2 | 2. | .29 | 1.45 | 20 | 30 | 50 | 1.76 | 7.85 | 61.95 | 30.2 | M | 4.1 | | | |
| 403 | 14 | 9 | 7 | 12 | 8 | 10. | 1.8 | 9. | 40 | 50 | 10 | 9.60 | 5 | 46.5 | 48.5 | MS | 8.85 | 6.10 | 3.28 | 5.40 |
| 406 | 9 | 14 | 14 | 10 | 15 | 12.4 | 3.05 | 15.25 | 80 | 10 | 10 | 13.76 | 5.6 | 30.25 | 64.15 | ML | 8.85 | 7.73 | 3.52 | 5.84 |
| 410 | 15 | 9 | 18 | 14 | 20 | 15.2 | 3.02 | 15.1 | 80 | 10 | 10 | 16.87 | 4.5 | 32 | 63.5 | MS | 9. | | | |
| 454 | 5 | 3 | 5 | 4 | 6 | 4.6 | 1.27 | 6.35 | 80 | 10 | 10 | 5.11 | 7. | 56 | 37 | - | 8.25 | 6.04 | 3.84 | 5.96 |
| 455 | 5 | 7 | 9 | 10 | 5 | 7.2 | 1.35 | 6.7 | 80 | 10 | 10 | 7.99 | 4.9 | 37.5 | 57.6 | S | 6 | | | |
| 459 | 14 | 7 | 16 | 11 | 6 | 10.8 | 1.95 | 9.75 | 70 | 10 | 20 | 11.99 | 8.25 | 48.1 | 43.65 | ML | 7.25 | 5.80 | 4.00 | 5.88 |

Table 3 (cont.)

| No. | Count 1 | 2 | 3 | 4 | 5 | Ave. | Seeds Gram | % | Dark Est.% | Med. by | Light count | % of seeds calculated from counts | % Stems, leaves | Cones % Whole | Brk'n | Size | Per cent Strigs | Color Hue | Chroma | Brilliance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 468 | 15 | 10 | 8 | 12 | 12 | 11.4 | 1.45 | 7.25 | 60 | 30 | 10 | 10.94 | 8.9 | 25.4 | 65.7 | ML | 6.1 | | | |
| 485 | 10 | 7 | 11 | 10 | 14 | 10.4 | 1.4 | 7 | 60 | 20 | 20 | 9.98 | 5.02 | 50.65 | 44.33 | L | 7.15 | 6.33 | 3.92 | 5.92 |
| 495 | 5 | 3 | 5 | 7 | 8 | 5.6 | 1.8 | 9 | 50 | 40 | 10 | 5.38 | 5.25 | 45. | 49.75 | MS | 5.85 | | | |
| 502 | 13 | 10 | 12 | 16 | 14 | 13.0 | 2.3 | 11.5 | 10 | 20 | 70 | 11.44 | 5.65 | 43.75 | 50.6 | ML | 7.25 | | | |
| 503 | 10 | 13 | 7 | 13 | 7 | 10 | 2.27 | 11.35 | 60 | 10 | 30 | 9.60 | 8.85 | 57.5 | 43.65 | SM | 7.95 | | | |
| 506 | 6 | 10 | 12 | 12 | 11 | 10.2 | 1.78 | 8.9 | 80 | 10 | 10 | 11.32 | 6. | 38.6 | | ML | 8.25 | | | |
| 507 | 5 | 4 | 3 | 5 | 4 | 4.2 | 1.6 | 8. | 70 | 20 | 10 | 4.66 | 9. | 48. | 43. | S | 7.65 | | | |
| 510 | 3 | 4 | 4 | 9 | 6 | 5.2 | 1.8 | 9. | 80 | 10 | 10 | 5.77 | 11.85 | 59.9 | 28.25 | M | 7. | | | |
| 512 | 7 | 8 | 10 | 14 | 12 | 10.2 | 2.42 | 12.1 | 30 | 20 | 50 | 8.98 | 2.75 | 18.25 | 79. | M | 8.25 | | | |
| 513 | 16 | 8 | 10 | 11 | 12 | 11.4 | 2.07 | 10.35 | 75 | 15 | 10 | 12.65 | 5.85 | 40.3 | 53.95 | M | 7.25 | 7.20 | 4.00 | 6.04 |
| 516 | 2 | 4 | 6 | 4 | 3 | 3.8 | .72 | 3.6 | | * | | | 8.65 | 24.6 | 66.75 | M | 6.05 | 9.39 | 3.92 | 5.92 |
| 519 | 31 | 29 | 22 | 35 | 30 | 29.4 | 3.75 | 18.75 | 80 | 10 | 10 | S. seeds 32.63 | 2.75 | 39.65 | 57.6 | ML | | 7.96 | 3.52 | 5.80 |
| 521 | 3 | 1 | 3 | 2 | 1 | 2. | .31 | 1.55 | | * | | | 11.07 | 49.99 | 38.95 | SM | 3. | | | |
| 546 | 5 | 2 | 3 | 1 | 5 | 12.2 | 2.42 | 12.1 | 40 | 10 | 50 | 11.71 | 4.1 | 43.9 | 52. | M | 8.45 | 4.24 | 4.16 | 5.97 |
| 547 | 12 | 10 | 11 | 14 | 15 | 10.4 | 2.52 | 12.6 | 30 | 40 | 30 | | 7.5 | 51.95 | 40.55 | ML | 8.35 | | | |
| 552 | 26 | 24 | 28 | 28 | 22 | 25.6 | 4.03 | 20.15 | 75 | 15 | 10 | S. seeds 28.42 | 2.1 | 41.35 | 56.55 | SM | | 3.54 | 3.84 | 5.92 |
| 566 | 9 | 7 | 6 | 4 | 5 | 6.2 | 1.35 | 6.7 | 60 | 10 | 30 | 5.95 | 7.5 | 46 | 46.5 | MS | | | | |
| 587 | 12 | 9 | 11 | 10 | 9 | 10.2 | 2.02 | 10.1 | 50 | 30 | 20 | 9.79 | 7.15 | 34.9 | 57.95 | ML | 5.6 | | | |
| 609 | 6 | 5 | 8 | 8 | 6 | 6.6 | 1.44 | 7.2 | 60 | 15 | 25 | 6.33 | 11.15 | 51. | 37.85 | ML | 6.4 | | | |
| 610 | 4 | 6 | 5 | 10 | 9 | 6.8 | 1.53 | 7.65 | 60 | 30 | 10 | 6.53 | 6.8 | 38.6 | 54.6 | SM | 7.15 | 7.55 | 3.92 | 5.96 |
| 611 | 8 | 10 | 12 | 7 | 9 | 9.2 | 2.05 | 10.25 | 40 | 40 | 20 | 8.83 | 4.5 | 46. | 49.5 | M | | | | |
| 619 | 15 | 15 | 17 | 13 | 20 | 16. | 2.77 | 13.85 | 60 | 10 | 30 | 15.36 | 7.6 | 38. | 54.4 | SM | 7.25 | 6.73 | 3.92 | 5.92 |
| 550A | 15 | 11 | 15 | 6 | 12 | 11.8 | 2.05 | 10.25 | 20 | 30 | 50 | 10.38 | 6.25 | 21.75 | 72 | M | 7.65 | | | |
| 550B1 | 9 | 7 | 16 | 10 | 12 | 10.8 | 2.32 | 11.6 | 70 | 10 | 20 | 12.10 | 11.25 | 30.8 | 57.95 | | 7.25 | | | |
| 550B2 | 10 | 7 | 14 | 12 | 14 | 11.4 | 2.5 | 12.5 | 70 | 20 | 10 | 12.65 | 6.25 | 31.25 | 62.5 | | 5.25 | | | |
| 550B3 | 8 | 11 | 10 | 11 | 4 | 8.8 | 3.15 | 15.75 | 60 | 30 | 10 | 8.45 | 4.5 | 19.25 | 76.25 | | 4.75 | | | |

* Couldn't read, because of sample condition.

Table 4

Analyses of Hop Samples Obtained from the T. A. Livesley Co. - 1937

| | Counts | | | | | | Seeds | | | % Seeds Computed from Counts | % Leaves Stems | Cones | | | Strigs | Color | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | 1 | 2 | 3 | 4 | 5 | Ave. | Gr. | % | D-M-L | | | Whole | Broken | Size | | Hue | Chroma | Br. | |
| | | | | | | | | | | | | | | | | 7.12 | 4.16 | 6.24 | |
| 1A | 3 | 5 | 4 | 9 | 5 | 5.2 | 1.63 | 8.15 | 20-50-30 | 4.58 | 3.3 | 41. | 55.8 | L | 8 | 7.78 | 3.60 | 6.32 | Ave. |
| 1A1 | 4 | 9 | 8 | 11 | 6 | 7.4 | 2 | 10. | 10-10-80 | 6.51 | 3.5 | 38.5 | 58 | M-L | 9 | | | | |
| 1A2 | 3 | 6 | 6 | 8 | 7 | 6. | 1.68 | 8.4 | 20-20-60 | 5.28 | 4.25 | 43.5 | 52.25 | L | 7.95 | | | | |
| 1A3 | 4 | 12 | 12 | 11 | 9 | 9.6 | 1.91 | 8.55 | 10-30-60 | 8.45 | 2.5 | 18.5 | 79. | M | 6.7 | 8.80 | 4.00 | 6.31 | |
| 1A4 | 7 | 8 | 7 | 7 | 5 | 6.8 | 1.51 | 7.55 | 10-20-70 | 5.98 | 4.7 | 21.5 | 74.8 | M-S | 9.2 | 7.45 | 3.68 | 6.04 | |
| 2A | 7 | 14 | 10 | 5 | 14 | 10 | 2.05 | 10.25 | 40-40-20 | 9.60 | 3. | 43.5 | 53.5 | L | 8.4 | 7.29 | 3.84 | 5.88 | Ave. |
| | | | | | | | | | | | | | | | | 7.92 | 3.84 | 6.00 | |
| 3A | 12 | 10 | 16 | 16 | 9 | 12.6 | 2.88 | 14.4 | 50-20-30 | 12.10 | 5.75 | 18.25 | 76. | S M | 8.7 | 6.36 | 3.52 | 5.63 | |
| 4A | 19 | 6 | 11 | 14 | 8 | 11.6 | 2.37 | 11.85 | 40-30-30 | 11.14 | 4.5 | 28.8 | 66.7 | M L | 10.5 | 6.53 | 3.92 | 5.84 | |
| 5A | 8 | 6 | 9 | 18 | 12 | 10.6 | 2.58 | 12.9 | 60-20-20 | 10.18 | 3.4 | 31.4 | 65.2 | M | 9.8 | | | | |
| 6A | 2 | 5 | 5 | 6 | 2 | 4 | .87 | 4.35 | 75-15-10 | 4.44 | 8.25 | 30. | 61.75 | SM | 9.25 | | | | |
| 7A | 11 | 5 | 7 | 7 | 7 | 7.4 | 2.08 | 10.4 | 50-20-30 | 7.10 | 10. | 40. | 50. | M | 10 | 8.09 | 3.76 | 6.08 | |
| 8A | 15 | 22 | 20 | 11 | 15 | 16.6 | 3.85 | 19.25 | 50-40-10 | 15.94 | 3.3 | 27. | 69.7 | S | 8.7 | 7.44 | 3.44 | 5.72 | |
| 9A | 10 | 6 | 7 | 5 | 8 | 7.2 | .8 | 4. | 40-50-10 | 6.91 | 7.7 | 18. | 74.3 | ML | 3.5 | 6.47 | 4.08 | 6.10 | |
| | | | | | | | | | | | | | | | | 7.08 | 3.84 | 5.96 | Ave. |
| $9A_1$ | 11 | 11 | 12 | 8 | 18 | 12. | 2.9 | 14.5 | 70-20-10 | 13.32 | 5.25 | 14.5 | 80.45 | M | 9.5 | 6.73 | 3.92 | 5.92 | |
| $9A_2$ | | | | | | | | | | | | | | | | | | | |
| 10A | 3 | 6 | 6 | 9 | 6 | 6 | 1.63 | 8.15 | 70-10-20 | 6.66 | 8.75 | 9.3 | 81.95 | MS | 9.55 | 7.76 | 3.92 | 5.96 | |
| $10A_1$ | 3 | 7 | 6 | 5 | 5 | 5.2 | 1.92 | 9.6 | 50-40-10 | 4.99 | 8.9 | 15.7 | 75.4 | M | 8.05 | 7.55 | 3.92 | 6.00 | |
| $10A_2$ | 3 | 15 | 4 | 5 | 17 | 8.8 | 1.85 | 9.2 | | | 8.3 | 35.95 | 55.75 | LM | 6.7 | | | | |
| 11A | 0 | 2 | 0 | 3 | 3 | 1.6 | .51 | 2.55 | 30-40-30 | 1.41 | 5.05 | 53.1 | 41.85 | L | 8.35 | 7.39 | 3.68 | 5.80 | |
| $11A_1$ | 1 | 4 | 2 | 1 | 2 | 2. | .5 | 2.5 | 20-60-20 | 1.76 | 4. | 47.5 | 48.5 | M | 6. | | | | |
| $11A_2$ | 3 | 2 | 1 | 2 | 2 | 2. | | | 20-20-60 | 1.76 | | | | | | | | | |
| 12A | 9.6 | 7.2 | 10.8 | 9 | 8.4 | 9.1 | 1.88 | 9.4 | 40-50-10 | 8.74 | 5.95 | 33.89 | 60.16 | M | 6.11 | 7.02 | 3.96 | 6.00 | Not |
| 13A | 15 | 12 | 10 | 10 | 6 | 12.6 | 2.75 | 13.75 | 60-30-10 | 12.10 | 7.25 | 28.5 | 64.75 | ML | 13.3 | 6.33 | 3.92 | 6.12 | |
| | | | | | | | | | | | | | | | | 6.40 | 4.00 | 6.08 | Ave. |
| $13A_1$ | 17 | 4 | 8 | 9 | 3 | 6.2 | | | 60-30-10 | 5.95 | | | | | | | | | Not |
| 14A | 6 | 6 | 4 | 4 | 7 | 5.4 | 1.36 | 6.8 | 10-30-60 | | 5 | 27.7 | 67.5 | S | 9.8 | 6.89 | 3.60 | 5.84 | |
| 15A | 3 | 8 | 8 | 8 | 5 | 6.4 | | | 60-20-20 | 6.14 | | | | | | 6.67 | 3.60 | 5.84 | Not |

Table 4 (cont.)

| No. | Counts 1 | 2 | 3 | 4 | 5 | Ave. | Seeds Gr. | % | D-M-L | % Seeds computed from counts | % Leaves stems | Cones Whole | Broken | Size | Strigs | COLOR Hue | Chroma | Br. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16A | 20 | 21 | 14 | 13 | 7 | 15. | 3.27 | 16.35 | 60-30-10 | 14.40 | 6. | 11. | 83. | M | 9. | 7.96 | 3.52 | 5.67 | |
| | | | | | | | | | | | | | | | | 8.41 | 3.52 | 5.67 | Ave. |
| 17A | 18 | 16 | 14 | 22 | 14 | 16.8 | 3.3 | 16.5 | 70-20-10 | 18.65 | 2.6 | 22.5 | 74.9 | M | 8.25 | | | | |
| 17A1 | 21 | 21 | 17 | 16 | 19 | 18.8 | 3.9 | 19.5 | 80-10-10 | 20.87 | 2.25 | 38.7 | 59.05 | - | 9.7 | | | | |
| 18A | 3 | 6 | 5 | 5 | 5 | 4.8 | 1.3 | 6.5 | 60-30-10 | 4.61 | 9.75 | 20.5 | 69.75 | SM | 9.05 | | | | |
| 18A1 | 11 | 11 | 8 | 13 | 7 | 10 | 1.9 | 9.5 | 60-30-10 | 9.60 | 5.7 | 10.9 | 83.7 | | 6.6 | | | | |
| 19A | | | | | | | | | 70-15-15 | | | | | | | 6.47 | 4.08 | 6.08 | |
| 20A | 11 | 13 | 18 | 10 | 11 | 12.6 | 2.65 | 13.2 | 60-20-20 | 12.10 | 6.3 | 23.7 | 70 | M | 8. | | | | |
| 21A | 8 | 12 | 14 | 5 | 15 | 10.8 | 3.1 | 15.5 | 80-10-10 | 11.99 | 4.4 | 22.65 | 72.95 | - | 8.2 | 4.53 | 4.16 | 6.20 | |
| 21A1 | 13 | 9 | 10 | 12 | 18 | 10.4 | 3.3 | 16.5 | 80-10-10 | 11.54 | 3.9 | 23.1 | 73 | MS | 7.7 | | | | |
| 22A | 9 | 12 | 15 | 10 | 10 | 11.2 | 2.1 | 10.5 | 30-60-10 | 9.86 | 5.9 | 28.7 | 65.4 | - | 1.2 | 6.54 | 4.16 | 6.12 | |
| 23A | 9 | 8 | 12 | 6 | 9 | 8.8 | 2.2 | 11 | 45-35-20 | 8.45 | 6.2 | 39.8 | 53. | - | 7. | 6.67 | 3.60 | 5.67 | |
| 24A | 9 | 7 | 12 | 6 | 12 | 9.2 | 1.8 | 9 | 50-40-10 | 8.83 | 5.75 | 38.3 | 55.95 | - | 6.5 | 6.78 | 4.08 | 6.12 | |
| | | | | | | | | | | | | | | | | 6.48 | 4.32 | 6.32 | Ave. |
| 25A | 17 | 16 | 16 | 13 | 9 | 14.5 | 2.75 | 13.7 | 60-30-10 | 13.92 | 5.5 | 23.3 | 71.2 | MS | 7.5 | | | | |
| 26A | 14 | 10 | 10 | 7 | 15 | 11.2 | 3.35 | 16.75 | 70-20-10 | 12.43 | 3.5 | 32.2 | 74.3 | M | 1.1 | 6.96 | 3.68 | 5.92 | |
| | | | | | | | | | | | | | | | | 7.36 | 4.24 | 6.16 | Ave. |
| 27A | 8 | 6 | 4 | 10 | 4 | 6.4 | .75 | 3.75 | 80-10-10 | 7.10 | 9.3 | 38.3 | 52.4 | M | 4.5 | 7.96 | 3.92 | 6.04 | |
| 28A | 4 | 4 | 13 | 6 | 11 | 7.6 | 2.45 | 12.25 | 60-20-20 | 7.30 | 8.4 | 30.6 | 61. | MS | 6. | 7.04 | 4.32 | 6.16 | |
| 28A1 | 4 | 15 | 9 | 10 | 14 | 10.4 | 2.22 | 11.1 | 70-20-10 | 11.54 | 9.6 | 37.8 | 52.6 | M | 6.9 | | | | |
| 29A | 13 | 7 | 16 | 15 | 17 | 13.6 | 2.44 | 12.2 | 30-20-50 | 11.97 | 3.8 | 38.7 | 57.5 | M | 5.8 | 7.76 | 3.92 | 6.08 | |
| 29A1 | 24 | 16 | 23 | 18 | 14 | 19 | 2.5 | 12.5 | 50-30-20 | 18.24 | 2.5 | 29.5 | 68 | L | 6.5 | 6.81 | 3.76 | 6.12 | |
| 29A2 | 19 | 13 | 22 | 10 | 11 | 15 | 2.36 | 11.8 | 70-20-10 | 16.65 | 4.5 | 35.5 | 60 | L | 5.5 | | | | |
| 30A | 24 | 13 | 10 | 14 | 13 | 14.8 | 2.04 | 10.2 | 10-70-20 | 13.02 | 10.9 | 28.15 | 60.95 | M | 7. | 6.82 | 3.52 | 5.72 | |
| | | | | | | | | | | | | | | | | 6.08 | 4.08 | 6.08 | Ave. |
| 30A1 | 10 | 6 | 8 | 9 | 7 | 8 | 1.9 | 9.5 | 40-40-20 | 7.68 | 12.5 | 32.95 | 54.55 | L | 7.7 | | | | |
| 31A | 4 | 5 | 7 | 14 | 12 | 8.4 | 1.56 | 7.8 | 40-20-40 | 8.06 | 3.25 | 31.4 | 65.35 | M | 7.7 | 6.54 | 4.16 | 6.16 | |
| | | | | | | | | | | | | | | | | 7.12 | 4.16 | 6.20 | Ave. |
| 31A1 | 9 | 10 | 11 | 6 | 14 | 10 | 1.56 | 7.8 | 40-20-40 | 9.60 | 4.75 | 27.65 | 67.6 | M | 8. | 7.27 | 4.40 | 6.31 | |
| 31A2 | 6 | 9 | 10 | 14 | 3 | 8.4 | 1.96 | 9.8 | 60-20-20 | 8.06 | 3.7 | 25. | 71.3 | M | 8.3 | 7.33 | 3.60 | 5.76 | |
| 32A | 12 | 4 | 6 | 8 | 10 | 8 | 1.98 | 9.9 | 30-50-20 | 7.04 | 8.8 | 24.5 | 66.7 | - | 8.1 | 6.33 | 3.92 | 6.08 | |
| 32A1 | 3 | 4 | 6 | 8 | 3 | 4.8 | 2.2 | 11 | 60-30-10 | 4.61 | 5.2 | 21. | 73.8 | M | 6.4 | | | | |
| 33A | 2 | 1 | 1 | 0 | 1 | 1 | .7 | 3.5 | 20-20-60 | 0.88 | 5.7 | 37 | 57.3 | M | 6. | 6.81 | 3.76 | 5.92 | |
| 33A1 | 2 | 1 | 3 | 0 | 0 | 1.2 | .5 | 2.5 | 60-20-20 | 1.15 | 7.7 | 38.1 | 54.2 | M | 7.4 | 7.12 | 4.16 | 5.92 | |
| 34A | 7 | 6 | 5 | 6 | 6 | 6 | 2.15 | 10.7 | 30-60-10 | 5.28 | 8.5 | 34 | 57.5 | ML | 7.7 | 8.00 | 4.00 | 6.08 | |
| 35A | 1 | 3 | 14 | 3 | 5 | 5.2 | .92 | 4.6 | 70-20-10 | 5.77 | 6.9 | 14 | 79.1 | M | 6.2 | | | | |

Table 4 (cont.)

| No. | Counts 1 | 2 | 3 | 4 | 5 | Ave. | Seeds Gr. | % | D-M-L | % Seeds computed from counts | % leaves stems | Cones Whole | Broken | Size | Strigs | Color Hue | Chroma | Br. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36A | 11 | 15 | 14 | 20 | 13 | 14.6 | 2.98 | 14.9 | 70-20-10 | 16.21 | 1.25 | 25.5 | 73.25 | ML | 8 | 7.40 | 4.00 | 6.00 | |
| 36A1 | 16 | 17 | 22 | 20 | 12 | 17.4 | 2.85 | 14.2 | 70-20-10 | 19.31 | 1.75 | 27.9 | 70.35 | M | 5.5 | | | | |
| 36A2 | 13 | 10 | 14 | 10 | 12 | 11.8 | 2.8 | 14 | 70-20-10 | 13.10 | 1.4 | 52.2 | 46.4 | M | 5.25 | 7.78 | 3.60 | 5.76 | |
| 36A3 | 11 | 9 | 8 | 9 | 8 | 9. | 2.36 | 11.8 | 70-20-10 | 9.99 | .2. | 55.3 | 42.7 | M | 7.8 | | | | |
| 37A | 14 | 18 | 17 | 12 | 15 | 15.2 | 3.02 | 15.1 | 60-30-10 | 14.59 | 1.25 | 35. | 63.75 | ML | 11.5 | 6.86 | 4.08 | 6.00 | |
| 37A1 | 17 | 16 | 19 | 14 | 15 | 16.2 | 3.5 | 17.5 | 60-30-10 | 15.55 | 2.5 | 45.5 | 52 | ML | 10.45 | | | | |
| 37A2 | 8 | 17 | 10 | 16 | 11 | 12.2 | 3.1 | 15.5 | 70-15-15 | 13.54 | 1.25 | 25.6 | 73.15 | M | 10.4 | 6.54 | 4.16 | 6. | |
| 37A3 | 14 | 10 | 11 | 15 | 14 | 12.8 | 3.02 | 15.1 | 80-10-10 | 14.21 | 2.25 | 39.5 | 58.25 | ML | 11 | | | | |
| 38A | 14 | 15 | 11 | 12 | 8 | 11 | 2 | 10 | 20-40-40 | 9.68 | 3.8 | 20.5 | 75.7 | M | 8.25 | 6.38 | 3.76 | 5.92 | |
| | | | | | | | | | | | | | | | | 6.82 | 3.52 | 5.96 | Ave. |
| 38A1 | 9 | 9 | 11 | 11 | 11 | 10.2 | 3 | 15 | 10-60-30 | 8.98 | 7.5 | 17.7 | 74.8 | M | 7.7 | | | | |
| 39A | 13 | 13 | 16 | 12 | 10 | 12.8 | 2.84 | 14.2 | 50-15-35 | 12.29 | 6. | 26.6 | 67.4 | ML | 10.35 | 7.97 | 3.92 | 5.67 | |
| 40A | 13 | 20 | 21 | 17 | 20 | 14 | | | 50-30-20 | 13.44 | | | | | | 7.40 | 4.00 | 6.20 | |
| 41A | 14 | 11 | 18 | 14 | 13 | 14 | 3.5 | 17.5 | 60-20-20 | 13.44 | 3. | 18.7 | 78.3 | SM | 10.5 | 6.40 | 4.00 | 6.10 | |
| 42A | 8 | 14 | 14 | 14 | 20 | 14 | 3.05 | 15.25 | 60-20-20 | 13.44 | 8.1 | 35.6 | 56.3 | M | 4.85 | 7.06 | 4.08 | 6.12 | |
| | | | | | | | | | | | | | | | | 7.17 | 4.24 | 6.20 | Ave. |
| 42A1 | 8 | 19 | 14 | 13 | 13 | 13.4 | 2.85 | 14.25 | 50-20-30 | 12.86 | 4.25 | 27.25 | 68.5 | M | 9.6 | 6.60 | 3.76 | 6.04 | |
| 43A | 8 | 10 | 5 | 7 | 12 | 8.4 | 1.3 | 6.5 | | | 9.3 | 28.5 | 62.2 | S | 6 | | | | Not |
| 43A1 | 6 | 6 | 5 | 5 | 5 | 5.4 | 1.2 | 6 | 70-20-10- | 5.99 | 14.5 | 27. | 58.5 | MS | 7.5 | | | | |
| 44A | 12 | 13 | 13 | 12 | 20 | 14 | 3.28 | 16.4 | 50-30-20 | 13.44 | 5 | 31.7 | 63.3 | M | 5.65 | | | | |
| 44A1 | 20 | 22 | 18 | 18 | 15 | 18.6 | 3.55 | 17.7 | 60-20-20 | 17.86 | 3.5 | 20. | 76.5 | SM | 5. | | | | |
| 45A | 7 | 8 | 7 | 12 | 7 | 8.2 | 1.34 | 6.7 | 30-30-40 | 7.22 | 8.9 | 53.5 | 37.6 | L | 7. | 6.40 | 4.00 | 6.00/7.78-3.60-5.92 | |
| | | | | | | | | | | | | | | | | 6.38 | 3.76 | 5.92 | Ave. |
| 45A1 | 6 | 5 | 2 | 7 | 5 | 5 | 1.75 | 8.75 | 10-50-40 | 4.40 | 3.4 | 58.7 | 37.9 | L | 7.5 | | | | |
| 46A | 10 | 7 | 9 | 6 | 7 | 7.8 | 2.3 | 11.5 | 80-10-10 | 8.66 | 5.7 | 16.7 | 77.6 | M | 7.7 | 7.56 | 3.60 | 5.88 | |
| 47A | 7 | 6 | 4 | 10 | 9 | 7.2 | 2.74 | 13.7 | 70-20-10 | 7.99 | 3.25 | 32.4 | 64.35 | ML | 8.3 | 6.88 | 3.84 | 6.00 | |
| 48A | 6 | 12 | 10 | 6 | 14 | 9.6 | 2.25 | 11.25 | 50-30-20 | 9.22 | 5 | 19 | 76 | SM | 14.5 | 5.96 | 3.76 | 6.00 | |
| | | | | | | | | | | | | | | | | 6.60 | 4.00 | 6.08 | Ave. |
| 49A | 12 | 16 | 13 | 11 | 16 | 13.6 | 3.1 | 15.5 | 50-40-10 | 13.06 | 6 | 16.5 | 77.5 | MS | 8 | 7.33 | 3.68 | 5.84 | |
| 49A1 | 8 | 10 | 11 | 9 | 13 | 10.2 | 3.3 | 16.5 | 80-10-10 | 11.32 | 4.7 | 8.2 | 87.1 | - | 6.8 | 7.17 | 3.68 | 5.76 | |
| 50A | 13 | 12 | 14 | 16 | 13 | 13.6 | 3.25 | 16.25 | 40-40-20 | 13.06 | 5.8 | 40.9 | 53.3 | L | 5.5 | 6.35 | 4.16 | 6.08 | |
| | | | | | | | | | | | | | | | | 6.43 | 4.48 | 6.12 | Ave. |
| 51A | 9 | 6 | 7 | 7 | 7 | 7.2 | 1.8 | 9 | 20-60-20 | 6.34 | 9.6 | 11.5 | 79.9 | MS | 13.1 | 6.00 | 4.40 | 6.80 | |
| 51A1 | 7 | 1 | 6 | 4 | 5 | 4.6 | 1.35 | 6.8 | 80-10-10 | 5.11 | 9. | 24. | 67 | MS | 5.7 | | | | |
| 52A | 3 | 6 | 3 | 4 | 6 | 4.4 | .8 | 4 | 70-20-10 | 4.88 | 7.1 | 34.3 | 58.6 | MS | 4.25 | 6.12 | 3.92 | 5.84 | |
| 53A | 18 | 16 | 23 | 11 | 16 | 16.8 | 3. | 15. | 70-10-20 | 18.65 | 5.25 | 20 | 74.75 | MS | 8 | 6.25 | 3.84 | 5.84 | |
| 54A | 21 | 16 | 15 | 14 | 12 | 15.6 | 3.35 | 16.75 | 60-20-20 | 14.98 | 3.75 | 28.5 | 67.75 | M | 9.25 | 8.33 | 3.84 | 5.96 | |

Table 4 (cont.)

| No. | Counts 1 | 2 | 3 | 4 | 5 | Ave. | Seeds Gr. | % | D-M-L | % Seeds computed from counts | % leaves stems | Cones Whole | Broken | Size | Strigs | Color Hue | Chroma | Br. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 55A | 12 | 17 | 17 | 7 | 16 | 13.8 | 1.7 | 8.5 | 60-20-20 | 13.25 | 2.5 | 13 | 84.5 | S | 8.5 | 6.86 | 4.08 | 6.16 | |
| 55A1 | 19 | 12 | 12 | 14 | 13 | 14 | 2.7 | 13.5 | 60-30-10 | 13.44 | 2.75 | 18.2 | 79.95 | - | 3.5 | | | | |
| 56A | 24 | 18 | 32 | 23 | 23 | 24 | 3.05 | 15.25 | 5-15-80 | 21.12 | 5.7 | 13.4 | 80.9 | - | 5.7 | | | | |
| 57A | 18 | 13 | 22 | 15 | 13 | 16.2 | 4.4 | 22. | 70-20-10 | 17.98 | 3.5 | 21.7 | 74.8 | M | 6.55 | 7.87 | 3.76 | 6.04 | |
| 58A | 12 | 21 | 15 | 10 | 11 | 13.8 | 3.28 | 16.4 | 70-20-10 | 15.32 | 4.2 | 33.3 | 62.5 | - | 5.5 | 5.83 | 3.92 | 6.24 | |
| 58A1 | 16 | 11 | 20 | 9 | 5 | 12.2 | 2.05 | 10.25 | 70-20-10 | 13.54 | 2.5 | 15. | 82.5 | M | 11.6 | 7.27 | 4.40 | 6.28 | |
| 59A | 9 | 16 | 14 | 6 | 13 | 11.6 | 3.11 | 15.55 | 50-40-10 | 11.14 | 2.85 | 25.2 | 71.95 | SM | 11.3 | | | | |
| 59A1 | 13 | 12 | 12 | 11 | 6 | 10.8 | 2.88 | 14.4 | 20-60-20 | 9.50 | 4.45 | 28.8 | 66.75 | M | 8.9 | 8.18 | 4.40 | 6.80 | |
| 60A | 164 | 14.4 | 16.8 | 18. | 17.2 | 16.56 | 3.11 | 15.55 | 80-10-10 | 18.38 | 7.75 | 27.47 | 64.68 | M | 5.56 | | | | |
| 60A1 | 11 | 11 | 8 | 9 | 11 | 10 | 3.5 | 17.5 | 60-30-10 | 9.6 | 5.25 | 25.25 | 69.5 | M | 6.5 | | | | |
| 61A | 4 | 10 | 13 | 8 | 9 | 8.8 | 3.3 | 16.5 | 50-20-30 | 8.45 | 5 | 35 | 60 | M | 7.2 | | | | |
| 62A | 8 | 8 | 11 | 8 | 8 | 8.6 | 2.2 | 11 | 50-40-10 | 8.26 | 8.15 | 35.55 | 56.35 | M | 6. | 6.46 | 3.84 | 6.02 | |
| 62A1 | | | | | | | 2.4 | 12 | 60-30-10 | | 9 | 30.25 | 60.75 | - | 4 | 6.08 | 4.08 | 6.12 | |
| 63A | 5 | 8 | 9 | 12 | 6 | 8 | 2.8 | 14 | 70-20-10 | 8.88 | 8 | 36.2 | 65.8 | M | 6 | 8.40 | 4.00 | 6.00/8.16-3.92-6.08 | |
| | | | | | | | | | | | | | | | | 7.73 | 3.52 | 5.80 | Ave. |
| 63A1 | 9 | 9 | 7 | 8 | 7 | 8 | 3 | 15 | 80-10-10 | 8.88 | 7.7 | 37.5 | 54.8 | - | 6 | | | | |
| 64A | 6 | 12 | 15 | 11 | 4 | 9.6 | 2.55 | 12.75 | 60-15-25 | 9.22 | 6.25 | 33. | 60.75 | M | 5.25 | 6.67 | 4.16 | 6.00 | |
| 64A1 | 16 | 19 | 19 | 9 | 14 | 15.4 | 1.7 | 8.5 | 40-30-30 | 14.78 | 5.2 | 38.5 | 56.3 | - | 5.5 | 6.98 | 3.44 | 5.67 | |
| 65A | 7 | 6 | 8 | 6 | 7 | 6.8 | 1.27 | 6.35 | 20-70-10 | 5.98 | 5. | 28 | 67 | MS | 7.65 | 7.32 | 3.28 | 5.63 | |
| 65A1 | 5 | 13 | 6 | 7 | 9 | 8 | 1.4 | 7 | 60-20-20 | 7.68 | 8.35 | 57.05 | 34.6 | SM | 4.5 | 7.27 | 3.52 | 5.72 | |
| 66A | 17 | 16 | 20 | 18 | 14 | 17 | 4.15 | 20.75 | 55-35-10 | 16.32 | 3.95 | 20.2 | 75.85 | SM | 10.9 | 7.00 | 4.00 | 6.08 | |
| | | | | | | | | | | | | | | | | 6.92 | 4.16 | 6.08 | Ave. |
| 66A1 | 14 | 8 | 13 | 7 | 12 | 10.8 | 3.6 | 18 | 20-60-20 | 9.50 | 4.9 | 26.5 | 68.6 | MS | 5.7 | Labeled 99A | | Small seeds | |
| 67A | | | | | | 9.96 | 1.83 | 9.15 | 70-20-10 | 11.06 | 7 | 45.6 | 47.4 | MS | 8.58 | 5.20 | 4.00 | 5.84 | |
| 68A | 6 | 6 | 11 | 8 | 5 | 7.2 | 2.1 | 10.5 | 50-30-20 | 6.91 | 3.85 | 52.3 | 43.85 | M | 4.6 | | | | |
| 69A | 10 | 10 | 13 | 14 | 10 | 11.4 | 2.5 | 12.5 | 70-20-10 | 12.21 | 2.5 | 44.5 | 53 | ML | 8 | 8.54 | 3.84 | 6.04 | |
| 69A1 | 18 | 15 | 12 | 20 | 19 | 16.6 | 2.9 | 14.5 | 30-40-30 | 14.61 | 3.35 | 62.7 | 33.95 | M | 5 | 8.37 | 3.92 | 5.93 | |
| 70A | 6 | 5 | 13 | 10 | 6 | 8 | 2.87 | 14.35 | 70-10-20 | 8.88 | 5.1 | 7. | 87.9 | S | 9.4 | | | | |
| 71A | 5 | 7 | 6 | 5 | 5 | 5.6 | 1.5 | 7.5 | 50-10-40 | 5.38 | 8.8 | 47.2 | 44 | LM | 5 | 7.17 | 3.68 | 5.88 | |
| 71A1 | 4 | 3 | 7 | 9 | 4 | 5.4 | 1.85 | 9.2 | 80-10-10 | 5.99 | 8.4 | 63.75 | 27.85 | ML | 7. | 6.22 | 3.60 | 5.72 | |
| 72A | 10 | 3 | 9 | 5 | 9 | 7.2 | 1.3 | 6.5 | 40-30-30 | 6.91 | 6.25 | 49 | 44.75 | M | 5.5 | 7.17 | 3.68 | 5.88 | |
| 73A | 13 | 7 | 16 | 14 | 19 | 13.8 | 2.9 | 14.5 | 70-20-10 | 15.32 | 7.2 | 35.7 | 57 | MS | 9.65 | 6.08 | 4.08 | 6.04 | |
| 73A1 | | | | | | | | | 70-20-10 | | | | | | | | | | |
| 74A | 6 | 7 | 14 | 6 | 5 | 7.6 | 1.84 | 9.2 | 30-40-30 | | 6.25 | 34.5 | 59.25 | M | 8 | 7.56 | 3.60 | 5.80 | |

Table 5
Distribution of Amounts of Foreign Material and Strigs

| Foreign Material | | | Strigs | | |
|---|---|---|---|---|---|
| No. of samples | Per cent by weight | Percentage of total samples | No. of samples | Per cent by weight | Percentage of total samples |
| 14 | 1 | 5.15 | 3 | 1 | 1.12 |
| 30 | 2 | 11.03 | 0 | 2 | |
| 33 | 3 | 12.13 | 3 | 3 | 1.12 |
| 36 | 4 | 13.23 | 11 | 4 | 4.13 |
| 52 | 5 | 19.12 | 27 | 5 | 10.15 |
| 27 | 6 | 9.92 | 38 | 6 | 14.29 |
| 28 | 7 | 10.29 | 60 | 7 | 22.56 |
| 25 | 8 | 9.19 | 62 | 8 | 23.31 |
| 9 | 9 | 3.31 | 27 | 9 | 10.15 |
| 5 | 10 | 1.84 | 21 | 10 | 7.89 |
| 8 | 11 | 2.94 | 7 | 11 | 2.63 |
| 3 | 12 | 1.10 | 3 | 12 | 1.12 |
| | 13 | | 3 | 13 | 1.12 |
| 2 | 14 | .74 | 1 | 14 | .37 |
| 272 | Total | 100.00 | 266 | | 100.00 |

Table 6
Distribution of Samples in Relation to Percentage of Seed

| Per cent of seeds by weight | No. of samples | Percentage of total samples |
|---|---|---|
| 1 | 2 | .73 |
| 2 | 7 | 2.57 |
| 3 | 8 | 2.94 |
| 4 | 7 | 2.57 |
| 5 | 5 | 1.83 |
| 6 | 21 | 7.72 |
| 7 | 17 | 6.25 |
| 8 | 20 | 7.35 |
| 9 | 24 | 8.82 |
| 10 | 24 | 8.82 |
| 11 | 26 | 9.55 |
| 12 | 21 | 7.72 |
| 13 | 13 | 4.77 |
| 14 | 18 | 6.61 |
| 15 | 21 | 7.72 |
| 16 | 12 | 4.41 |
| 17 | 10 | 3.67 |
| 18 | 6 | 2.21 |
| 19 | 4 | 1.47 |
| 20 | 4 | 1.47 |
| 21 | 1 | .37 |
| 22 | 1 | .37 |
| 23 | 0 | |
| 24 | 0 | |
| 25 | 1 | .37 |
| | | 100.00% |

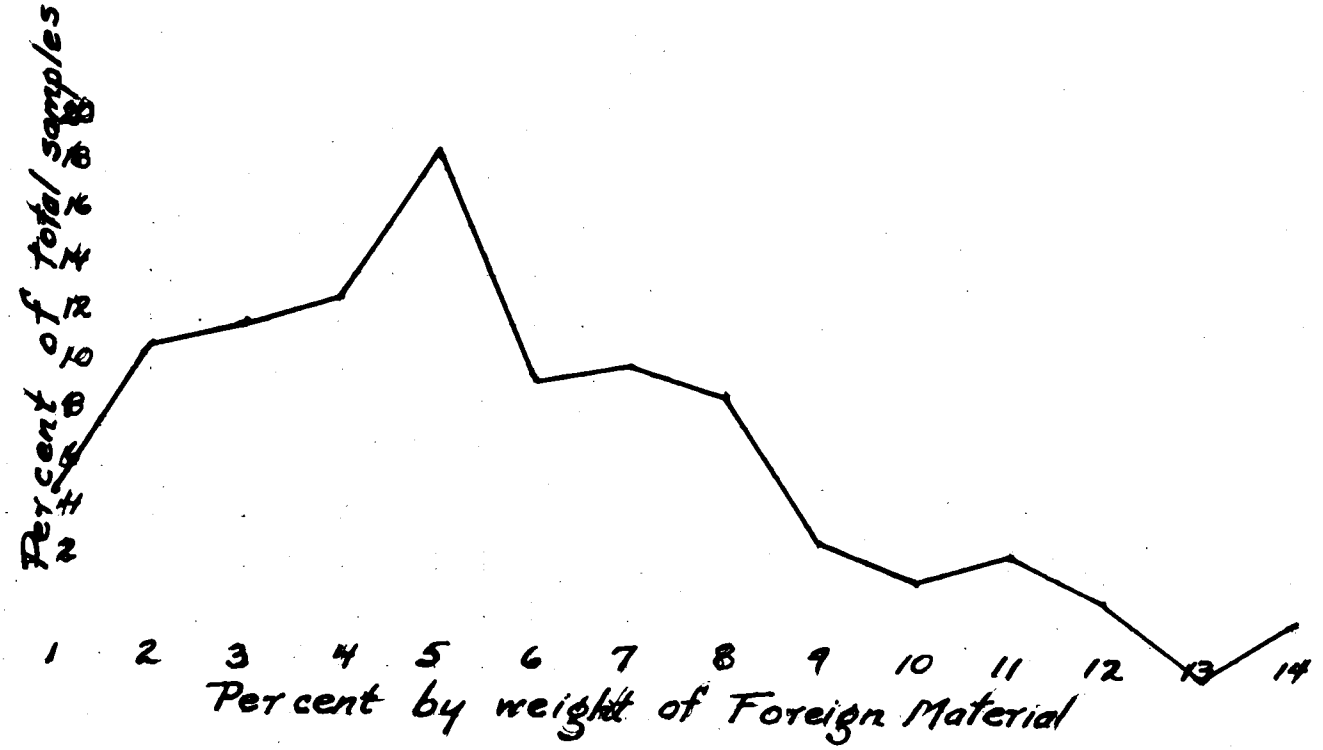
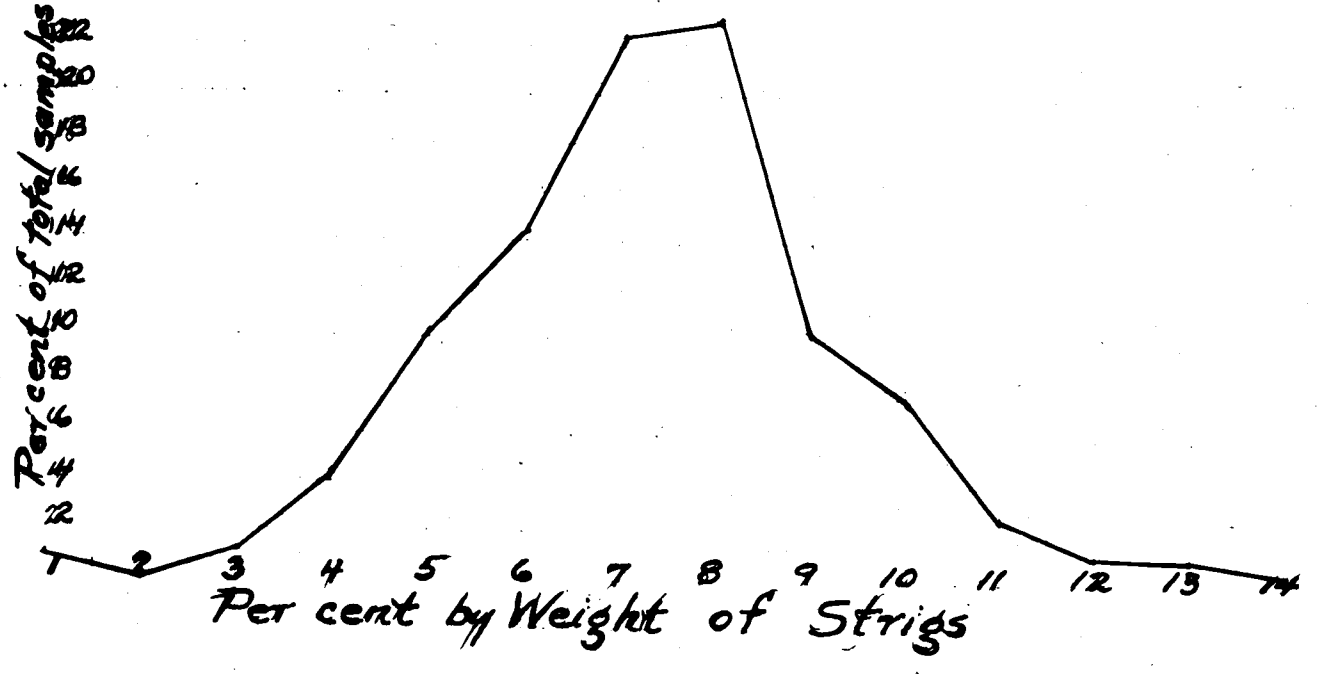
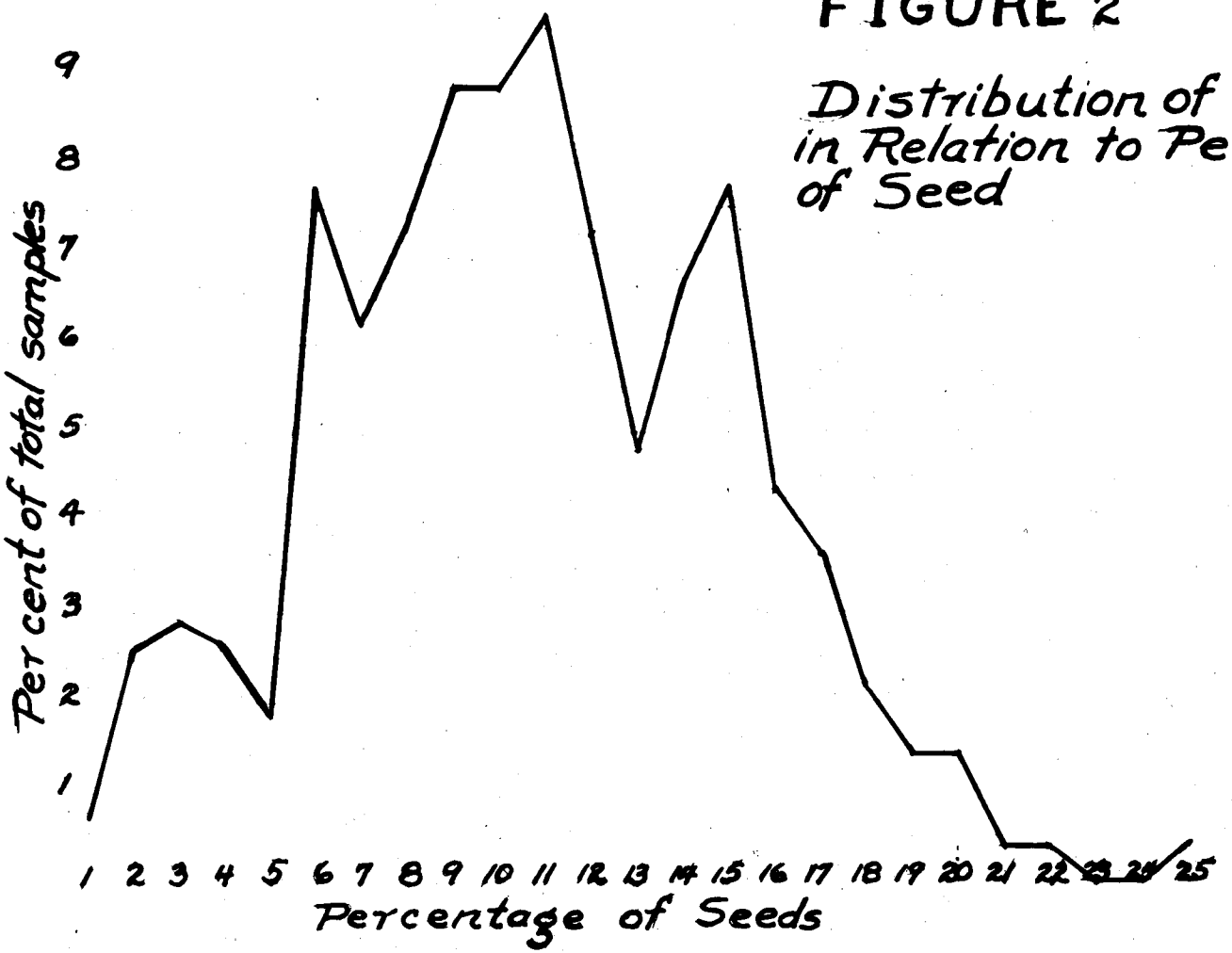

Percent of total samples
2
4
6
8
10
12
14
16
18
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Per cent by weight of Foreign Material

FIGURE 1


Percent of total samples
2
4
6
8
10
12
14
16
18
20
22
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Per cent by Weight of Strigs

# FIGURE 2

Distribution of Samples in Relation to Percentage of Seed



## Relation between weight of seed and number of seeds

In order to obtain more definite information on the relation between the number of seeds in a sample and the weight of them, seed from 34 samples of hops was subjected to a further analysis. It was noted that seed from various samples varied in color from dark to light. It was also noticed that the dark seeds were solid throughout while the light-colored seeds were almost always hollow. It appeared that the color of the seed was an indication of the maturity of the hop. These differences in appearance and condition suggested that possibly the relationship between count and weight of seed could be established much more accurately if the condition and maturity of the seed were considered.

Analyses of the seed from 34 samples are given in Table 7. These figures show very clearly that the dark-colored seeds are much heavier than the light-colored seeds. The average weight of the dark colored seeds is .0053 grams per seed, of the medium seeds .0031 grams, and of the light seeds .0015 grams. In other words the medium seeds are twice the weight of the light seeds and the heavy or dark seeds are 3 1/3 times the weight of the light seed.

From these data it was possible to compute a factor which could be applied to a count appearing on the cut surface of the sample, but transforms seed counts into percentage of seed weight. The factors were figured for three groups, 70 per cent dark seeds or over, 40 to 70 per cent dark seeds, and less than 40 per cent dark seeds. The ratios between count and weight for these groupings were 1.11, .96 and .88 respectively. The calculated percentages by weight shown in Tables 3 and 4 were obtained by the use of these factors.

In order to compare the actual percentages as determined by weight and the calculated percentages were compared by Student's method. The

odds determined for the three groups were 1 to 1, 2.5 to 1, and 3 to 1. These odds indicate that for the group as a whole, the difference is between the actual and calculated percentages were so slight as to have no statistical value. Despite the agreement in the averages for the group, individual variations appear to be sufficiently high as to introduce a serious error when the counting method was used on a single sample. As a result, the attempt to determine seed weights by counting the number on a cut surface was dropped from further consideration.

Table 7

Data on Variation of Color and Weight of Hop Seeds - 1937

| Sample no. | % of seeds | Dark | | | | Medium | | | | Light | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. | Per cent | Weight grams | Per cent | No. | Per cent | Weight grams | Per cent | No. | Per cent | Weight grams | Per cent |
| 241 | 12.2 | 353 | 54 | 1.73 | 72 | 142 | 22 | .48 | 20 | 153 | 24 | .20 | 8 |
| 249 | 10.4 | 58 | 8 | .32 | 15 | 367 | 49 | 1.21 | 58 | 329 | 43 | .55 | 27 |
| 252 | 13.0 | 309 | 47 | 1.67 | 65 | 251 | 38 | .74 | 29 | 102 | 15 | .15 | 6 |
| 265 | 5.7 | 149 | 66 | 1.00 | 88 | 54 | 24 | .12 | 10 | 24 | 10 | .02 | 2 |
| 281 | 4.9 | 132 | 66 | .84 | 89 | 39 | 19 | .08 | 9 | 29 | 15 | .02 | 2 |
| 292 | 12.6 | 455 | 70 | 2.12 | 86 | 166 | 26 | .32 | 13 | 24 | 4 | .02 | 1 |
| 317 | 10.0 | 287 | 63 | 1.55 | 81 | 87 | 19 | .26 | 14 | 79 | 18 | .10 | 5 |
| 320 | 9.6 | 263 | 59 | 1.56 | 82 | 119 | 27 | .29 | 15 | 65 | 14 | .06 | 3 |
| 339 | 12.6 | 112 | 18 | .75 | 30 | 266 | 44 | 1.22 | 49 | 228 | 38 | .53 | 21 |
| 360 | 9.1 | 193 | 48 | 1.20 | 67 | 87 | 21 | .39 | 22 | 123 | 31 | .20 | 11 |
| 396 | 1.4 | 23 | 30 | .16 | 64 | 43 | 57 | .08 | 32 | 10 | 13 | .01 | 4 |
| 406 | 15.2 | 222 | 25 | 1.17 | 39 | 499 | 57 | 1.64 | 54 | 152 | 18 | .22 | 7 |
| 454 | 6.3 | 169 | 68 | 1.12 | 88 | 47 | 19 | .12 | 9 | 33 | 13 | .04 | 3 |
| 459 | 9.7 | 232 | 36 | 1.11 | 59 | 209 | 32 | .55 | 29 | 207 | 32 | .23 | 12 |
| 468 | 7.2 | 63 | 15 | .33 | 24 | 288 | 66 | .95 | 68 | 83 | 19 | .11 | 8 |
| 485 | 7.0 | 33 | 8 | .17 | 33 | 236 | 56 | .88 | 67 | 155 | 36 | .27 | 20 |
| 503 | 11.3 | 360 | 64 | 1.87 | 87 | 103 | 18 | .17 | 8 | 104 | 18 | .10 | 5 |
| 506 | 8.9 | 261 | 73 | 1.52 | 91 | 52 | 15 | .11 | 7 | 45 | 12 | .04 | 2 |
| 507 | 8.0 | 214 | 77 | 1.40 | 92 | 46 | 16 | .10 | 7 | 20 | 7 | .02 | 1 |
| 510 | 9.0 | 50 | 20 | 1.00 | 55 | 122 | 49 | .65 | 36 | 77 | 31 | .17 | 9 |
| 512 | 12.1 | 85 | 10 | .50 | 21 | 438 | 55 | 1.42 | 59 | 280 | 35 | .48 | 20 |
| 513 | 10.3 | 79 | 12 | .45 | 22 | 310 | 48 | 1.08 | 54 | 255 | 40 | .47 | 24 |
| 516 | 3.6 | 87 | 66 | .62 | 93 | 12 | 9 | .03 | 4 | 32 | 25 | .02 | 3 |
| 519 | 18.7 | 660 | 48 | 2.20 | 59 | 451 | 33 | 1.10 | 29 | 272 | 19 | .45 | 12 |
| 521 | 1.6 | 33 | 52 | .20 | 74 | 19 | 30 | .06 | 22 | 11 | 18 | .01 | 4 |
| 546 | 3.8 | 86 | 41 | .53 | 71 | 63 | 30 | .13 | 17 | 62 | 29 | .09 | 12 |
| 547 | 12.6 | 363 | 55 | 1.79 | 73 | 208 | 32 | .56 | 23 | 87 | 13 | .09 | 4 |
| 552 | 20.1 | 1029 | 82 | 3.57 | 88 | 199 | 16 | .42 | 10 | 33 | 2 | .04 | 2 |
| 566 | 6.6 | 134 | 48 | .83 | 63 | 89 | 32 | .38 | 29 | 54 | 20 | .10 | 8 |
| 587 | 10.1 | 199 | 46 | 1.17 | 59 | 160 | 37 | .66 | 33 | 69 | 17 | .16 | 8 |
| 609 | 8.6 | 263 | 61 | 1.48 | 85 | 130 | 30 | .22 | 13 | 40 | 9 | .03 | 2 |
| 611 | 8.6 | 114 | 25 | .70 | 39 | 252 | 56 | .94 | 52 | 86 | 19 | .16 | 9 |
| 610 | 7.6 | 164 | 46 | .99 | 65 | 158 | 44 | .50 | 33 | 36 | 10 | .04 | 2 |
| 619 | 13.8 | 246 | 29 | 1.19 | 44 | 400 | 47 | 1.24 | 45 | 208 | 24 | .30 | 11 |
| | | | 45.2 | | 63.4 | | 34.5 | | 28.5 | | 20.3 | | 8.1 |

## Relation between Chemical and Physical Analyses

Chemical analyses from approximately 100 samples of hops were made by D. E. Bullis of the Department of Agricultural Chemistry. Results of chemical analyses are given in Tables 8 and 9. These data are shown in a report by Mr. Bullis and the only purpose of including them here is to show relationship to certain physical characteristics. An attempt was made to correlate physical characters with the total soft resins in these samples. Correlation coefficients between certain physical characteristics are shown in Table 10. As indicated in this table, there is practically no correlation between any of these characters and the soft resins. Inasmuch as these characters are used by the trade in evaluating hops, this lack of relationships between physical characters and soft resins indicates either first, that some physical characters are being over-emphasized, or second, that the soft resins have less value than is generally considered.

The lack of relationship between the physical and chemical characters of hops indicates the necessity for continuation of these studies. From the data available, it is impossible to say whether these relationships will persist in another season. Certainly, everyone is agreed that the 1937 season was rather abnormal for hop production and that the 1937 crop is not typical of the hops generally grown in this area. It will be necessary, therefore, to obtain similar data over a two or three-year period before definite conclusions may be drawn.

Table 8
1937 Crop Grades and Standards - Hop Samples from T. A. Livesley & Company, Salem

| Sample no. | Variety | Moisture | Total Resins | | A Resins | | B Resins | | Hard Resins | | Preservative Value 10(A+B/3) | | No. Bales | Grower | Description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Original | Dry | Original | Dry | Original | Dry | Original | Dry | Original | Dry | | | |
| 3A | | 5.64 | 12.76 | 13.51 | 5.04 | 5.34 | 6.46 | 6.84 | 1.26 | 1.33 | 84.5 | 89.5 | 75 | Geo. Rosich | Choice, yellow |
| 10A | | 5.24 | 15.61 | 16.48 | 6.48 | 6.84 | 8.04 | 8.49 | 1.09 | 1.15 | 91.6 | 96.7 | 65 | Mrs. Lena Fessler | Good,green,medium,dirty picked |
| 11A | | 5.28 | 16.32 | 17.22 | 8.05 | 8.50 | 7.05 | 7.45 | 1.22 | 1.29 | 104.0 | 109.8 | 31 | C. E. Geelan | Good,medium,greenish, seedless type, mottled |
| 16A | Fuggles | 5.64 | 14.82 | 15.71 | 4.75 | 5.03 | 8.96 | 9.50 | 1.11 | 1.18 | 77.4 | 82.3 | 14 | San Fawver | Poor, greenish |
| 17A | Fuggles | 5.36 | 16.15 | 17.07 | 5.30 | 5.60 | 9.47 | 10.01 | 1.38 | 1.46 | 84.6 | 89.5 | 78 | Robin Day | Good, medium, greenish yellow |
| 20A | | 6.68 | 17.51 | 18.75 | 6.07 | 6.50 | 10.41 | 11.15 | 1.03 | 1.10 | 95.4 | 102.2 | 74 | W. L. Murray & Son | Choice, greenish yellow |
| 23A | | 4.84 | 17.60 | 18.50 | 6.38 | 6.71 | 10.16 | 10.68 | 1.06 | 1.11 | 97.7 | 102.5 | 55 | Alving Thompson | Poor, greenish |
| 24A | | 4.56 | 17.73 | 18.57 | 5.68 | 5.95 | 10.25 | 10.74 | 1.80 | 1.88 | 91.0 | 95.3 | 53 | J. N. Gooding | Medium, greenish yellow |
| 27A | | 5.00 | 17.72 | 18.67 | 5.80 | 6.10 | 10.88 | 11.47 | 1.04 | 1.10 | 94.3 | 99.3 | 62 | Henry Annen | Poor, greenish, dirty picked, semi-seedless |
| 28A | | 4.96 | 17.67 | 18.59 | 6.62 | 6.97 | 9.98 | 10.49 | 1.07 | 1.13 | 99.5 | 104.5 | 67 | Harold Satern | Poor, greenish yellow, dirty picked |
| 31A | | 6.28 | 18.15 | 19.38 | 6.80 | 7.26 | 10.34 | 11.04 | 1.01 | 1.08 | 102.5 | 109.4 | 124 | Arthur Goffin | Medium, greenish yellow, dirty picked |
| 36A | | 6.44 | 17.02 | 18.19 | 6.19 | 6.62 | 9.89 | 10.57 | .94 | 1.00 | 94.9 | 101.3 | 516 | Ben Hilton (DL1,DL2) | Medium good, dull, mottled |
| 37A | | 6.56 | 17.51 | 18.73 | 6.18 | 6.62 | 10.39 | 11.11 | .94 | 1.00 | 96.4 | 103.0 | 328 | " " (HE1,HE2) | Poor, Yellow |
| 39A | | 6.40 | 18.00 | 19.24 | 6.29 | 6.72 | 10.71 | 11.43 | 1.00 | 1.07 | 98.6 | 105.1 | 460 | Fook Chung | Poor, greenish |
| 44A | | 6.28 | 18.20 | 19.44 | 5.09 | 5.44 | 11.85 | 12.66 | 1.26 | 1.34 | 89.9 | 96.1 | 124 | Jerman & Chittenden | Good, medium greenish |
| 47A | | 6.32 | 18.42 | 19.67 | 6.33 | 6.76 | 10.95 | 11.69 | 1.14 | 1.22 | 99.8 | 106.5 | 112 | V. O. Kelley | Good,medium greenish yellow |
| 56A | Fuggles | 6.60 | 14.75 | 15.70 | 5.21 | 5.55 | 8.41 | 8.95 | 1.13 | 1.20 | 80.1 | 85.3 | 270 | Dave Titus | Good, medium, greenish yellow |
| 57A | | 6.32 | 17.31 | 18.48 | 5.37 | 5.73 | 10.66 | 11.38 | 1.28 | 1.37 | 89.2 | 95.3 | 91 | Collins & Collins | Poor, greenish |
| 59A | | 6.16 | 17.18 | 18.30 | 5.58 | 5.95 | 10.48 | 11.16 | 1.12 | 1.19 | 90.7 | 96.7 | 265 | " " | Good, medium greenish |
| 62A | | 5.96 | 17.46 | 18.58 | 5.82 | 6.19 | 10.60 | 11.28 | 1.04 | 1.11 | 93.5 | 99.5 | 128 | Robin Day | Medium greenish yellow |
| 66A | | 6.56 | 16.97 | 18.17 | 5.24 | 5.62 | 10.46 | 11.20 | 1.27 | 1.36 | 87.3 | 93.5 | 394 | Ross Wood & Hugh Nelson | Good, medium greenish |
| 69A | | 6.64 | 16.27 | 17.42 | 5.62 | 6.02 | 9.53 | 10.20 | 1.12 | 1.20 | 88.0 | 94.2 | 62 | Frank Buckley | Good, medium greenish |
| 71A | | 6.24 | 17.07 | 18.20 | 6.31 | 6.73 | 9.77 | 10.43 | .99 | 1.05 | 95.7 | 102.0 | 62 | Bill Annen | Poor, medium, dull-greenish, dirty picked |

Table 9
1937 Crop Grades and Standards - Hop Samples from Pacific Hop Growers, Inc., Salem

| Sample no. | Variety | Moisture | Total Resins | | A Resins | | B Resins | | Hard Resins | | Preservative Value 10 (A + B/3) | | No. Bales | Grower | Description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Original | Dry | Original | Dry | Original | Dry | Original | Dry | Original | Dry | | | |
| 1 | Sacramentos | 6.16 | 13.24 | 14.11 | 4.43 | 4.72 | 7.74 | 8.25 | 1.07 | 1.14 | 70.1 | 74.7 | 1000 | C. L. Ross | |
| 3 | Fuggles | 6.20 | 15.02 | 16.01 | 5.42 | 5.78 | 8.20 | 8.74 | 1.40 | 1.49 | 81.5 | 86.9 | 151 | Ben Eppers | |
| 9 | | 6.24 | 15.56 | 16.60 | 5.23 | 5.58 | 9.20 | 9.82 | 1.13 | 1.20 | 83.0 | 88.6 | 44 | John Grafte | |
| 14 | Fuggles | 6.16 | 15.27 | 16.27 | 4.39 | 4.68 | 9.74 | 10.38 | 1.14 | 1.21 | 76.4 | 81.4 | 20 | John Jacobs | |
| 16 | Fuggles | 6.24 | 14.38 | 15.35 | 4.60 | 4.91 | 8.58 | 9.16 | 1.20 | 1.28 | 74.6 | 79.6 | 50 | Ray Morley | |
| 25 | | 5.64 | 16.70 | 17.69 | 6.21 | 6.57 | 9.29 | 9.85 | 1.20 | 1.27 | 93.1 | 98.6 | 16 | Chas. Swartout | |
| 27 | Fuggles | 6.56 | 16.94 | 18.12 | 5.94 | 6.36 | 9.91 | 10.59 | 1.09 | 1.17 | 92.4 | 98.9 | 65 | C. Messenger | |
| 31 | E. Clusters | 6.12 | 16.40 | 17.46 | 5.39 | 5.74 | 9.59 | 10.21 | 1.42 | 1.51 | 85.9 | 91.9 | 32 | Willamette Hop Co. | |
| 33 | | 6.32 | 17.23 | 18.39 | 5.65 | 6.03 | 10.46 | 11.16 | 1.12 | 1.20 | 91.4 | 97.6 | 250 | Mission Bottom Hop Co. | |
| 36 | | 5.84 | 15.65 | 16.63 | 5.80 | 6.16 | 8.78 | 9.33 | 1.07 | 1.14 | 87.3 | 92.8 | 300 | John Morley | |
| 38 | | 5.64 | 16.39 | 17.36 | 6.05 | 6.41 | 9.23 | 9.78 | 1.11 | 1.17 | 91.3 | 96.3 | 20 | John Zies | |
| 42 | Fuggles | 6.20 | 15.54 | 16.56 | 5.12 | 5.45 | 9.42 | 10.04 | 1.00 | 1.07 | 82.6 | 88.0 | 54 | John Morley | |
| 44 | | 5.84 | 17.53 | 18.63 | 6.77 | 7.20 | 9.74 | 10.35 | 1.02 | 1.08 | 100.2 | 106.4 | 12 | John Moe | |
| 47 | | 5.80 | 17.07 | 18.13 | 6.77 | 7.19 | 9.28 | 9.86 | 1.02 | 1.08 | 98.6 | 104.6 | 14 | Paul Dettwyler | |
| 49 | | 5.76 | 17.06 | 18.11 | 6.34 | 6.73 | 9.77 | 10.37 | .95 | 1.01 | 96.0 | 101.8 | 35 | Mike Zies | |
| 51 | Fuggles | 5.72 | 17.03 | 18.07 | 5.09 | 5.40 | 10.84 | 11.50 | 1.10 | 1.17 | 87.0 | 92.3 | 22 | Adolph Hari | |
| 53 | | 6.56 | 15.92 | 17.03 | 4.42 | 4.73 | 10.30 | 11.02 | 1.20 | 1.28 | 78.5 | 84.0 | 116 | Downing & Stutesman | |
| 58 | | 6.56 | 16.60 | 17.76 | 5.65 | 6.05 | 9.81 | 10.49 | 1.14 | 1.22 | 89.2 | 95.4 | 42 | Ed. Harnsberger | |
| 63 | Fuggles | 6.28 | 17.27 | 18.43 | 5.07 | 5.41 | 11.19 | 11.94 | 1.01 | 1.08 | 88.0 | 93.9 | 336 | F. E. Needham | |
| 65 | | 6.08 | 16.97 | 18.06 | 5.87 | 6.25 | 10.06 | 10.70 | 1.04 | 1.11 | 92.2 | 98.2 | 43 | Henry Johnson | |
| 68 | | 5.84 | 16.98 | 18.05 | 5.55 | 5.90 | 10.28 | 10.93 | 1.15 | 1.22 | 89.8 | 95.5 | 60 | Emil Loe | |
| 75 | | 5.60 | 15.57 | 16.49 | 5.23 | 5.54 | 9.35 | 9.90 | .99 | 1.05 | 83.5 | 88.5 | 19 | Harold McKay | |
| 80 | | 5.64 | 17.89 | 18.94 | 5.25 | 5.56 | 11.57 | 12.25 | 1.07 | 1.13 | 91.1 | 96.5 | 175 | Vinton and Loop | |
| 83 | | 5.56 | 19.17 | 20.20 | 6.09 | 6.45 | 11.97 | 12.67 | 1.11 | 1.17 | 102.8 | 108.8 | 30 | Holman Bros. | |
| 84 | | 5.92 | 17.68 | 18.80 | 6.11 | 6.50 | 10.27 | 10.92 | 1.30 | 1.38 | 95.3 | 101.4 | 27 | Joe Zies | |
| 88 | Fuggles | 6.04 | 14.93 | 15.88 | 5.25 | 5.58 | 8.51 | 9.05 | 1.17 | 1.25 | 80.9 | 86.1 | 358 | Virgil De Coster | |
| 97 | | 6.24 | 17.45 | 18.61 | 5.92 | 6.32 | 10.58 | 11.28 | .95 | 1.01 | 94.5 | 100.8 | 500 | F. E. Needham | |
| 148 | | 6.72 | 16.95 | 18.18 | 6.04 | 6.48 | 9.89 | 10.61 | 1.02 | 1.09 | 93.4 | 100.1 | 40 | J D. Lofgren | |
| 157 | | 6.80 | 19.02 | 20.40 | 6.12 | 6.57 | 11.75 | 12.60 | 1.15 | 1.23 | 100.4 | 107.7 | 388 | Sloper Bros. | |
| 159 | Sacramentos | 6.52 | 13.41 | 14.35 | 3.96 | 4.24 | 8.28 | 8.86 | 1.17 | 1.25 | 67.2 | 71.9 | 125 | Green and Reese | |
| 162 | | 6.40 | 19.48 | 20.84 | 7.29 | 7.80 | 11.06 | 11.83 | 1.13 | 1.21 | 109.8 | 117.4 | 125 | Oscar Satern | |
| 166 | | 6.12 | 19.10 | 20.34 | 6.75 | 7.19 | 11.11 | 11.73 | 1.24 | 1.32 | 104.5 | 111.3 | 51 | Wenger Bros. | |
| 168 | | 6.16 | 18.84 | 20.07 | 6.84 | 7.29 | 10.28 | 10.95 | 1.72 | 1.83 | 102.7 | 109.4 | 40 | Turner and Vaughn | |
| 170 | | 6.08 | 17.75 | 18.90 | 6.01 | 6.40 | 10.49 | 11.17 | 1.25 | 1.33 | 95.1 | 101.2 | 20 | R. Davidson | |
| 172 | | 5.84 | 16.64 | 17.68 | 5.35 | 5.68 | 10.15 | 10.79 | 1.14 | 1.21 | 87.3 | 92.8 | 150 | Lee Quare | |
| 175 | | 5.52 | 16.89 | 17.89 | 5.18 | 5.48 | 10.53 | 11.14 | 1.18 | 1.25 | 86.9 | 92.0 | 136 | Hedges estate | |
| 185 | | 7.16 | 17.12 | 18.42 | 7.09 | 7.63 | 8.94 | 9.62 | 1.09 | 1.17 | 100.7 | 108.4 | 68 | A. Schar | |
| 188 | | 6.28 | 15.88 | 16.95 | 5.35 | 5.71 | 8.94 | 9.54 | 1.59 | 1.70 | 83.3 | 89.0 | 53 | J. N. Gooding | |
| 190 | | 6.80 | 16.27 | 17.47 | 5.64 | 6.06 | 9.43 | 10.12 | 1.20 | 1.29 | 87.8 | 94.3 | 37 | Eric Larson | |
| 192 | | 6.60 | 16.70 | 17.88 | 6.05 | 6.48 | 9.12 | 9.76 | 1.53 | 1.64 | 90.9 | 97.3 | 22 | Art Brenden | |
| 194 | | 6.44 | 18.72 | 20.01 | 7.25 | 7.75 | 10.13 | 10.83 | 1.34 | 1.43 | 106.3 | 113.6 | 47 | Lorelin | |
| 196 | | 7.88 | 18.28 | 19.85 | 6.29 | 6.83 | 10.70 | 11.62 | 1.29 | 1.40 | 98.6 | 107.0 | 60 | A. E. Jergeson | |
| 198 | | 6.92 | 15.81 | 16.99 | 5.18 | 5.57 | 9.33 | 10.03 | 1.30 | 1.39 | 82.9 | 89.1 | 270 | Dave Titus | |
| 200 | E. Clusters | 6.60 | 17.57 | 18.82 | 6.22 | 6.66 | 10.10 | 10.82 | 1.25 | 1.34 | 95.9 | 102.7 | 125 | Homer Gouley | |
| 202 | | 7.24 | 19.86 | 21.40 | 5.82 | 6.27 | 12.50 | 13.47 | 1.54 | 1.66 | 99.9 | 107.7 | 180 | E. A. Miller | |

Table 9 (cont.)

| Sample no. | Variety | Moisture | Total Resins Original | Total Resins Dry | A. Resins Original | A. Resins Dry | B Resins Original | B Resins Dry | Hard Resins Original | Hard Resins Dry | Preservative Value 10 (A + B/3) Original | Preservative Value 10 (A + B/3) Dry | No. bales | Grower | Description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 207 | | 6.76 | 17.27 | 18.51 | 5.78 | 6.19 | 10.30 | 11.04 | 1.19 | 1.28 | 92.1 | 98.7 | 128 | Robin Day | |
| 209 | | 7.52 | 15.27 | 16.51 | 5.07 | 5.48 | 9.11 | 9.85 | 1.09 | 1.18 | 81.1 | 87.7 | 38 | P. C. Magnus | |
| 215 | Fuggles | 7.48 | 16.74 | 18.10 | 4.99 | 5.40 | 10.48 | 11.33 | 1.27 | 1.37 | 84.8 | 91.7 | 27 | L. S. Christofferson | |
| 217 | | 8.08 | 17.09 | 18.58 | 4.88 | 5.31 | 10.62 | 11.54 | 1.59 | 1.73 | 84.2 | 91.5 | 50 | Christofferson & Sandgathe | |
| 219 | | 7.44 | 16.77 | 18.12 | 5.40 | 5.84 | 10.32 | 11.15 | 1.05 | 1.13 | 88.4 | 95.4 | 17 | F. E. Needham | |
| 221 | | 6.40 | 19.36 | 20.68 | 6.33 | 6.76 | 11.97 | 12.79 | 1.06 | 1.13 | 103.2 | 110.3 | 32 | Brown Island | |
| 232 | | 6.84 | 17.01 | 18.27 | 6.45 | 6.93 | 9.51 | 10.21 | 1.05 | 1.13 | 96.2 | 103.3 | 45 | Ivan Branton | |
| 235 | E. Clusters | 7.56 | 16.27 | 17.60 | 5.42 | 5.86 | 9.49 | 10.27 | 1.36 | 1.47 | 85.8 | 92.8 | - | Roger Batt | Idaho |
| 242 | " " | 7.12 | 17.15 | 18.47 | 6.25 | 6.73 | 9.84 | 10.60 | 1.06 | 1.14 | 95.3 | 97.4 | 53 | Chas. Feller | |
| 247 | | 7.31 | 16.77 | 18.10 | 4.37 | 4.72 | 10.93 | 11.79 | 1.47 | 1.59 | 80.1 | 86.4 | 72 | A. Nusom | |
| 251 | | 7.04 | 15.17 | 16.31 | 4.20 | 4.52 | 9.87 | 10.61 | 1.10 | 1.18 | 74.9 | 80.6 | 66 | S. A. Varble | |
| 253 | | 7.04 | 18.76 | 20.18 | 6.45 | 6.93 | 11.17 | 12.02 | 1.14 | 1.23 | 101.7 | 109.4 | 43 | L. E. Stafford | |
| 266 | | 7.27 | 16.94 | 18.27 | 6.05 | 6.53 | 9.71 | 10.47 | 1.18 | 1.27 | 93.2 | 100.6 | 81 | John Brunner | |
| 284 | | 6.95 | 15.98 | 17.18 | 5.35 | 5.75 | 9.39 | 10.10 | 1.24 | 1.33 | 84.8 | 91.2 | 48 | H. G. Lucht | |
| 301 | | 7.27 | 17.45 | 18.81 | 4.79 | 5.17 | 11.21 | 12.08 | 1.45 | 1.56 | 85.3 | 92.0 | 310 | V. O. Kelley | |
| 319 | | 7.19 | 16.36 | 17.62 | 5.53 | 5.96 | 9.73 | 10.48 | 1.10 | 1.18 | 87.7 | 94.4 | 109 | A. E. Feller | |
| 332 | Fuggles | 7.27 | 15.09 | 16.27 | 4.16 | 4.48 | 9.86 | 10.64 | 1.07 | 1.15 | 74.4 | 80.2 | 180 | Cooper & Fawver | |
| 356 | | 7.31 | 16.90 | 18.23 | 6.14 | 6.62 | 9.76 | 10.53 | 1.00 | 1.08 | 93.9 | 101.4 | 56 | Hattie Hovenden | |
| 374 | | 7.35 | 18.34 | 19.81 | 5.65 | 6.10 | 11.45 | 12.34 | 1.24 | 1.34 | 95.0 | 102.6 | 325 | Lee Hing | |
| 403 | | 7.19 | 18.07 | 19.47 | 6.61 | 7.12 | 10.32 | 11.12 | 1.14 | 1.23 | 100.5 | 108.2 | 78 | Hattie Hovenden | |
| 410 | | 7.19 | 18.16 | 19.56 | 5.29 | 5.70 | 11.78 | 12.69 | 1.09 | 1.17 | 92.2 | 99.3 | 55 | Chas. Chikus | |
| 455 | | 6.47 | 18.59 | 19.87 | 7.00 | 7.48 | 10.52 | 11.25 | 1.07 | 1.14 | 105.1 | 112.4 | 11 | R. Stadeli | |
| 468 | Yakimas | 6.79 | 15.77 | 16.94 | 4.72 | 5.07 | 9.68 | 10.40 | 1.37 | 1.47 | 79.5 | 85.3 | 105 | B Belair | |
| 495 | | 6.95 | 17.71 | 19.04 | 6.49 | 6.98 | 10.06 | 10.81 | 1.16 | 1.25 | 98.4 | 105.8 | 34 | Joe Jacobs | |
| 503 | | 7.08 | 18.31 | 19.70 | 6.39 | 6.88 | 10.70 | 11.51 | 1.22 | 1.31 | 99.6 | 107.2 | 36 | Otto Lucht | |
| 507 | | 6.84 | 17.62 | 18.92 | 6.11 | 6.56 | 10.44 | 11.21 | 1.07 | 1.15 | 95.9 | 103.0 | 86 | Fred Kaser | |
| 512 | | 6.44 | 16.93 | 18.09 | 4.63 | 4.95 | 11.22 | 11.99 | 1.08 | 1.15 | 83.7 | 89.5 | 55 | Ralph DeSart | |
| 516 | | 6.32 | 18.14 | 19.37 | 7.25 | 7.74 | 9.84 | 10.51 | 1.05 | 1.12 | 105.3 | 112.4 | 50 | Schutz Bros. | |
| 521 | | 6.56 | 18.27 | 19.54 | 7.35 | 7.86 | 9.55 | 10.22 | 1.37 | 1.46 | 105.3 | 112.7 | 60 | John Beck | |
| 547 | | 6.24 | 17.89 | 19.08 | 6.00 | 6.40 | 10.67 | 11.37 | 1.22 | 1.31 | 95.6 | 102.0 | 77 | Wm. Nicholson | |
| 550A | | 6.40 | 15.69 | 16.77 | 5.87 | 6.27 | 9.04 | 9.67 | .78 | .83 | 88.8 | 94.9 | 199 | Mrs. Weston | |
| 550B | | 6.64 | 17.22 | 18.43 | 6.20 | 6.64 | 10.12 | 10.83 | .90 | .96 | 95.7 | 102.4 | 199 | " " | |
| 566 | | 6.80 | 16.45 | 17.66 | 5.59 | 6.00 | 9.59 | 10.30 | 1.27 | 1.36 | 88.9 | 95.4 | 14 | Oral Egan | |
| 609 | | 6.56 | 16.00 | 17.12 | 5.25 | 5.62 | 9.53 | 10.20 | 1.22 | 1.30 | 84.3 | 90.2 | 119 | Eric Larson | |
| 611 | | 5.80 | 17.17 | 18.23 | 6.30 | 6.69 | 9.70 | 10.30 | 1.17 | 1.24 | 95.3 | 101.3 | 66 | O J. Schlottman | |

Table 10
Correlation Coefficients Between Certain Physical and Chemical Characters of Hops - 1937 Crop

| Characters | Correlation Coefficient | Probable Error |
|---|---|---|
| Per cent whole cones - soft resins | -.207 | ± .099 |
| Per cent foreign material - soft resins | .099 | ± .101 |
| Per cent dark seed - soft resins | -.024 | ± .011 |
| Per cent seeds - soft resins | .018 | ± .070 |