1957
ANNUAL REPORT

of

HOP INVESTIGATIONS
(OAES 36, CRe5)

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by

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cooperating

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INTRODUCTION

This 1957 annual report of the hop investigations in the Pacific Northwest includes data which were collected and summarized during the calendar year. These investigations are those conducted cooperatively by personnel of the U. S. D. A., A. R. S., the Oregon Agricultural Experiment Station, and the Irrigation Experiment Station at Prosser, Washington. For ease in reviewing, descriptions, summaries and summarizing data are included in the fore part of the report by specific line project. Additional data which are important enough to include as a matter of permanent record are included in an appendix at the end of the report.

Since some of the line projects are conducted cooperatively by personnel located at Oregon State College, more than one investigator may have work reported in one line project report. An attempt has been made to give each investigator full credit for his contribution to the year's work.

The work reported in this report is directed along five lines involving studies on hop culture, breeding, disease and quality investigations. The studies on hop culture and breeding are cooperative among the agronomist, the chemist and the plant pathologist. The studies on disease control are conducted by the plant pathologist. Chemical studies are cooperative between the Chemist and the agronomist on certain phases, and other phases are conducted independently by the Chemist. A fifth type of investigation includes studies of field, greenhouse and laboratory techniques relative to the breeding, disease and agronomic lines of endeavor. Any one of the project leaders may have work reported under this line project from time to time.

Financial support of these investigations is borne by A. R. S., the Oregon Agricultural Experiment Station, and the Irrigation Experiment Station at Prosser, Washington. In addition, certain annual grants of funds are

contributed by the Brewing Industries Research Institute for partial support of specific phases of the work conducted in Oregon. Oregon State College furnishes laboratory, greenhouse, office and field facilities for conducting the work at Corvallis. The Irrigation Experiment Station also furnishes field, office, laboratory and greenhouse facilities in support of the work at Prosser.

Hop production traditionally has been subject to wide variation in total acreage, total production and center of production. The hop industry suffered a severe recession in the early 1950's due to low prices. Since 1956 there has been considerable improvement in this situation, and the industry is once again on a sound basis. A continuation of expansion could, however, bring about another recession by 1961. The future of hops will depend upon the export market to a large extent in the next 3 or 4 years.

Following is a table showing acreages and production since 1946.

Hop acreage and production in the Pacific Northwest, 1946-1957.

State	Acreage harvested*		Yield per acre(lbs.)*		January, 1958 estimate of 1958 hop acreage **	
	1946-55	1957	1946-55	1957	new acres	total acres
Washington	13,360	15,200	1,686	1,560	3,450	18,650
California	8,210	5,600	1,564	1,220	400	6,000
Oregon	12,980	4,500	1,083	1,230	650	5,150
Idaho	1,075	2,400	1,802	1,690	1,100	3,500
P N W	35,625	27,700	1,446	1,449	5,600	33,300

* From Hop Market Review, Vol. XXXVIII No. 1, January 20, 1958, U.S.D.A., A.M.S., Grain Division.

** From The Brewers Bulletin, Vol. 51, No. 6, January 20, 1958.

Climatological data taken at Hyslop Agronomy Farm, near Corvallis, Oregon, in 1957, and during previous years.

Month	Avg. Max. Temp. (°F) 1957	Avg. Max. Temp. (°F) 25 yr. avg.	Avg. Min. Temp. (°F) 1957	Avg. Min. Temp. (°F) 25 yr. avg.	Avg. Mean Temp. (°F) 1957	Avg. Mean Temp. (°F) 25 yr. avg.	Precipitation (inches) 1957	Precipitation (inches) 5 yr. avg.
1956								
Oct.	61.16	65.4	40.07	43.8	50.96	54.6	5.86	3.62
Nov.	50.50	53.1	32.66	38.3	41.58	45.8	1.38	5.42
Dec.	46.45	47.6	34.90	36.0	39.43	41.9	4.56	7.21
1957								
Jan.	37.61	46.0	25.87	33.2	31.74	39.6	2.78	6.26
Feb.	49.21	51.0	34.50	35.1	41.86	43.1	4.89	4.74
Mar.	53.13	55.9	39.52	37.7	46.33	46.8	7.01	3.91
Apr.	61.13	63.0	40.77	40.9	50.95	51.6	2.11	2.05
May	67.45	69.0	47.48	45.1	57.47	57.0	3.21	1.83
June	72.87	73.8	49.53	49.1	61.20	61.7	1.07	1.14
July	78.06	80.7	49.13	52.2	63.6	66.4	.17	.36
Aug.	77.48	81.3	48.35	51.9	62.9	66.7	.22	.44
Sept.	80.23	76.7	48.80	49.1	64.5	63.0	1.50	1.35
Yearly total							34.76	38.33
Yearly mean	61.3	63.7	41.0	42.7	51.0	53.2		

Month	Rel. humid. @ 8 AM (%) 1957	Rel. humid. @ 8 AM (%) 5yr. Avg.	Evaporation (in.) 1957	Evaporation (in.) 26 yr. Avg.	Sky cover (days) No. clear 1957	Sky cover (days) No. clear 17 yr. Avg.	Sky cover (days) No. ptly. cloudy 1957	Sky cover (days) No. ptly. cloudy 17 yr. Avg.	Sky cover (days) No. cloudy 1957	Sky cover (days) No. cloudy 17 yr. Avg.	Sky cover (days) No. rainy 1957	Sky cover (days) No. rainy 17 yr. Avg.	Avg. wind velocity (MPH) 1957	Avg. wind velocity (MPH) 5 yr. Avg.
1957														
Apr.	78.5	81.2		2.744	7	8.9	19	10.8	3	9.4	12	13.3	1.74	2.10
May	79.5	76.0	3.430	4.061	12	9.9	12	12.4	7	8.5	14	10.6	1.00	1.27
June	75.4	75.6	4.624	4.685	3	8.3	20	12.2	7	9.2	6	8.9	1.08	1.31
July	69.9	70.7	7.046	6.485	8	17.4	23	10.3	0	3.1	2	2.8	1.86	1.47
Aug.	76.0	74.8	5.868	5.923	13	15.9	14	9.	4	6.1	2	3.1	1.89	1.50
Sept.	74.0	81.0	5.036	3.829	18	15.9	7	8.9	5	5.1	3	5.5	1.88	1.61
Yearly total					61	76.2	95	63.6	26	41.4	39	44.2		
Yearly mean	75.6	76.6	5.20	4.621									1.58	1.54

HOP BREEDING FOR IMPROVEMENT IN DISEASE RESISTANCE, QUALITY, AND YIELDING ABILITY. (CRs5-1, OAES 36-1)

Stanley N. Brooks

The results from this line project and the work done under it will be reported in two sections, breeding and evaluation. This line project is necessarily broad and involves the work of all three project leaders. In order to make the results more meaningful, agronomic, chemical and disease data are all summarized by evaluation trial within this line project rather than being separated into three sections of the report.

Genetic diversity for the breeding program consists of four widely grown varieties and approximately 75 introductions of which only a few remain. Many of them are now represented only by first or later generation progeny, and some have been discarded entirely. None of the varieties or introductions have exhibited immunity to downy mildew. Some of them possess acceptable quality and agronomic characteristics, but none of them are sufficiently satisfactory in all important features that improvement through breeding is not desirable.

The breeding program has been confined, in general, to inter-varietal crossing involving both domestic and foreign varieties. Selection is based upon resistance to disease, primarily downy mildew, desirable agronomic characteristics, and chemical analyses.

The testing of advanced lines has now reached the point where it is necessary for final evaluation to take place under actual field conditions in several locations. Release of any of the lines as recommended varieties is contingent upon their performance in such trials.

An informal memorandum of understanding has been drawn up which will regulate an off-station testing program in Oregon and Washington in cooperation with hop growers. Several lines have been increased and will be tested in large plots (50-100 hills) on several growers' yards beginning in 1958.

The lines 103-I, 107-I, 108-I, 135-I, 128-I, and 139-I will be tested in Washington. The lines 112-I, 135-I, 128-I and 144-I will undergo testing in Oregon. By 1959 most of these lines probably will be in test programs in California and Idaho.

There have been additional changes made in this line project this year. The Early Maturity and the Late Maturity yield trials were discontinued at the end of the 1956 season after having yielded five years of data on the constituent lines. It was decided that none of the lines would be carried further in the program.

The high-low Fuggles selections were discontinued at the end of the 1956 season, and the results are being summarized for publication. Most of the selections are being held in order that eventually a study can be made to determine the causes for their differences.

Genetic estimates were not computed this year due to lack of time. It is planned that more work along this line will be done, however, it will have to wait another year. More extensive genetic estimates were made during 1957 from data collected in 1956 in the High-low Fuggles selections. No summary of these data will be made here, but it will be included in the publication on this particular trial.

BREEDING

Crossing

Seed was collected from a total of 262 controlled parentage and open-pollinated sources in 1957.

The first 40 crosses (Group I) in the list involve combinations of downy mildew resistant x resistant, resistant x susceptible, susceptible x resistant, and susceptible x susceptible individuals using the following female and male plants as parents.

Resistant females	Susc. females	Resistant males	Susc. males
106(506) C19032	210(410) C19027	121-2(525) C19062M	221-2(425-1)C51101M
209(409) C19026	212(412) C19028	421-1,2(225)C19040M	317-1,2(317)C19041M
409-2(209-2)C19067	216(416) C19029	521-4,5(126)C19010M	321-1(325) C19049M
25-S I19120	314(314) C19076		
214-2(414-2)C19084	505(105) C19063		

Wherever sufficient seedlings are obtained from a progeny, approximately 100 randomly selected plants will be grown under close spacing in the field for a period of two or three production years. These progenies will be used to furnish inheritance data on resistance to downy mildew and perhaps other characteristics. Clones of the parental material will be grown in the same nursery area.

Any seedlings in excess of 100 will be subjected to a greenhouse downy mildew epiphytotic during the spring of 1958 for the purpose of screening out downy mildew susceptible plants. Records will be kept of seedling progeny performances for future comparison with mature plant progeny performances.

19 crosses (Group II) were made involving the parental combinations from which at least 5 downy mildew resistant seedlings were obtained in 1957 or which had an insufficient number of seedlings in their progenies to constitute a good test in 1957.

These crosses were:

57042	57136	57161	57197
57047	57138	57162	57218
57071	57141	57184	57225
57073	57145	57186	57256
57088	57149	57196	

79 crosses (Group III) were made involving female parents which, on the basis of their open-pollinated progenies in 1956 and 1957, exhibited promise as parents. These females produced progeny (OP) from which downy mildew resistant seedlings were selected. The males used in these crosses were those which had resistant seedlings in either 1956 or 1957 when they were crossed with females other than these.

This group of crosses was by far the largest group of controlled crosses made, and except for group II could be expected to produce the greatest percentage of superior seedlings, since all parents have been progeny tested to some extent.

Females:

102-3	214-3	501-3	7-S	48-S
111-2	304-2	503-2	15-S	50-S
113-1	314	504-1	23-S	58-S
201-1	315-2	504-2	34-S	61-S
202-3	315-3	507-1	35-S	94-S
203	401	507-2	36-S	148-S
208-3	403	507-3	41-S	
211-1	405-2	511-3	46-S	

Males:

119-1,2	219-1,2	417-1,2	520-1,2
119-4,5	219-5	417-5	521-2
120-1,2	318-1,2	418-1,2	108-S
120-5	318-4,5	418-5	110-S
121-4,5	319-2(noX's)	419-1,2	119-S
217-1,2	319-4,5	420-4,5	124-S
217-4,5	320-1,2	517-1,2	221-1
218-1,2	320-4,5		

Crosses:

57044	57086	57146	57215	57245
57051	57092	57147	57230	57246
57053	57104	57148	57231	57247
57054	57105	57152	57232	57248
57062	57106	57153	57233	57249
57063	57128	57154	57234	57250
57066	57129	57156	57235	57251
57067	57130	57160	57236	57252
57068	57131	57183	57237	57253
57069	57132	57185	57238	57254
57070	57133	57192	57239	57255
57072	57134	57194	57240	57257
57074	57135	57198	57241	57258
57080	57137	57204	57242	57259
57081	57143	57206	57243	57262
57082	57144	57214	57244	

Group IV consisted of 18 crosses constituting a progeny test on a number of new male lines which had not been used in the 1956 crossing program. These males were crossed with two to four unselected females. Superior breeding male lines will be selected for use in the breeding program on the basis of the performance of their progenies in the 1958 nursery.

Males	Progeny test crosses obtained
518-2 (C52040M)	57178
518-5 (C52041M)	57175, 57120
519-2 (C52042M)	57177, 57121
219-4 (C51061M)	57176, 57119
223-S (C53088M)	57078
201-S (C53078M)	57179, 57122
199-S (C53076M)	57111
317-4 (C51054M)	57110, 57155, 57170
419-5 (C52048M)	57150, 57157, 57171
520-5 (C52044M)	57172

No seed was obtained from crosses involving male line 197-S. This male, along with 518-2, 223-S, and 520-5, should be further tested next year. 199-S and 201-S have already been discarded because of extreme susceptibility to downy mildew.

Open-pollinated seed was collected from all female plants in the breeding block which were acquired in 1950 or later, in addition to Fuggles and Late Clusters. This group of crosses (Group V) will constitute a progeny test of new females in the 1958 nursery. Selection of superior females will be made on the basis of progeny performance. Selected females will be retained in the breeding program.

Open-pollinated seed lots obtained from:

101-2	114-3	215-2	306-1	405-2	502-1	507-1	513-2
102-3	115-2(D)	215-3	306-2	405-3	502-2	507-3	513-3
103-3	122	222	306-3	406-1	502-3	508-1	514-2
104-1	201-1	301-1	308-3	406-2	503-1	509-1	515-3(D)
109-1	201-2	3-1-2	309-1(D)	406-3	503-2	510-1	516-1(D)
111-1	202-3	301-3	309-2(D)	407-2	504-1	510-2	516-2(D)
111-2	204-2(D)	302-1	313-1(D)	408-2	504-2	511-1	109-S
113-1	208-3	302-3	313-2	413-2	504-3	511-2	139-S
113-2	211-1	303-2(D)	316-1	413-3	506-1	511-3	
113-3	211-2	304-1	316-2	501-1	506-2	512-1	
114-2	213-2(D)	304-2	405-1	501-3	506-3	512-3	

Group VI in 1957 consisted of obtaining open-pollinated seed from two new introductions which were acquired in 1956. These introductions are Hallertau and Backa, I 56001 and I 56002, respectively. The intention is to initiate a backcrossing program for the purpose of developing lines which possess the quality characteristics of the introductions in combination with disease resistance, vigor, and adaptability of the better males.

17 crosses (Group VII) were made after August 1 which combined several of the very late lines in the breeding block.

Late females:			Late males:	Crosses:	
110-2(noX's)	306-3(noX's)	513-3	118-4	57076	57123
115-2(noX's)	309-1	514-2	120-5	57077	57126
204-2	309-2	515-3	121-5	57083	57127
209	312	516-1(noX's)	217-2	57084	57168
213-2	313-2	516-2(noX's)	218-1	57090	57221
301-3(noX's)	316-1(noX's)		219-1(noX's)	57091	57223
303-2(noX's)	407-3		220-1	57114	57224
306-1(noX's)	502-2(noX's)		221-2	57115	57227
306-2(noX's)	511-2(noX's)		318-5	57117	

Following stratification at 36°F in moist vermiculite for a period of six weeks the seed will be germinated in the greenhouse. With the exception of portions of the progenies in Group I, all seedlings will be subjected to a downy mildew screening test in the greenhouse. Only selected seedlings will be transferred to the field for further evaluation.

As a matter of interest, no seed was obtained from a fairly large open-pollinated sample of cones from BB 107-1 (507-3) C 54029 in 1957. This line may be sterile similar to 128 I (C 19113) and 515-1 (115-3) C 54009.

Seedling Nursery

A total of 827 seedlings were selected following the greenhouse downy mildew screening program in the spring of 1957. These seedlings were transplanted in the field under normal spacing where they will grow until the end of the 1958 season. At that time a small number of the outstanding seedlings will be selected for subsequent evaluation.

The 827 seedlings represent 197 progenies out of a total of 273 controlled parentage and open-pollinated sources obtained in 1956. These seedlings comprise approximately two percent. of the 40,000 seedlings subjected to the greenhouse screening program.

Selections saved in 1957

21 selections were saved from the 1953, 1954 and 1955 material in the disease nursery. 19 selections were saved from the 1956 nursery. The males in these groups will go into the breeding block where they will be progeny tested for breeding behavior. The females from these groups will be increased and grown in five-hill observation plots. The observation plots will serve also as increase plots for those lines which appear to warrant further evaluation in the disease nursery and in yield trials.

Crosses and OP's for 1958 Nursery

Cross No.	Pedigree
57001	106 (506) C 19032 x 121-2 (525) C 19062 M
57002	106 (506) C 19032 x 221-2 (425-1) C 51101 M
57003	106 (506) C 19032 x 317-1,2 (317) C 19041 M
57004	106 (506) C 19032 x 321-1 (325) C 19049 M
57005	106 (506) C 19032 x 421-1,2 (225) C 19040 M
57006	106 (506) C 19032 x 521-4,5 (126) C 19010 M
57007	209 (409) C 19026 x 121-2 (525) C 19062 M
57008	209 (409) C 19026 x 221-2 (425-1) C 51101 M
57009	209 (409) C 19026 x 317-1,2 (317) C 19041 M
57010	209 (409) C 19026 x 321-1 (325) C 19049 M
57011	209 (409) C 19026 x 421-1,2 (225) C 19040 M
57012	209 (409) C 19026 x 521-4,5 (126) C 19010 M
57013	210 (410) C 19027 x 317-1 (317) C 19041 M
57014	210 (410) C 19027 x 521-4,5 (126) C 19010 M
57015	212 (412) C 19028 x 121-2 (525) C 19062 M
57016	212 (412) C 19028 x 221-2 (425-1) C 51101 M
57017	212 (412) C 19028 x 317-1,2 (317) C 19041 M
57018	212 (412) C 19028 x 321-1 (325) C 19049 M
57019	212 (412) C 19028 x 421-1,2 (225) C 19040 M
57020	212 (412) C 19028 x 521-4,5 (126) C 19010 M
57021	214-2 (414-2) C 19084 x 317-1,2 (317) C 19041 M
57022	216 (416) C 19029 x 321-1 (325) C 19049 M
57023	216 (416) C 19029 x 521-4,5 (126) C 19010 M
57024	314 (314) C 19076 x 121-2 (525) C 19062 M
57025	314 (314) C 19076 x 221-2 (425-1) C 51101 M

Cross No.	Pedigree
57026	314 (314) C 19076 x 317-1,2 (317) C 19041 M
57027	314 (314) C 19076 x 321-1 (325) C 19049 M
57028	314 (314) C 19076 x 421-1,2 (225) C 19040 M
57029	314 (314) C 19076 x 521-4,5 (126) C 19010 M
57030	409-2 (209-2) C 19067 x 317-1,2 (317) C 19041 M
57031	409-2 (209-2) C 19067 x 521-4,5 (126) C 19010 M
57032	505 (105) C 19063 x 121-2 (525) C 19062 M
57033	505 (105) C 19063 x 221-2 (425-1) C 51101 M
57034	505 (105) C 19063 x 317-1,2 (317) C 19041 M
57035	505 (105) C 19063 x 421-1,2 (225) C 19040 M
57036	505 (105) C 19063 x 521-4,5 (126) C 19010 M
57037	25-S-I 19120 x 317-1,2 (317) C 19041 M
57038	25-S-I 19120 x 321-1 (325) C 19049 M
57039	25-S-I 19120 x 421-1,2 (225) C 19040 M
57040	25-S-I 19120 x 521-4,5 (126) C 19010 M
57041	101-2 (501-2) C 50075 x O P
57042	101-2 (501-2) C 50075 x 120-1,2(523) C 19060 M
57043	102-3 (502-1) C 50091 x O P
57044	102-3 (502-1) C 50091 x 320-1,2 (323) C 19047 M
57045	103-3 (503-1) C 52016 x O P
57046	104-1 (504-3) C 53046 x O P
57047	108 (508) C 19033 x 124-S-C 19183 M
57048	109-1 (509-3) C 53050 x O P
57049	111-1 (511-3) C 53052 x O P
57050	111-2 (511-2) C 50054 x O P

Cross No.	Pedigree
57051	111-2 (511-2) C 50054 x 419-1,2 (221) C 19037 M
57052	113-1 (513-3) C 53053 x O.P.
57053	113-1 (513-3) C 53053 x 124-S C 19183 M
57054	113-1 (513-3) C 53053 x 219-1,2 (421) C 19053 M
57055	113-2 (513-2) C 52018 x O P
57056	113-3 (513-1) C 52017 x O P
57057	114-2 (514-2) C 52021 x O P
57058	114-3 (514-1) C 52020 x O P
57059	115-2 (515-2) C 53054 x O P
57060	122- I 19208 x O P
57061	201-1 (401-3) C 53030 x O P
57062	201-1 (401-3) C 53030 x 119-1,2 (521) C 19058 M
57063	201-1 (401-3) C 53030 x 217-1,2 (417) C 19050 M
57064	201-2 (401-2) C 52006 x O P
57065	202-3 (402-1) C 53031 x O P
57066	202-3 (402-1) C 53031 x 217-4,5 (418) C 19085 M
57067	202-3 (402-1) C 53031 x 320-1,2 (323) C 19047 M
57068	203 (403) C 19022 x 120-1,2 (523) C 19060 M
57069	203 (403) C 19022 x 121-4,5 (524) C 19061 M
57070	203 (403) C 19022 x 218-1,2 (419) C 19051 M
57071	203 (403) C 19022 x 318-1,2 (319) C 19043 M
57072	203 (403) C 19022 x 320-4,5 (324) C 19048 M
57073	203 (403) C 19022 x 418-1,2 (219) I 19006 M
57074	203 (403) C 19022 x 119-S- C 19180 M
57075	204-2 (404-2) C 53035 x O P

Cross No.	Pedigree
57076	204-2 (404-2) C 53035 x 217-1,2 (417) C 19050 M
57077	204-2 (404-2) C 53035 x 220-1 (423) C 19054 M
57078	206 (406) C 19024 x 223-S- C 53088 M
57079	208-3 (408-1) C 53037 x O P
57080	208-3 (408-1) C 53037 x 119-4,5 (520) C 19057 M
57081	208-3 (408-1) C 53037 x 120-5 (522-1) C 19059 M
57082	208-3 (408-1) C 53037 x 318-4,5 (320) C 19044 M
57083	209 (409) C 19026 x 121-5 (524) C 19061 M
57084	209 (409) C 19026 x 217-2 (417) C 19050 M
57085	211-1 (411-3) C 53040 x O P
57086	211-1 (411-3) C 53040 x 119-S- C 19180 M
57087	211-2 (411-2) C 53039 x O P
57088	211-2 (411-2) C 53039 x 219-1,2 (421) C 19053 M
57089	213-2 (413-2) C 54025 x O P
57090	213-2 (413-2) C 54025 x 217-2 (417) C 19050 M
57091	213-2 (413-2) C 54025 x 220-1 (423) C 19054 M
57092	214-3 (414-1) C 19083 x 420-4,5 (224) C 19039 M
57093	215-2 (415-2) C 52013 x O P
57094	215-3 (415-1) C 52012 x O P
57095	222- I 19209 x O P
57096	301-1 (301-3) C 50040 x O P
57097	301-2 (301-2) C 50024 x O P
57098	301-3 (301-1) C 50019 x O P
57099	302-1 (302-3) C 52001 x O P
57100	302-3 (302-1) C 51065 x O P

Cross No.	Pedigree
57101	303-2 (303-2) C 53022 x O P
57102	304-1 (304-3) C 52002 x O P
57103	304-2 (304-2) C 53023 x O P
57104	304-2 (304-2) C 53023 x 219-1,2 (421) C 19053 M
57105	304-2 (304-2) C 53023 x 218-1,2 (419) C 19051 M
57106	304-2 (304-2) C 53023 x 318-1,2 (319) C 19043 M
57107	306-1 (306-3) C 51105 x O P
57108	306-2 (306-2) C 51104 x O P
57109	306-3 (306-1) C 51103 x O P
57110	307 (307) C 19020 x 317-4 (318-2) C 51054 M
57111	307 (307) C 19020 x 199-S- C 53076 M
57112	308-3 (308-1) C 51021 x O P
57113	309-1 (309-3) C 53026 x O P
57114	309-1 (309-3) C 53026 x 120-5 (522-1) C 19059 M
57115	309-1 (309-3) C 53026 x 318-5 (320) C 19044 M
57116	309-2 (309-2) C 53025 x O P
57117	309-2 (309-2) C 53025 x 120-5 (522-1) C 19059 M
57118	309-2 (309-2) C 53025 x 219-1- (421) C 19053 M
57119	311 (311) I 19001 x 219-4 (422-2) C 51061 M
57120	311 (311) I 19001 x 518-5 (120) C 52041 M
57121	311 (311) I 19001 x 519-2 (121) C 52042 M
57122	311 (311) I 19001 x 201-S- C 53078 M
57123	312 (312) C 19021 x 318-5 (320) C 19044 M
57124	313-1 (313-3) C 53028 x O P
57125	313-2 (313-2) C 52004 x O P

Cross No.	Pedigree
57126	313-2 (313-2) C 52004 x 318-5 (320) C 19044 M
57127	313-2 (313-2) C 52004 x 120-5 (522-1) C 19059 M
57128	314 (314) C 19076 x 120-5 (522-1) C 19059 M
57129	314 (314) C 19076 x 121-4,5 (524) C 19061 M
57130	314 (314) C 19076 x 221-1 (425-2) C 51114 M
57131	314 (314) C 19076 x 218-1,2 (419) C 19051 M
57132	314 (314) C 19076 x 100-S- C 19173 M
57133	314 (314) C 19076 x 124-S- C 19183 M
57134	315-2 (315-2) C 19078 x 318-4,5 (320) C 19044 M
57135	315-2 (315-2) C 19078 x 319-4,5 (322) C 19046 M
57136	315-3 (315-1) C 19077 x 110-S- C 19173 M
57137	315-3 (315-1) C 19077 x 417-1,2 (217) C 19036 M
57138	315-3 (315-1) C 19077 x 119-1,2 (521) C 19058 M
57139	316-1 (316-3) C 52005 x O P
57140	316-2 (316-2) C 53029 x O P
57141	316-2 (316-2) C 53029 x 218-1,2 (419) C 19051 M
57142	322- I 56001 x O P
57143	401 (201) C 19012 x 217-2 (417) C 19050 M
57144	401 (201) C 19012 x 219-1,2 (421) C 19053 M
57145	401 (201) C 19012 x 219-5 (422-1) C 51060 M
57146	401 (201) C 19012 x 221-1 (425-2) C 51114 M
57147	401 (201) C 19012 x 320-4,5 (324) C 19048 M
57148	401 (201) C 19012 x 418-1,2 (219) I 19006 M
57149	401 (201) C 19012 x 521-4,5 (126) C 19010 M
57150	402 (202) C 19013 x 419-5 (222) C 52048 M

Cross No.	Pedigree
57151	402 (202) C 19013 x 197-S-C 53074 M
57152	403 (203) C 19011 x 119-1,2 (521) C 19058 M
57153	403 (203) C 19011 x 217-4,5 (418) C 19085 M
57154	403 (203) C 19011 x 318-4,5 (320) C 19044 M
57155	404 (204) C 19014 x 317-4 (318-2) C 51054 M
57156	403 (203) C 19011 x 419-1, 2 (221) C 19037 M
57157	404 (204) C 19014 x 419-5 (222) C 52048 M
57158	405-1 (205-3) C 54012 x O P
57159	405-2 (205-2) C 54011 x O P
57160	405-2 (205-2) C 54011 x 219-5 (422-1) C 51060 M
57161	405-2 (205-2) C 54011 x 417-5 (218) C 52046 M
57162	405-2 (205-2) C 54011 x 418-5 (220) C 52047 M
57163	405-3 (205-1) C 54010 x O P
57164	406-1 (206-3) C 54013 x O P
57165	406-2 (206-2) C 50022 x O P
57166	406-3 (206-1) C 50021 x O P
57167	407-2 (207-2) C 54015 x O P
57168	407-3 (207-1) C 54014 x 118-4 (518) I 19005 M
57169	408-2 (208-2) C 51049 x O P
57170	411 (211) C 19015 x 317-4 (318-2) C 51054 M
57171	411 (211) C 19015 x 419-5 (222) C 52048 M
57172	411 (211) C 19015 x 520-5 (124) C 52044 M
57173	413-2 (213-2) C 50053 x O P
57174	413-3 (213-1) C 50052 x O P
57175	416 (216) I 19003 x 518-5 (120) C 52041 M
57176	416 (216) I 19003 x 219-4 (422-2) C 51061 M

Cross No.	Pedigree
57177	416 (216) I 19003 x 519-2 (121) C 52042 M
57178	416 (216) I 19003 x 518-2 (119) C 52040 M
57179	416 (216) I 19003 x 201-S- C 53078 M
57180	422 I 56002 x O P
57181	501-1 (101-3) C 50016 x O P
57182	501-3 (101-1) C 50008 x O P
57183	501-3 (101-1) C 50008 x 320-4,5 (324) C 19048 M
57184	501-3 (101-1) C 50008 x 420-4,5 (224) C 19039 M
57185	501-3 (101-1) C 50008 x 517-1,2 (117) C 19008 M
57186	501-3 (101-1) C 50008 x 521-4,5 (126) C 19010 M
57187	502-1 (102-3) C 51048 x O P
57188	502-2 (102-2) C 51041 x O P
57189	502-3 (102-1) C 51027 x O P
57190	503-1 (103-3) C 50028 x O P
57191	503-2 (103-2) C 53002 x O P
57192	503-2 (103-2) C 53002 x 318-4,5 (320) C 19044 M
57193	504-1 (104-3) C 54004 x O P
57194	504-1 (104-3) C 54004 x 318-1,2 (319) C 19043 M
57195	504-2 (104-2) C 54003 x O P
57196	504-2 (104-2) C 54003 x 221-2 (425-1) C 51101 M
57197	504-2 (104-2) C 54003 x 221-1 (425-2) C 51114 M
57198	504-2 (104-2) C 54003 x 521-2 (125) C 52045 M
57199	504-3 (104-1) C 54002 x O P
57200	506-1 (106-3) C 50032 x O P

Cross No.	Pedigree
57201	506-2 (106-2) C 50031 x O P
57202	506-3 (106-1) C 50030 x O P
57203	507-1 (107-3) C 54007 H x O P
57204	507-1 (107-3) C 54007 H x 221-1 (425-2) C 51114 M
57205	507-3 (107-1) C 54005 x O P
57206	507-3 (107-1) C 54005 x 319-4,5 (322) C 19046 M
57207	508-1 (108-3) C 50046 x O P
57208	509-1 (109-3) C 50056 x O P
57209	510-1 (110-3) C 52038 x O P
57210	510-2 (110-2) C 52037 x O P
57211	511-1 (111-3) C 50080 x O P
57212	511-2 (111-2) C 50071 x O P
57213	511-3 (111-1) C 53007 x O P
57214	511-3 (111-1) C 53007 x 318-1,2 (319) C 19043 M
57215	511-3 (111-1) C 53007 x 418-5 (220) C 52047 M
57216	512-1 (112-3) C 50114 x O P
57217	512-3 (112-1) C 53008 x O P
57218	512-3 (112-1) C 53008 x 217-4,5 (418) C 19085 M
57219	513-2 (113-2) C 50017 x O P
57220	513-3 (113-1) C 53010 x O P
57221	513-3 (113-1) C 53010 x 218-1 (419) C 19051 M
57222	514-2 (114-2) C 53013 x O P
57223	514-2 (114-2) C 53013 x 218-1 (419) C 19051 M
57224	514-2 (114-2) C 53013 x 221-2 (425-1) C 51101 M
57225	514-2 (114-2) C 53013 x 521-2 (125) C 52045 M

Cross No.	Pedigree
57226	515-3 (115-1) C 53014 x O P
57227	515-3 (115-1) C 53014 x 118-4 (518) I 19005 M
57228	516-1 (116-3) C 53018 x O P
57229	516-2 (116-2) C 53017 x O P
57230	7-S C 19102 x 119-S C 19180 M
57231	7-S C 19102 x 217-4,5 (418) C 19085 M
57232	7-S C 19102 x 517-1,2 (117) C 19008 M
57233	15-S C 19110 x 318-1,2 (319) C 19043 M
57234	15-S C 19110 x 110-S C 19173 M
57235	23-S C 19118 x 217-1,2 (417) C 19050 M
57236	23-S C 19118 x 110-S C 19173 M
57237	34-S C 19123 x 121-4,5 (524) C 19061 M
57238	34-S C 19123 x 221-1 (425-2) C 51114 M
57239	34-S C 19123 x 108-S C 19172 M
57240	35-S C 19124 x 417-5 (218) C 52046 M
57241	35-S C 19124 x 108-S C 19172 M
57242	36-S C 19125 x 520-1,2 (123) C 19009 M
57243	36-S C 19125 x 124-S C 19183 M
57244	41-S C 19129 x 121-4,5 (224) C 19061 M
57245	41-S C 19129 x 420-4,5 (224) C 19039 M
57246	41-S C 19129 x 520-1,2 (123) C 19009 M
57247	46-S C 19134 x 319-4,5 (322) C 19046 M
57248	46-S C 19134 x 517-1,2 (117) C 19008 M
57249	48-S I 19016 x 419-1,2 (221) C 19037 M
57250	48-S I 19016 x 124-S C 19183 M

Cross No.	Pedigree
57251	50-S I 19137 x 120-1,2 (523) C 19060 M
57252	58-S C 19139 x 119-S C 19180 M
57253	61-S C 19142 x 119-4,5 (520) C 19057 M
57254	61-S C 19142 x 521-2 (125) C 52045 M
57255	61-S C 19142 x 108-S C 19172 M
57256	73-S C 19152 x 108-S C 19172 M
57257	94-S C 19164 x 119-1,2 (521) C 19058 M
57258	94-S C 19164 x 418-5 (220) C 52047 M
57259	94-S C 19164 x 110-S C 19173 M
57260	109-S C 52033 x O P
57261	139-S C 52036 x O P
57262	148-S C 19200 x 521-2 (125) C 52045 M

Note: Revised breeding block numbers listed first and old numbers listed second.

Selections saved in 1957

Disease nursery:

DN 101	C 53091 M	Good vigor, some mildew
106	C 55004	Fair hop, strong (pleasant), some mildew
122	C 55014	Not much vigor, strong (pleasant), some mildew
307	C 53118	Fuggles type, fair vigor, some mildew
312	C 55036	Not much vigor, fairly rich (sweet), some mildew
318	C 55039	Fair vogor, late (looks rich), no mildew
321	C 55125	Young plant, mild (somewhat off), no mildew
324	C 55042	Late, small cones, no mildew
421	C 54039	Fuggles type, no mildew
412	C 55048 M	Small plant, no mildew
403	C 54033	Good vigor, sweet, no mildew
502	C 55055	Mild (low lupulin), no mildew
508	C 55058	Small plant, sweet, no mildew
519	C 54049	Very good vigor, sweet, some mildew
604	C 55068	Good vigor, poor cones, late, no mildew
705	C 54066 M	Fair vigor, no mildew
708	C 55083	Good vigor, rich, seeded, mildew susceptible
720	C 55088	Hermaphroditic, male and female fertile
812	C 55096	Young plant, Fuggles type, some mildew
809	C 54076	Leafless, rich (sweet), some mildew
904	C 55104	Late, no mildew

1956 nursery:

C 56003	Med. aroma, long cone, not hopped down well
C 56004	Med. strong, small cone
C 56005	Mild, high prop. cones, large cones, shatters, red vine
C 56006	Sweet, late, good set
C 56007 M	Very good vigor, nice appearance
C 56008	Strong, sweet, long pointed cone, not much vigor
C 56009	Med. aroma, good set, small dark cones
C 56010	Med. aroma, tight cones
C 56011	Mild, good set
C 56012	Med. aroma, good vigor, dark cones
C 56013	Med. strong, long arms, high prop. cones, small cones
C 56014	Sweet, small cones, not hopped down well
C 56015 M	Good vigorous male
C 56016	Med. aroma, compact cone, seedless, not much vigor
C 56017	Med. mild, large cones, good set
C 56018	Rich, strong, ragged cone, not much vigor
C 56019	Med. aroma, large cones, shatters, hopped down well, good set
C 56020	Large tight cone, does not shatter
C 56021	Ragged, seedless, very poor vigor

Disease Nursery

(Chester E. Horner)

A disease nursery was established in 1955 to aid in field evaluation of promising lines for resistance to downy mildew. In dry seasons it is not possible to obtain accurate evaluation of resistance to downy mildew in the field. The disease nursery provides conditions favorable for downy mildew development in spite of the weather. An overhead mist spray system with automatic humidistat is installed over an area where approximately 200 individual plants can be tested in any one year. The nursery area contains a scattering of mildew susceptible varieties around and throughout to provide for inoculum and for maintenance of mildew.

Testing Procedure:

Selected lines were planted in the nursery area in 1955 and 1956. These included selected individuals from the 1953 and 1955 bulk plantings and 2 or 3 plants each of lines in the Corvallis-Prosser yield trial. On May 21, 1957 all plants were uniformly inoculated with a downy mildew spore suspension. At that time the nursery area already contained a large amount of natural infection. Inoculation was made during a period when conditions for infection were good. Disease development was rapid and severe.

Results:

On May 31 and again on July 6, each plant was examined and rated for mildew severity. The table below shows mildew rating and disposition of the plants.

1957 Hop Disease Nursery Mildew Ratings

Row & Plant No.	Acc. No. or Name	Mildew rating* May 31	Mildew rating* July 6	Comments	Row & Plant No.	Acc. No. or Name	Mildew rating* May 31	Mildew rating* July 6	Comments
**1-1	C53091M	L	M		2-1	Hallertau	L	L	small
1-2		S	S		2-2		S	S	
1-3		M	S		2-3		S	S	
1-4		O	S		2-4		S	S	
1-5		L	S		2-5		S	S	
**1-6	C55004	O	M		2-6		-	-	
1-7		S	S		2-7	Hallertau	M	L	small
1-8		L	S		2-8		-	-	
1-9		M	S		2-9		L	S	
1-10		S	S	no new mildew	2-10		-	-	
1-11		S	S		2-11		L	S	
1-12		S	S		2-12		S	S	
1-13		S	S		2-13	Backa	L	S	
1-14		S	S		2-14		S	S	
1-15		M	S		2-15		S	S	
1-16		S	S		2-16		S	S	
1-17		O	L		2-17		L	M	
1-18		L	S		2-18		S	S	
1-19		S	M		2-19		L	S	
1-20		S	S		2-20		O	S	
1-21		O	M	vigor	2-21		M	S	
**1-22	C55014	O	M		2-22		-	-	
1-23		-	-		2-23		S	S	
1-24		-	-		2-24		-	-	
1-25	L.C.	L	M		2-25		O	S	

* Rating key: -- = missing hill
O = no mildew
L = light mildew - some leaf infection - no spikes
M = moderate mildew - 1 to 3 spikes
S = severe mildew - 3 or more spikes

** Selections saved for further testing. All others discarded except named varieties and lines already in yield test. See report section entitled "Selections saved in 1957".

1957 Hop Disease Nursery Mildew Ratings cont.

Row & Plant No.	Acc. No. or Name	Mildew rating* May 31	Mildew rating* July 6	Comments	Row & Plant No.	Acc. No. or Name	Mildew rating* May 31	Mildew rating* July 6	Comments
3-1	132 I	M	M		4-1	L.C.	-	L	small
3-2		S very severe	S		4-2		O	S	
3-3		M	S		**4-3	C54033	O	L	
3-4		M	S		4-4		-	-	
3-5		S	S		4-5		-	-	
3-6		M	S		4-6		S	S	
**3-7	C53118	M	L		4-7	L.C.	S	S	
3-8		-	-		4-8		-	-	
3-9		S	S		4-9		-	-	
3-10		S	S		4-10		S	S	
3-11		S	S		4-11		S	S	
**3-12	C55036	O	M		**4-12	C55048	O	L	
3-13		M	S		4-13	L.C.	M	S	
3-14		-	-		4-14		L	M	
3-15		L	S		4-15		L	S	
3-16		O	S	yellow	4-16		M	S	small
3-17		O	S		4-17		M	S	
**3-18	C55039	O	L		4-18		L	S	
3-19		S	S		4-19	L.C.	O	L	small
3-20		-	-		4-20		-	-	
**3-21	C53125	O	L	small	**4-21	C54039	L	L	
3-22		-	-		4-22		virus	S	
3-23		O	S		4-23		O	S	
**3-24	C55042	O	O		4-24		M	S	
3-25		O	S		4-25	L.C.	L	M	

1957 Hop Disease Nursery Mildew Ratings cont.

Row & Plant No.	Acc. No. or Name	Mildew rating* May 31	July 6	Comments	Row & Plant No.	Acc. No. or Name	Mildew rating* May 31	July 6	Comments
5-1	L.C.	L	S		6-1	L.C.	virus	S	
**5-2	C55055	O	L		6-2		M	S	
5-3		S	S		6-3		L	S	
5-4		L	S		**6-4	C55068	O	L	
5-5		L	M		6-5		O	L	small
5-6		L	S		6-6		L	S	
5-7		M	S		6-7		M	S	
**5-8	C55058	L	L	small	6-8		M	S	
5-9		S	S		6-9		S	S	
5-10		-	-		6-10		S	S	
5-11		S	S	small	6-11		S	S	
5-12		-	-		6-12		-	-	
5-13		L	S		6-13		S	S	
5-14		-	-		6-14		-	-	
5-15		S	S		6-15		M	S	
5-16		O	S		6-16		S	S	
5-17		M	S		6-17		bunchy	S	
5-18		S	S		6-18		S head	S	
**5-19	C54049	M	M		6-19		M	S	
5-20		L	S		6-20		S	S	
5-21		M	S		6-21		S	S	
5-22		M	M		6-22		M	S	
5-23		M	S		6-23	138 I	O	S	small
5-24		-	-		6-24		S	S	
5-25		-	-		6-25		L	S	

1957 Hop Disease Nursery Mildew Ratings cont.

Row & Plant No.	Acc. No. or Name	Mildew rating* May 31	Mildew rating* July 6	Comments	Row & Plant No.	Acc. No. or Name	Mildew rating* May 31	Mildew rating* July 6	Comments
7-1	L.C.	L	S		8-1	L.C.	O	M	
7-2		S	S		8-2		M	S	
7-3		S	S		8-3		S	S	
7-4		-	-		8-4		M	L	
**7-5	C54066M	O	L		8-5		S	S	
7-6		-	-		8-6		S	S	small
7-7	L.C.	M	S		8-7		S	S	
**7-8	C55083	S	S		8-8		L	S	
7-9		S	S		**8-9	C54076	L	M	
7-10		-	-		8-10		S	S	
7-11		S	S		8-11		S	S	
7-12		S	S		**8-12	C55096	M	M	
7-13	L.C.	S	S		8-13		O	S	
7-14		-	-		8-14		-	-	
7-15		S	S		8-15		M	S	
7-16		S	S		8-16		S	S	
7-17		S	S		8-17		S	S+	
7-18		S	S		8-18		-	-	
7-19	L.C.	S	S		8-19		S	S+	
**7-20	C55088	M	L		8-20		-	-	
7-21		S	S		8-21		M	S	
7-22		-	-		8-22		-	-	
7-23		S	S+		8-23		S	S	
7-24		-	-		8-24		-	-	
7-25	L.C.	L	S		8-25		small	M	small

1957 Hop Disease Nursery Mildew Ratings cont.

Row & Plant No.	Acc. No. or Name	Mildew rating* May 31	July 6	Comments	Row & Plant No.	Acc. No. or Name	Mildew rating* May 31	July 6	Comments
9-1	L.C.	S	S		10-1		-	-	
9-2		M	S		10-2		L	S	
9-3	Fuggle	O	L		10-3	132-I	M	S	
** 9-4	C55104	O	L		10-4	109-I	L	L	small
9-5		-	-		10-5	135-I	O	M	small
9-6		S	S		10-6		-	-	
9-7		-	-		10-7	L.C.	S	S	small
9-8		-	-		10-8	Br. G.	O	L	small
9-9		-	-		10-9	135-I	O	L	small
9-10	104-I	L	L	small	10-10	124-I	O	L	small
9-11	104-I	S	S		10-11	109-I	O	L	small
9-12	132-I	L	L	small	10-12		-	-	
9-13	107-I	O	L	small	10-13	L.C.	S	S	
9-14		-	-		10-14	124-I	O	L	small
9-15	108-I	S	S		10-15	127-I	O	L	small
9-16	123-I	M	S	small	10-16	139-I	O	S	small
9-17	109-I	L	S		10-17	Fugg.	O	L	
9-18		-	-		10-18	Backa	O	S	small
9-19	112-I	S	S		10-19	L.C.	S	S	
9-20	135-I	O	S	small	10-20	103-I	M	S	
9-21	123-I	S	S		10-21	108-I	S	S	
9-22		-	-		10-22		-	-	
9-23	124-I	O	S		10-23	Bull.	S	S	
9-24	123-I	S	S	small	10-24	138-I	O	L	small
9-25	127-I	O	S		10-25	L.C.	S	S	

1957 Hop Disease Nursery Mildew Ratings cont.

Row & Plant No.	Acc. No. or Name	Mildew rating* May 31	July 6	Comments	Row & Plant No.	Acc. No. or Name	Mildew rating* May 31	July 6	Comments
11-1	L.C.	M	S		12-1	L.C.	L	S	
11-2	107-I	O	M	small	12-2	C19039M	O	S	small
11-3		-	-		12-3	139-I	S	S	
11-4		-	-		12-4	C19039M	O	L	small
11-5	104-I	O	M		12-5	C19046M	O	L	small
11-6		-	-		12-6	C19044M	O	L	small
11-7		-	-		12-7	Fugg.	O	L	
11-8		-	-		12-8		-	-	
11-9	108-I	L	S		12-9	C51101M	L	L	
11-10		-	-		12-10	C19170M	L	S	
11-11	C19009M	O	S	small	12-11		-	-	
11-12		L	S	small	12-12	C19037M	O	S	small
11-13		-	-		12-13		-	-	
11-14	C19173M	M	M	small	12-14		-	-	
11-15	123-I	M	S		12-15	C19041M	L	L	small
11-16		-	-		12-16		-	L	small
11-17	124-I	O	S		12-17	107-I	L	S	
11-18	C19173M	O	M	small	12-18		-	-	
11-19	127-I	O	S		12-19	108-I	S	S	
11-20	C19170M	L	L		12-20	C19047M	M	S	
11-21		-	-		12-21	C19050M	O	L	
11-22		-	-		12-22	I19007M	O	S	
11-23	135-I	O	L		12-23	112-I	S	S	
11-24	I19005M	O	M	small	12-24		-	-	
11-25	C19050M	L	L	small	12-25	123-I	S	S	

1957 Hop Disease Nursery Mildew Ratings cont.

Row & Plant No.	Acc. No. or Name	Mildew rating* May 31	July 6	Comments
13-1	L.C.	M	S	
13-2	C19061M	O	S	
13-3	124-I	O	L	small
13-4	C19061M	O	L	small
13-5	127-I	O	L	
13-6	I19007M	O	L	small
13-7	L.C.	L	S	
13-8	I19005M	O	L	
13-9	C19038M	L	L	
13-10	0511101M	O	L	
13-11	135-I	O	S	
13-12	C19060M	O	L	
13-13	L.C.	O	L	
13-14		-	-	
13-15		-	-	
13-16		-	-	
13-17	139-I	O	M	
13-18		-	-	
13-19	L.C.	S	S	
13-20		-	-	
13-21		-	-	
13-22		-	-	
13-23	Fugg.	S	S	
13-24		-	-	
13-25	L.C.	S	S	

Discussion and conclusions:

Twenty-one individuals were selected for further testing on the basis of their resistance to downy mildew. Disease development in the nursery was so severe that many susceptible plants were completely debilitated. Plants with a high degree of resistance stood out sharply in comparison to susceptible plants. Heavy inoculation, the abundance of natural inoculum and favorable environment for disease development provided conditions for selection of plants with good downy mildew resistance.

Seedling Reaction of 1956 Crosses to Downy Mildew

(Chester E. Horner)

Seedlings from 187 crosses and open pollinated sources were evaluated for downy mildew resistance by a greenhouse screening test. Previous tests (1956 Report pp. 15-23) demonstrated that most of the mildew susceptible progeny could be eliminated from further testing by greenhouse inoculation with downy mildew, and that differences in degree of susceptibility existed both among crosses and among the individuals within certain crosses. The same general procedures were followed in 1957 as in 1956.

Procedure:

Seed from the 1956 crosses was germinated and seedlings planted in flats in the usual way by S. N. Brooks. When seedlings were 10-11 weeks old they were heavily inoculated with downy mildew spores on April 25, then inoculated again May 2 and May 10. Inoculum consisted of sporangia collected from 6 different varieties or lines of hops to include possible different races of mildew. Sources of inoculum came from Early Clusters, Late Clusters, 128-I, 18-S and 2 selections in the disease nursery.

Spore suspensions were prepared by washing systemically infected "spikes" then filtering to remove the larger particles of soil and plant debris. Inoculation was accomplished with an electrically powered paint sprayer operating at 20 pounds pressure. Twenty milliliters of uniform spore suspension were applied to the undersides of the leaves of seedlings in each flat. Humid conditions were maintained by covering the seedlings with several layers of cheesecloth saturated frequently with water.

Good infection was obtained and disease development was satisfactory, but not as rapid or severe as in the 1956 test. Selection for resistant plants was made May 21 to May 25. The number of progeny from each cross was recorded. A record was made of the number of plants becoming systemically infected in each cross. In addition each cross was rated for mildew severity on a scale of 0-3 representing none, light, moderate and severe disease.

Results:

Downy mildew infection was uniform and disease development was good. By observation it was apparent that differences in susceptibility existed among the progeny. In contrast to the 1956 test, many cases of escape or immunity of individual seedlings were observed. It was apparent, however, that differences in degree of susceptibility existed both among crosses and among individuals within certain crosses. The table below shows the reaction of seedling from the 1956 crosses to downy mildew.

Mildew Severity Rating of 1956 Crosses.

Cross Number	No. progeny tested	No. progeny systemically infected	Per cent systemic infection	Mildew severity rating	No. plants kept
1-OP	388	23	5.9	3	11
12-OP	459	19	4.1	3	6
13	376	11	2.9	2	0
14	30	0	0.0	1.5	15
15-OP	245	3	1.2	2	10
22-OP	480	10	2.1	2.5	8
23	152	2	1.3	2	5
24-OP	335	3	0.9	2.5	7
28	92	4	4.3	2	7
29	87	0	0.0	2	0
30-OP	109	1	0.9	3	2
32-OP	311	1	0.3	3	5
33	68	3	4.4	3	2
36	70	4	5.7	3	1
35	42	3	7.1	3	1
37	79	0	0.0	2	5
42-OP	91	2	2.2	2.5	3
41-OP	297	9	3.0	3	5
43	135	4	2.9	3	2
44	142	7	4.9	3	0
49-OP	383	4	1.0	3	7
50-OP	39	0	0.0	2	4
58	44	3	6.8	3	4
51-OP	204	2	.98	3	5

* Based on a scale of 0 = none, 1 = light, 2 = moderate and 3 = severe disease development.

Cross Number	No. progeny tested	No. progeny systemically infected	Per cent systemic infection	Mildew severity rating	No. plants kept
273-OP	301	0	0.0	3	4
5-OP	479	2	0.42	3	5
6	139	1	0.72	2	4
7	134	2	1.5	2.5	2
8-OP	408	6	1.5	3	9
16	168	0	0.0	2	7
19-OP	280	3	1.1	2	6
20-OP	176	2	1.1	2	10
26-OP	342	5	1.5	2	7
27-OP	222	7	3.1	2.5	3
34-OP	308	14	4.5	3	4
45-OP	88	3	3.4	3	1
31-OP	261	12	4.6	2	7
38-OP	122	1	0.82	3	4
46-OP	217	6	2.8	2	5
47	271	4	1.5	2	5
48	131	0	0.0	2	2
52-OP	346	0	0.0	2.5	6
53	112	0	0.0	2	4
54-OP	251	9	3.6	3	4
147	137	1	0.73	1.5	3
150-OP	118	17	14.4	2.5	5
154-OP	131	4	3.0	2.5	2
149-OP	121	6	4.9	2.5	1
145	138	0	0.0	2	5
155	131	5	3.8	2	5
156	128	0	0.0	2	2
159	133	11	8.3	3	1
161	117	12	10.2	3	2
163	97	5	5.1	2.5	4
164	114	4	3.5	2	3
170-OP	42	0	0.0	2	3
167	44	0	0.0	2	2
171-OP	212	14	6.6	2	5
178-OP	204	23	11.3	3	2
180-OP	237	7	2.9	2.5	2
182-OP	121	4	3.3	3	4
185	51	2	3.9	2	0
188	141	0	0.0	2.5	6
194-OP	216	9	4.2	3	1
201	129	0	0.0	2.5	3
205-OP	114	4	3.5	3	3
207-OP	240	4	1.7	2.5	3
209-OP	97	1	1.0	3	1
213-OP	118	6	5.1	2.5	1
252-OP	242	14	5.8	3	3
256-OP	126	1	0.79	2	1
257-OP	230	11	4.8	3	3
260-OP	205	9	4.4	2	1
146	91	3	3.3	2	3
148-OP	238	13	5.5	3	5
151-OP	215	4	1.9	2	7
152	130	3	2.3	2.5	2
158-OP	226	14	6.2	3	8

Cross Number	No. progeny tested	No. progeny systemically infected	Per cent systemic infection	Mildew severity rating	No. plants kept
160-OP	140	2	1.4	2	4
162-OP	220	11	5.0	3	6
165-OP	127	2	1.6	3	3
174-OP	197	7	3.5	2	7
177-OP	130	5	3.8	2.5	3
179-OP	233	1	0.43	2	5
181-OP	240	13	5.4	2.5	5
187	44	1	2.3	2	2
196-OP	33	4	12.1	2	7
189-OP	251	16	6.4	3	5
199-OP	129	5	3.9	3	4
200-OP	211	11	5.2	3	3
206-OP	231	17	7.3	2.5	5
207-OP	130	10	7.7	3	1
211-OP	114	4	3.5	2	4
218	44	1	2.3	1.5	5
237	31	7	22.6	3	1
254-OP	138	3	2.2	2	3
255-OP	251	6	2.4	2	3
246	30	4	13.3	3	2
258	47	2	4.2	2	4
259	158	1	0.6	3	1
262	31	1	3.2	2	3
261	118	1	0.8	2	4
60	240	4	1.7	2	5
62	128	11	8.6	2.5	3
63	141	1	0.71	2	8
74-OP	308	6	1.9	2	8
65	140	6	4.3	3	3
66-OP	341	9	2.6	2	9
81-OP	150	3			2
86	150	0			2
87-OP	150	0			2
88-OP	300	0			2
90-OP	131	6	4.5	2	2
105-OP	256	2	0.78	2	3
106-OP	240	9	3.7	2	9
109-OP	135	9	6.7	2	4
110-OP	269	3	1.1	2	4
108	108	8	7.4	3	1
107-OP	250	9	3.6	2	3
104-OP	216	5	2.3	3	2
103	130	0	0.0	2	3
102-OP	121	6	4.9	3	2
100	211	5	2.4	3	3
97-OP	221	5	2.3	3	3
89	131	4	3.0	3	3
85-OP	218	12	5.8	2	4
82-OP	257	3	1.2	2	3
80	142	1	0.7	2	4
77-OP	211	6	2.8	3	2
76	143	0	0.0	1.5	9

Cross Number	No. progeny tested	No. progeny systemically infected	Per cent systemic infection	Mildew severity rating	No. plants kept
75	36	1	2.8	1	7
73	27	0	0.0	1.5	2
69-OP	217	12	5.5	3	3
67	128	4	3.1	3	1
64-OP	254	22	8.7	3	2
61	117	1	0.8	2	0
251-OP	138	4	2.9	2.5	1
194-OP	137	2	1.4	2.5	2
59	141	5	3.5	3	3
57-OP	318	7	2.2	2	8
136-OP	128	5	3.9	3	3
248-OP	133	0	0.0	2	3
251-OP	131	2	1.5	2.5	0
250	140	0	0.0	2	3
242-OP	218	20	9.2	3	3
238	219	1	0.4	2	2
234	136	1	0.7	2	3
233	129	4	3.1	2	2
232-OP	246	7	2.8	2	7
226-OP	212	6	2.8	2	5
219-OP	138	0	0.0	2	5
223-OP	150	0	0.0	1	0
225-OP	216	21	9.7	3	2
229-OP	31	0	0.0	1	8
239	25	2	8.0	3	0
231-OP	226	7	3.1	2.5	4
236-OP	230	2	0.9	1.5	6
240-OP	233	3	1.3	2	6
241-OP	221	4	1.8	2	5
247-OP	211	9	4.3	3	2
248-OP	140	1	0.7	1	4
138-OP	129	2	1.5	2.5	5
55-Op	381	4	1.0	2.5	3
56-OP	127	1	0.8	3	4
54-OP	133	1	0.7	2	2
143-OP	257	1	0.4	2.5	16
138-OP	138	0	0.0	2	2
133	117	6	5.1	2.5	6
134-OP	217	17	7.8	3	8
144	120	2	1.7	2.5	6
141	139	1	0.7	2	3
129	131	3	2.3	2	6
140-OP	118	3	2.5	2	4
136-Op	101	2	2.0	3	5
132-OP	112	4	3.6	2.5	4
128	128	4	3.1	2	6
130	26	2	7.7	2	2
131	33	1	3.0	2	1
125	201	9	4.5	3	5

Cross Number	No. progeny tested	No. progeny systemically infected	Per cent systemic infection	Mildew severity rating	No. plants kept
126	25	0	0.0	2	2
127	29	0	0.0	3	1
124-OP	240	7	2.9	3	1
119-OP	222	9	4.0	3	8
117-OP	211	12	5.7	3	6
122	130	2	1.5	2	3
121	29	2	6.9	2	1
123	30	0	0.0	2	3
120	37	1	2.7	2	3
114-OP	26	3	11.5	2	1
112-OP	115	5	4.3	3	2
118-OP	235	8	3.4	3	4

No. crosses	Total plants
187	31,357

Discussion and conclusions:

From the data in the table above there are apparent differences in susceptibility of progeny of certain crosses to systemic infection. Resistance to systemic infection is more important from a field resistance standpoint than any other type. Degree of systemic infection ranged from 0 to 24 per cent among progeny from 187 crosses. Certain crosses showed good overall mildew resistance, and several, such as cross No. 14, showed both resistance and vigor.

Approximately 827 seedlings were selected for field planting. From these, desirable agronomic types will be selected and placed in the disease nursery for further evaluation.

As a result of the 1956 mildew screening program 363 seedling were selected from among about 8,000 tested. These were observed during the 1957 season. Twenty-six, or about 7 per cent, became infected with mildew but only two were severely affected. At the same time, susceptible varieties in the yard were from 50 to 80 per cent infected, on a hill count basis. Thus, it appears that the greenhouse screening program is eliminating most of the downy mildew susceptible plants resulting in efficiency of the breeding program.

EVALUATION

Corvallis-Prosser Yield Trial

Objectives:

See 1956 Annual Report, p. 25.

Duration of Experiment:

See 1956 Annual Report, p. 25.

Procedure:

See 1956 Annual Report, p. 25.

Experimental results:

At Corvallis data were obtained on yield, relative maturity, alpha-acid, oil content, and sidearm length. Because of missing and young hills in the quality trial at Corvallis no attempt was made to provide statistical analysis for alpha-acid and oil content.

At Prosser data were obtained on yield, alpha-acid and oil content. Yield data are not available at this writing and will not be included in this report. It is a matter of interest that harvesting at Prosser was done with the mechanical experimental picker developed by the Irrigation Experiment Station.

A table follows which summarizes the most important information obtained on these lines in 1957. Additional agronomic data and brewer evaluation on these and other lines are contained in the Experimental Yield Trial section under CRe5-1. Additional chemical quality data are given in sections A, B and C of this report under CRe5-5.

Data obtained in the Corvallis-Prosser Yield Trial in 1957.

		Corvallis							Prosser	
		Yield (lbs/A)		Sidearm length (in.)	Maturity	Storage stability	Alpha acid (%)	Oil (ml./100g)	Alpha acid (%)	Oil (ml./100g)
		1957	Avg. 1956-57	1957	1957	1956 1/	1957 1/	1957 1/	1957 1/	1957 1/
Late Cl.	I19208	2210	1880	31	Med.late	V.good	5.44	0.48	6.20	0.75
Fuggles	I19209	—	—		Med.early	Fair	5.33	0.75	—	—
B. Gold	I19001	1510	1250	24	Med.	Poor	8.11	2.89	—	—
Bullion	I55081	—	—		Med.	V.poor	7.60	2.48	—	—
103-I	(W)C19105	2140	1640	26	Late	Poor	3.34	1.38	2.47	0.55
104-I	C19123	1500	1340	32	Late	Good	3.47	1.48	2.04	0.49
107-I	(W)C19213	2760	2040	33	Med.	Good	3.97	1.04	3.99	0.76
108-I	(W)C19138	1940	1850	32	Med.late	Good	4.28	0.70	5.52	1.22
109-I	C19145	2100	1600	30	Med.	Good	6.30	1.13	4.31	1.34
112-I	(O)C19215	2680	1850	36	Late	Good	—	—	5.95	1.06
123-I	C19081	2270	2270	37	Med.	Good	6.33	0.72	6.70	0.92
124-I	C19086	1650	1570	33	Med.	Good	3.98	0.84	2.90	0.53
127-I	C19108	1140	1060	28	Med.	—	5.72	1.25	3.54	0.79
132-I	C19136	1920	1520	33	Med.	Good	3.51	0.48	3.00	0.31
135-I	(O.W)C19151	1740	1310	29	Med.late	Good	2.38	1.20	2.45	0.60
138-I	C19202	1290	1320	25	Med.	Good	5.47	0.69	4.91	0.90
139-I	(W)C19195	1980	1470	35	Late	Good	3.78	0.60	3.63	0.44
144-I	(O)C19077	2160	1690	28	Med.late	Good	4.90	1.66	2.35	0.58
Mean		1940	1600	30.4					4.00	0.75
LSD 5%		690	480	7					0.63	0.15
CV (%)		21	20	30					10.	12.

1/ Data supplied by S. T. Likens.
(O) Lines slated for off-station testing in Oregon.
(W) Lines slated for off-station testing in Washington.

Discussion and conclusions:

Significant differences were indicated for yield in 1957 as well as for the two-year period ending in 1957. None of the lines yielded greater than Late Clusters during the two-year period on the basis of the LSD. Lines 104-I, 127-I, 135-I, 138-I and Brewer's Gold were lower yielding than Late Clusters during the two years. In 1957 only lines 104-I, 127-I, 138-I and Brewer's Gold were lower yielding than Late Clusters. Some lines require a longer period of time to reach maximum yield. Late Clusters reaches its maximum yield usually by the second or third year in Oregon, and under mildew free conditions is an excellent producer. It is anticipated that by next year a few of the lines will exceed Late Clusters in yield.

With regard to date of maturity, none of the lines were as early as Fuggles. Most of them were medium between Fuggles and Late Clusters, however 103-I, 104-I, 112-I and 139-I appeared to be somewhat later than Late Clusters. Maturity is difficult to determine and these observations are subject to modification.

The results on storage stability are of interest. A more complete discussion is given of this in section CRe5-5 part C, however a few comments should be made at this point. In general most of the lines appeared to store well based on one year's observation. 103-I deteriorated quite badly, but it retained its original condition better than Brewer's Gold and Bullion, two commercial varieties which are objectionable in this respect. None of the lines appeared to store as well as Late Clusters.

Significant differences in alpha-acid percentage and oil content were indicated in the Prosser samples. In general, both alpha-acid and oil were lower in the Prosser samples than they were in the Corvallis samples of the same lines.

The value of high acid or low acid seems to be a matter of individual preference among brewers and no statement can be made at this time regarding which is better. Characterization of varieties for this characteristic is important, however.

The question of oil content is in the same category as alpha-acid except that less attention has been paid to it. It seems quite likely that this characteristic will be used more extensively as a basis of evaluation in industry in future years.

Experimental Yield Trial

Objectives:

See 1956 Annual Report, page 31.

Duration of experiment:

See 1956 Annual Report, page 31.

Procedure:

The 29 entries were planted from vegetative clonal material in 1953 in 5-hill plots replicated five times in a randomized block design.

The 27 experimental lines represented a group of selections which had been made in 1950 out of crosses made in 1949. Although most of them were intermediate in maturity there was considerable range for this characteristic from medium early to late (later than Late Clusters).

The trial has been grown under irrigation and has received from two to four irrigations per season. Applications of N, P, and K fertilizers have been made every year either by ringing the hills or by broadcast application. Attempts have been made to control insect and disease pests. The overall cultural program on this trial has been carried out in a manner consistent with good management practices.

Experimental results:

In 1957 data were obtained on yield and relative moisture loss in drying. The kiln-dried samples were subjected to organoleptic evaluation by representatives of B.I.R.I. for the third consecutive year.

A summary of these results is given in the following table.

Further information on some of these lines is given in the Corvallis-Presser Yield Trial report and sections A, B, and C of CRe5-5 report.

Data obtained from the Experimental Yield Trial in 1957 and previous years.

			Yield (lbs/a) Avg. 1957	Yield (lbs/a) Avg. 1954-57	% Dry-down (DW/HW) 1957	Replants necessary (out of 25 total) 1955	1956	1957	Physical evaluation of 1957 samples 1/
1	Fuggles	I19209	1690	1410	27.7	0	1	1	Very nice hop (4th best)
2 *	L.C.	I19208	2030	2190	23.8	7	0	2	Mild, but atypical
3	101I	C19210	1690	1530	26.7	2	1	0	Mild, atypical, sweet & grassy
4	102I	C19211	2050	1790	28.2	0	0	0	Fair, flavor slightly perfumie
5 *	103I	C19105(W)	2800	2470	24.9	0	0	0	Flavor off, bitter
6 *	104I	C19123	2110	1760	23.6	1	0	0	Off, weedy aroma
7	106I	C19212	1890	1680	26.1	1	0	0	Nice hop (5th best)
8 *	107I	C19213(W)	2930	2410	23.3	1	0	0	Strong, sweet
9 *	108I	C19138(W)	2220	2160	20.8	4	1	0	Bitter aroma
10*	109I	C19145	1560	1960	22.3	5	2	1	Slightly bitter
11*	112I	C19215(O)	3130	2690	23.6	0	1	0	Slightly off, fair hop
12	117I	C19217	1630	1520	21.7	0	0	0	Weedy and bitter
13	118I	C19218	2490	2460	25.4	0	0	0	Off, bad
14	121I	C19221	2170	2010	23.7	0	0	0	Sweet, slightly bitter
15	122I	C19222	2320	1880	23.5	0	0	0	Good hop (2nd best)
16*	123I	C19081	2230	1970	23.7	9	0	1	Off, weedy
17*	124I	C19086	1570	1960	20.2	1	0	1	Slightly weedy and bitter
18	125I	C19088	1760	1630	25.6	0	0	0	Off, slightly garlicky
19	126I	C19203	1200	1720	25.0	2	0	0	Slightly off, sweet
20*	127I	C19108	2200	1920	21.0	4	3	2	Off, weedy, bitter
21	128I	C19113(O,W)	2650	2230	25.2	2	0	0	Sweet, strong, bitter
22	130I	C19134	2460	2180	24.9	2	0	0	Sweet and bitter
23	131I	C19016	1490	1530	21.3	4	0	0	Off, strong
24*	132I	C19136	1560	1610	22.8	0	1	0	Sweet, chalky
25*	135I	C19151(O,W)	2290	2100	23.2	1	0	0	Very good hop (1st, best)
26*	138I	C19202	1800	2040	24.3	2	1	1	Off, strong, bad
27*	139I	C19195	2510	2250	26.7	3	2	2	Sweet, strong, grassy
28	141I	C19204	2770	2380	25.3	2	1	1	Off, strong
29*	144I	C19077(O)	1460	1730	23.8	3	0	0	Good hop (3rd best)
Mean			2090	1970	24.1				
LSD (5%)			520	330	2.2				
CV (%)			20	18	6				

* Entries in the Corvallis-Prosser Yield Trial

(O,W) Entries slated for off-station testing in Oregon and Washington respectively.

1/ Notes taken from comments made by Mr. Frank Schwaiger (Anheuser-Busch).

Underlined yields are greater than that of Fuggles on the basis of the LSD (5%)

Discussion and conclusions:

Yields in this trial in 1957 were slightly above the average for the four-year period during which yield data have been obtained. Significant differences in yielding ability were indicated in 1957. The range in yield for the 29 entries was over 1900 lbs. of kiln-dried hops per acre. 126-I was low with a yield of 1200 lbs. per acre and 112-I was high with a yield of 3130 lbs. per acre. Twelve of the varieties outyielded Fuggles on the basis of the LSD.

In the four-year summary of yields, significant differences were indicated for lines, replications, years, and the reps. x years and lines x years interactions. These data suggest that the lines yielded differently from each other, that their performance was influenced by seasons, and that the seasonal influence was not the same for all lines. The data further suggest that the replications yielded differently and were subject to seasonal (probably cultural) variation from year to year.

Yields over the four-year period ranged from 1520 lbs. for 117-I to 2690 lbs. per acre for 112-I, a range of 1170 lbs. per acre. 20 of the entries appeared to out-yield Fuggles on the basis of the LSD.

The data on dry-down percentage probably indicate differences in maturity. Some of the known earlier maturing lines had higher dry-down percentages than some of the known later maturing lines. These values are a reflection of the dry matter content of the hops at harvest time, and a low value indicates more moisture loss than a high one.

Records have been kept on the number of replants (or missing hills) during the past three years. Late Clusters, 108-I, 109-I, 123-I, 127-I, and 139-I appeared to have an unduly high amount of replants needed. This may be a reflection of the resistance to root die-out of these lines, however the cause of missing hills was not investigated in this case. This particular phenomenon needs considerable study before conclusions can be drawn.

For the third year in a row the same varieties appeared to exhibit satisfactory physical quality characteristics. 135-I, 122-I, 144-I, Fuggles, and 106-I were judged the best of the group. 144-I and 106-I drew highly favorable comment this year for the first time, however in previous years they have been judged "good".

THE EVALUATION OF FUNGICIDES AS DUSTS OR SPRAYS FOR HOP DISEASE CONTROL (CRe5-2, OAES 36-12)

Chester E. Horner

Objectives:

The objectives of this project are to evaluate fungicides by laboratory, greenhouse and field trials for their effectiveness in controlling hop diseases, and to provide treated hop samples for chemical residue studies. Investigations of this nature have been conducted periodically for several years.

Previous work:

A large increase in the number of fungicidal chemicals used in agriculture has taken place the past few years. Laboratory and greenhouse screening trials were conducted from 1949 to 1954 by G. R. Hoerner who went on leave status April, 1955. During 1955 field trials were conducted with promising materials. As a result of data on disease control and residue analyses, Federal Registration for the use of zineb was approved with a tolerance of 60 parts per million. Zineb is currently being used by hop growers for downy mildew control, but is not entirely satisfactory because a large number of applications are necessary to achieve good control when conditions are favorable for mildew.

During 1955, streptomycin was used experimentally in small scale greenhouse and field tests. It was found that streptomycin was absorbed and translocated by hop plants, and that it was active against the downy mildew fungus.

During 1956 comparisons were made in field tests of zineb and streptomycin as cover sprays. Streptomycin was slightly superior to zineb but not effective enough to justify its use as a cover spray because of the higher cost of the antibiotic.

Another experiment conducted in 1956 produced results which formed the basis for most of the 1957 tests. In this experiment sprays of streptomycin at concentrations of 1000 to 5000 ppm were found to arrest or eradicate internal systemic downy mildew from infected shoots and in many cases to transform systemically infected shoots (spikes) to normal, healthy vines.

1957 Downy Mildew Control Trials

Experiment No. 1

Procedure:

Streptomycin dusts (Phytomycin) and sprays (Agri-Strep) both at 1000 ppm, were applied at four different dates to the young growth at the crown area of hop plants. Plots consisted of 100 hills with 8 replications. Sprays were applied at the rate of approximately 100 mls per hill or 20 gallons per acre. Dusts were applied at the rate of one-half ounce per hill or about 25 pounds per acre. Both dusts and sprays were applied to thoroughly cover all young growth arising from the crown. Treatments were made on April 23, 5 to 12 days after crown pruning; May 29, 5 days after the first vine training; June 13, when vines were three-fourths of the way to the overhead wires; and June 30, when most vines were to the wires.

Results:

Data on incidence of systemic infection were taken 13 to 15 days after each treatment and are summarized in the table below. The earliest application (April 23) was distinctly superior to later applications. Sprays were greatly superior to dusts at all dates of application; however, both sprays and dusts decreased disease significantly.

Effect of streptomycin sprays and dusts applied at different dates on incidence of systemic hop downy mildew infection.

Application date	Number of spikes per plot*				Disease as % of check	
	dust	spray	check	L.S.D.5%	dust	spray
April 23	45.3	7.0	47.0	4.1	96.5	14.8
May 29	350.5	171.5	446.1	24.9	78.7	38.6
June 13	261.9	117.3	373.6	15.4	70.4	31.6
June 30	240.4	44.6	283.9	18.9	83.4	18.8

* Spike count is the mean of 8 replications of 100 hills.

Discussion and Conclusions:

At the time the earliest treatment was made, many systemically infected shoots (spikes) already were evident, but sporulation had not yet started. Young shoots which could definitely be recognized as spikes were marked and observed for treatment effects. Approximately 85 per cent of the marked spikes were transformed to normal shoots in the April 23 spray treatment plots, while none were transformed in either dust treated or check plots. All spray treatments induced a mottled chlorosis of many of the treated leaves. This effect has been observed as a streptomycin effect on plants and has been explained as a streptomycin induced manganese deficiency by W. G. Rosen.

The greatest obstacle in obtaining satisfactory downy mildew control by current protective fungicides is the high frequency of systemically infected shoots and the persistence of such systemic infections as sources of inoculum. When new shoots develop in the spring from winter-dormant buds on the perennial hop crown, many are already systemically infected. Such systemically infected shoots produce tremendous numbers of spores which serve to spread the disease. Infection by these spores results in either local or systemic disease development. Systemic disease development usually results when meristematic stem or leaf tissue is infected. Thus, the primary source of inoculum for spread of downy mildew in the spring consists of the early emerging systemically infected shoots.

Results of the past 2 years work show that systemic infection in young shoots can be largely arrested or eliminated by the use of properly timed sprays of streptomycin.

Experiment No. 2

Objectives and Procedure:

Another field trial was conducted in 1957 to compare four commercial preparations of agricultural grade streptomycin for hop downy mildew control and to test the value of glycerol in increasing the effectiveness of streptomycin. Agri-Strep (Merck & Co, 37% streptomycin sulfate), Agrimycin 100 (Chas. Pfizer & Co., 15% streptomycin sulfate plus 1.5% terramycin), Phytomycin (Olin Mathieson Co., 20% streptomycin nitrate) and Lederle Streptomycin (American Cyanamid Co., 15% streptomycin sulfate) were each applied as spray at 1000 and 2000 ppm streptomycin with and without the addition of glycerol at a concentration of 1 per cent in the spray mixture.

Treatments were applied June 4 to 7 to four replications of plots containing 10 diseased hills each. Data were taken on the number of systemically infected shoots at the time of treatment and the number remaining 2 weeks after treatment.

Results:

All formulations of streptomycin, at both concentrations, and both with and without glycerol, significantly reduced disease incidence as shown in the summary table below.

Table 3. Comparison of four formulations of streptomycin at two concentrations with and without glycerol for control of hop downy mildew.

Treatment	Number of spikes* Treated	Number of spikes* Remaining**	Percent disease Remaining **
1. Agri-Strep, 1000 ppm w. 1% glycerol	128.2	7.2	5.6
2. Agri-Strep, 2000 ppm w. 1% glycerol	107.2	4.5	4.2
3. Agri-Strep, 1000 ppm	123.8	29.5	23.8
4. Agri-Strep, 2000 ppm	126.5	21.8	17.2
5. Agri-mycin 100, 100 and 10 ppm, w. 1% glycerol	118.8	3.2	2.7
6. Agri-mycin 100, 200 and 20 ppm, w. 1% glycerol	131.0	6.7	5.1
7. Agri-mycin 100, 100 and 10 ppm	135.8	7.5	5.5
8. Agri-mycin 100, 200 and 20 ppm	131.2	5.8	4.4
9. Phytomycin, 1000 ppm w. 1% glycerol	131.5	14.5	11.0
10. Phytomycin, 2000 ppm w. 1% glycerol	127.0	8.8	6.9
11. Phytomycin, 1000 ppm	111.2	24.5	22.1
12. Phytomycin, 1000 ppm.	127.2	22.5	17.7
13. Lederle strep., 1000 ppm w. 1% glycerol	124.5	7.5	6.0
14. Lederle strep., 2000 ppm w. 1% glycerol	124.5	2.5	2.0
15. Lederle strep., 1000 ppm	101.0	24.5	24.3
16. Lederle strep., 2000 ppm	124.2	27.8	22.3
17. 1% Glycerol in water	156.0	123.8	79.2
18. 1% Glycerol in water	137.8	107.0	77.6
19. No treatment	134.5	94.5	68.4
20. No treatment	112.2	82.0	73.0

L.S.D. 5% = 4.64

* Means of 4 replications of 10 diseased hills.

** Two weeks after treatment

Discussion and Conclusions:

All four formulations of streptomycin appeared to be equally effective at either 1000 or 2000 ppm. This is not in agreement with earlier results (1956 report pp. 72-73) in which increased concentration of streptomycin resulted in increased disease control. No explanation for this discrepancy is apparent.

The addition of glycerol to the spray mixture appeared to increase the effectiveness of Agri-Strep, Phytomycin, and Lederle Streptomycin, but did not increase the effectiveness of Agrimycin 100. Agrimycin 100, without glycerol was as effective as Agri-Strep, Phytomycin and Lederle Streptomycin with glycerol. Since glycerol has been reported to increase the absorption of streptomycin by plants, the results appear consistent except in the case of Agrimycin 100. An inquiry was made to the manufacturers of Agrimycin and they stated that Agrimycin 100 contained an optimum amount of an adjuvent which would explain the results. Whether the other formulations of streptomycin contain a similar adjuvent was not determined.

Experiment No. 3

Objectives and Procedure:

An experiment conducted in the summer of 1956 (see 1956 report p. 74) indicated that the antibiotic griseofulvin might be of value in eliminating systemic downy mildew infection from hops. This experiment will be briefly reviewed here because of observations made in the spring of 1957 which indicated carry-over effects of griseofulvin on downy mildew.

In the 1956 experiment griseofulvin in water suspension at 500 and 1000 ppm was used to soak-drench downy mildew infected hills on July 8. Approximately one pint of antibiotic mixture was used per hill. Twenty-three days after treatment no systemically infected shoots were found on treated hills while numerous infected shoots persisted on untreated hills. In the spring of 1957 observations on the areas treated in 1956 with griseofulvin showed only 10 diseased hills in 300 checked, while an adjacent untreated area had 141 of 300 hills infected with downy mildew when the new growth first appeared in the spring. This observation suggested possible carry-over effects of griseofulvin.

A test was initiated in 1957 to determine if griseofulvin would arrest or eliminate systemic downy mildew from infected shoots and to determine if carry-over effects observed in the 1956 test were due to chance, since the 1956 test was not a randomized and replicated trial.

Griseofulvin was dissolved in dimethyl formamide and suspended in water at a concentration of 1000 ppm of the antibiotic. Sprays were then applied to the crown area and basal growth of hops in plots consisting of 48 hills with 6 replications. Treatments were made on 4 different dates: May 23, June 18, August 18 and September 20, 1957. The exact location of all infected hills in each plot was tabulated.

Results:

Griseofulvin at 1000 ppm did not appear to be as effective as streptomycin at 1000 ppm on the basis of ability to arrest or eradicate systemic infection. Very few cases were noted where infected shoots were transformed to healthy vines. Although griseofulvin and streptomycin were not compared directly in this experiment, an adjacent experiment using streptomycin at the same rate and concentration was available for comparison.

Griseofulvin reduced downy mildew infection as shown in the summary table below for dates 1 and 2.

Effect of griseofulvin on incidence of systemic downy mildew infection 14 to 17 days after treatment on two different dates.

Rep.	Treatment	Number of basal spikes: Date 1 - May 23	Number of basal spikes: Date 2 - June 18
I	Griseofulvin	61	88
	Check	186	183
II	Griseofulvin	55	106
	Check	194	215
III	Griseofulvin	44	61
	Check	199	205
IV	Griseofulvin	59	55
	Check	194	168
V	Griseofulvin	49	63
	Check	151	191
VI	Griseofulvin	36	38
	Check	142	147

No quantitative data were taken for the August and September treatments due to the normal late summer disappearance of the disease. Data will be taken in the spring of 1958 to determine any possible carry over effects.

Discussion and Conclusions:

Considerable work has been done in England by Brian and others on the effects of griseofulvin on fungi. Results of their experiments show that griseofulvin is not active against the Phycomycete class of fungi, which would include downy mildews. Since griseofulvin is known to be absorbed and translocated by plants, the nature of its action against hop downy mildew could be the result of its effect on the plant rather than on the fungus directly. This possibility warrants further investigation because such effects are little known or understood.

That griseofulvin did have an effect on the incidence of downy mildew is clearly shown in the table above. Griseofulvin does not, however, appear to be as effective in downy mildew control as streptomycin.

Soil Treatment Trial for Root Rot Control

A trial was established in 1956 to determine if certain soil chemical treatments would reduce the amount of die-out caused by root and crown rots. Procedures and materials are given in more detail on page 77 of the 1956 report.

Results:

Data were taken in 1957 on number of plants surviving and total growth as measured by total vine and crop weight. These data are presented in the table below.

Effect of four chemical soil treatments on survival and growth of hop plants

Treatment	No. of 40 plants surviving	Average weight (lbs) per vine	Average plot * weight (lbs)
Chloropicrin	38	3.90	118.7
Vapam	37	3.05	86.2
Mylone	37	3.97	114.0
Terraclor	38	3.95	100.4
Check	40	3.92	124.2

* Averages are from four replications.

Discussion and conclusions:

Statistical analysis revealed no significant differences among treatments for either weight per vine or total plot weights. This trial is probably ~~not~~ located in an area where root die-out is not sufficient to obtain treatment differences. Survival data will be obtained in the spring of 1958 and if differences are not indicated, the experiment will be dropped from the current location.

Observations on Disease in Oregon and Washington Hop Yards, 1957.

Oregon:

Downy mildew was more severe during the 1957 growing season than it has been for several years. In two yards of highly susceptible Late Clusters 80 to 90 per cent of the hills carried systemic infection. Several yards of mildew resistant Fuggles were mildly affected. The moderately susceptible varieties Bullion and Brewer's Gold were not badly damaged by mildew, principally because of vigerous control programs by the growers.

Root die-out was about normal - 1 to 5 per cent in 4 yards checked.

Verticillium wilt was found in another location near Independence, Oregon in 1957. This was on the Mike Walker Farm. The planting consisted of Bullion hops with scattered hills of Fuggles throughout. Fuggles were showing severe wilt symptoms when the planting was observed in early August. Bullion hops were not showing any visible disease symptoms even when adjacent to dying Fuggles. Isolations were made from both Fuggles and Bullions. *Verticillium albo-atrum* was recovered from roots of both varieties and from the stems of Fuggles but not from the stems of Bullion. A thorough check of the infested area indicated that Bullion hops were tolerant to the disease whereas Fuggles were susceptible and badly damaged.

Washington:

Downy mildew was severe in many Yakima Valley hop yards early in the growing season. The disease is prevalent only in the spring and disappears with the advent of hot dry weather characteristic of the summer growing season in that area. All varieties of hops grown in the Yakima Valley are very susceptible to downy mildew. The disease has increased considerably the past few years, and appears to be contributing substantially to root die-out. Systemic crown infection is common and is the principal means by which the disease persists.

Zinc deficiency is another serious problem in many Yakima Valley hop yards. This condition can be corrected by soil or foliar application of zinc.

Root die-out continues to be a very serious problem. Its exact cause or causes remain unknown. Considerable research on this problem is being conducted by the Prosser Experiment Station.

THE DEVELOPMENT OF FIELD, GREENHOUSE AND LABORATORY TECHNIQUES RELATIVE TO BREEDING, DISEASE AND AGRONOMIC INVESTIGATIONS ON HOPS (GRs5-3, OAES 36-38, 11, 12)

Chester E. Horner

Techniques developed over the past several years have served to speed up research and make possible more critical experimentation and evaluation. The studies have involved determination of resistance to downy mildew, methods of vegetative propagation, indusing hop seed germination, field plot techniques, plant spaing trials and absorption and translocation of antibiotics by hops. Several papers have been published on various techniques.

Detailed information on experiments back to and including 1950 can be found in previous annual reports as listed below:

1950. pp. 62-109. Seed Germination under Greenhouse Conditions.

pp. 109-113. Uniformity Trial on Hops.

1951. pp. 105-119. Seed Germination Under Greenhouse Conditions.

pp. 120. Hop Tissue Analyses.

1952. pp. 94-117. Seed Germination in Hops.

1953. pp. 121-122. Methods for Increasing Vegetative Propagation.

pp. 123-130. Use of Chemicals for Basal Stripping and Suckering.

1954. pp. 219-220. Methods for Increasing Vegetative Propagation.

pp. 221-228. Use of Chemicals for Basal Stripping and Suckering.

1955. pp. 70-76. Methods of Clonal Propagation.

pp. 77-81. Techniques Relative to Maintaining Downy Mildew in the Greenhouse.

1956. pp. 80-85. Methods of Clonal Propagation.

pp. 86-90. Streptomycin Absorption, Translocation and Assay Techniques.

Absorption and Translocation of Streptomycin by Hops.

In previous tests, streptomycin eliminated or arrested systemic downy mildew infection in hops. The effective internal dose of streptomycin is not known. The pattern of absorption and translocation of streptomycin by hops was not known. An experiment was designed to obtain information on streptomycin absorption and translocation by hops.

Objective:

To determine the amount, rate and pattern of streptomycin absorption by hops.

Procedure:

A series of young hop plants from cuttings were selected for uniformity. Fifty micrograms of streptomycin was applied to the lower stem in one gram of lanolin paste per plant. Samples of leaves and other plant parts were collected at 1/2, 1, 2,, 4, 8, 16, 24, 36, 48, and 72 hours, 7, 10 and 13 days after application and immediately quick frozen at -20°C. Bioassays for streptomycin in extracted plant sap were conducted as described in the 1956 report pp. 86-90. Samples were also collected at different heights above the point of application. Two forms of the antibiotic were used: streptomycin nitrate and streptomycin sulfate.

Results:

Summary data on amount of streptomycin absorbed and rate and amount of translocation are presented in the following tables:

Table 1. Average Concentration of Streptomycin in Sap from Whole Plant Samples

Time after application	Concentration of Streptomycin (ppm)
30 minutes	8.6
1 hour	11.8
2 "	13.2
4 "	15.5
8 "	19.1
16 "	27.6
24 "	46.2
48 "	7.6
72 "	2.5
12 days	1.2

Table 2. Maximum Concentration of Streptomycin in Hop Leaves at Varying Distances from the Source

Height of sample from source (cm)	Time required to reach max conc. (hours)		Max. conc. reached (ppm)	
	Strep.SO_4	Strep.NO_3	Strep.SO_4	Strep.NO_3
4	4	6	133	142
10	8	11	69	83
20	24	24	59	69
30	24	30	20	16
40	24	30	17	13
60	24	30	12	12
74	18	22	28	36

Table 3. Rate of Translocation of Streptomycin by Hops.

Distance from source (cm)	Time required to reach measurable concentration	
	Streptomycin sulfate	Streptomycin nitrate
4 below	absent	absent
8 below	absent	absent
4 above	2 minutes	1+ minutes
10 above	5 "	4-5 "
20 above	7-9 "	6 "
30 above	10-12 "	9-11 "
40 above	11-14 "	11-12 "
60 above	14-16 "	15 "
74	15-20 "	18 "

Discussion and Conclusions:

Streptomycin was readily absorbed and rapidly translocated by hop plants when applied in a lanolin paste to the stems. No downward translocation was obtained. The maximum concentration of streptomycin in whole plant samples was 46 parts per million, 24 hours after application. After 3 days concentration had dropped to 2.5 ppm, and to 1.2 ppm after 12 days.

In leaf samples taken at different heights above the source, the maximum concentration was obtained in the lowest leaves and tended to decrease as distance from the source increased up to but not including the tip, where it again increased. The time required for streptomycin to reach maximum concentration in leaves at different distances from the antibiotic source was 24 to 30 hours except for lowest leaves and the growing tip, where maximum concentrations were obtained in a shorter time.

Rate of translocation of streptomycin was rapid in hops. It was detected within 15 to 20 minutes after application in the tips at an average distance of 74 centimeters from the source.

Both streptomycin sulfate and nitrate acted similarly with respect to absorption and translocation by hop plants.

The next logical steps will be to determine:

(a) What concentration of streptomycin is required in the tissue to arrest or eliminate downy mildew infection.

(b) What concentration is required in the plant to prevent downy mildew infection.

AGRONOMIC INVESTIGATIONS RELATIVE TO INCREASING AND MAINTAINING YIELD AND QUALITY IN HOPS. (Crf5-4, OAES 36-4).

Stanley N. Brooks

The objectives of this line project are to determine the effects of various fertilizer elements, cultural practices and methods of crop handling on yield and quality of hops.

Numerous agronomic trials have been conducted on hops in cooperation with the Oregon Agricultural Experiment Station since as early as 1910. These investigations have involved studies concerning irrigation, cultivation, number of vines per plant, fertilizer trials, stripping and suckering, crowning and pruning, time of hoeing, and the use of various cover crops. Many of these studies were of a preliminary nature and more complete information is needed.

Since there are interrelationships between field practice and quality or between field practice and disease factors, this line project necessarily entails the work of specialists in various fields. For that reason much of the work reported in this section has been obtained by cooperative effort of more than one investigator.

In 1957 the following studies were conducted under this line project:

1. Chemical stripping and suckering study.
2. Irrigation-fertility experiment.
3. Height of stripping study.
4. Date and severity of pruning trial.
5. A new series of cultural studies on an imported variety of hops.

Chemical Stripping and Suckering Trial

Objectives:

See 1955 Annual Report, page 82.

Duration of experiment:

To be discontinued in its present form after one more year.

Reasons for undertaking the work:

See 1955 Annual Report, page 82.

Nature and extent of previous work:

See 1955 Annual Report, page 83.

Procedure:

The procedures used in 1957 resembled those in 1956 (see Annual Report, page 91) except that different dates were involved and there was some substitution of treatments.

Shed-a-leaf was discarded at the close of the 1956 season due to its erratic effect. In its place a new chemical was substituted. This was SD-1369, and it was applied at rates of 1, 2, and 3 pounds actual (2# actual per gal. formulation) material in 100 gallons of water.

Two sprayings were made during the season. One application was made on June 7 when the hops were approximately eight feet high. There was a moderate amount of basal growth at that time. A second application was made on July 5 at which time the hops were flowering. Approximately 35 gallons of spray per acre were required on June 7, but somewhat less than this amount was needed on July 5.

Visual ratings were made on July 5 and July 15.

Experimental Results:

Data obtained in the Chemical Stripping and Suckering Trial, 1957.

Treatment and rate	Harvest wt. (lbs./plot) 1957	Harvest wt. (lbs./plot) 1956-57	Alpha-acid 1/ (%) 1957	Vine injury 7/5/57	Extent of effectiveness, 1957 2/ Stripping& Suckering 7/5 Avg.	Range	Stripping 7/15 Avg.	Range	Suckering 7/15 Avg.	Range
1 Check(hand worked)	36.3	38.3	5.57	—	1.0	all 1	1.0	all 1	1.0	all 1
2 Check(no treatment)	41.5	43.0	5.92	—	10.0	all 10	10.0	all 10	10.0	all 10
4 Endothal 3#/100gal.	31.7	32.1	5.61	moderate	3.0	2-4	1.0	all 1	1.2	1-2
5 Endothal 5# "	32.6	36.6	5.69	light	2.2	2-3	1.0	all 1	1.0	all 1
6 Endothal 7# "	34.6	36.0	6.22	moderate	1.8	1-2	1.0	all 1	1.0	all 1
7 SD-1369 1# "	33.6	—	6.04	none	3.5	2-7	7.5	6-9	7.8	7-8
8 SD-1369 2# "	36.4	—	6.26	light	2.8	2-4	2.0	1-3	2.2	2-3
9 SD-1369 3# "	32.7	—	6.35	moderate	2.5	1-3	1.0	all 1	1.8	1-2
Mean	34.9	37.2	5.96							
LSD (5%)	NS	6.7	NS							
CV (%)	15	13	10							

1/ Data supplied by S. T. Likens.

2/ Rating of 1 is equal to hand check, a rating of 10 is equal to no treatment. Data furnished by W. R. Furtick.

Discussion and conclusions:

No differences in yielding ability were indicated in 1957 among the eight treatments. There did not appear to be any differences in alpha-acid content either. Although year to year observations may indicate no detrimental effects of chemical treatment, cumulative effects are the most important in this study. Final conclusions will be based on a summary of several individual year's results.

Significant differences in yielding ability were indicated among five treatments in a two-year summary of results. These five treatments consisted of the two checks and the three rates of endothal. The results suggest that there may be some detrimental effects on yield caused by endothal, however another year's data should be obtained before final conclusions are drawn.

No statistical analysis was made on the data obtained on the effectiveness of the treatments for stripping and suckering. Wide differences were apparent, however.

On the basis of visual evaluation endothal at 5 lbs. actual per 100 gallons of solution appeared to be fully as effective as hand stripping without causing an undue amount of vine injury. With regard to suckering endothal was not entirely effective even at the highest rate early in the season when there was a moderate amount of growth at the base. After the basal growth had once been cleaned off treatment with endothal at the 5 lb. rate gave satisfactory control.

SD-1369 at the rates used in this study was not as effective as endothal. Rates of this material up to 3 pounds actual did not control sucker growth completely. Some stem or vine injury was apparent with this chemical at the highest rates.

On the basis of the results from the last two years, it would appear that endothal has shown the most promise of any of the chemicals studied for chemical stripping and suckering of hops. An additional year's data should supply adequate evidence for a decision regarding the use of this material as recommended farm practice.

Fuggles Irrigation — Fertility Experiment

Objectives:

(a) To determine the effects of irrigation and soil fertility levels on yield and quality of hops.

(b) To determine the volume of soil from which the hop plant will use water.

Reasons for undertaking the work:

The irrigation requirements of hops for optimum production and quality have not been established. Current irrigation practices vary widely even among growers within a region, and this is believed to contribute to the wide variation in yields obtained. The development of improved irrigation and soil fertility practices may be effective in helping growers maintain optimum production and quality levels in Oregon.

Nature and extent of previous work:

With other crops on which research has been done, the response to the additions of fertilizer is influenced by irrigation scheduling. The same results would be expected for hops, but experimental data are lacking.

It has been estimated that the net irrigation requirement for hops grown in the Willamette Valley is 13 inches per season. The installation of the irrigation system on the experimental yard in 1939 was estimated to have caused a 27% increase in hop yields.

Data from previous fertilizer trials on hops are inconsistent regarding the effects of fertilizer applications on quality. Yield responses have been obtained primarily by applications of nitrogen fertilizers.

Cooperating agencies:

This experiment is cooperative among the Crops Research Division, A.R.S., and the departments of Farm Crops, Soils, and Agricultural Chemistry, of Oregon State College. The Brewing Industries Research Institute provides partial financial support.

Location and duration of the experiment:

This study is located on the College East Farm. It was planted in 1956, however no results were obtained until the 1957 season. It is expected that it will be conducted over a four-year period, 1957-1960.

Procedure:

This study was planted in a split-plot arrangement of four replications. Main treatments consisted of 7 x 4 hill plots and the sub-treatments consisted of 1 x 4 hill plots. Border rows were planted around the main plots to prevent over-lapping of irrigation treatments.

The treatments were designed as follows:

Main treatments, irrigation:

A. Low moisture, no irrigation.

B. One irrigation at initial burring.

C. One irrigation at initial coning.

D. High moisture, maximum tension 0.8 atm.

E. Medium moisture, maximum tension 2.0 atm.

Subtreatments, fertility:

	N lbs./a.	P_2O_5 lbs./a.	K_2O lbs./a.
1	0	75	75
2	67	75	75
3	133	75	75
4	200	75	75
5	67	0	75
6	133	0	75
7	133	75	0
Comparisons	(1,2,3,4) (2,3,5,6)	(2,3,5,6)	(3,7)

One subplot, fertility treatment 4, in each of the main irrigation plots A, D and E was selected for moisture study and control. Four gypsum stakes were installed in each of these supolots by which soil moisture tension was measured near four plants at depths of 6, 12, and 24 inches each.

Each main moisture plot was irrigated independently when the moisture records from the subplot within the main plot indicated a predetermined mean tension in the top two feet of soil or when the stage of growth of the hop plants indicated that an irrigation treatment was scheduled for that particular plot. Following is an outline of the irrigation schedule in 1957.

Inches of water applied by treatments and replications on each date in 1957.

		7/6	7/10	7/12	7/18	7/21	7/24	7/27	7/30	8/2	8/5	8/11	Total
Treat. B	I		2.50										2.50
	II		2.50										2.50
	III		2.50										2.50
	IV		2.50										2.50
Treat. C	I										4.50		4.50
	II										3.50		3.50
	III										3.50		3.50
	IV										3.50		3.50
Treat. D	I	2.00		2.84			2.40			2.28			9.52
	II	2.00		2.38				2.53		2.44		2.48	11.83
	III	2.00							2.55				4.55
	IV	2.00						2.58				2.27	6.85
Treat. E	I				3.29							3.35	6.64
	II	3.31								3.35			6.66
	III						3.21					3.30	6.51
	IV					3.20							3.20

In all irrigations, an amount of water was applied equal to the amount calculated to bring the upper two feet of the soil back to field capacity. Irrigation was accomplished by means of four-inch "perfo-rain" type sprinkler pipe lying on the ground.

Fertilizers were applied in early spring by hand application in the form of a ring around each hill followed by discing.

Fuggles Irrigation-Fertility Experiment
College East Farm

Well

	C 7 422	C 5 423	C 4 424	C 6 425	C 1 426	C 2 427	C 3 428	D 1 429	D 4 430 (boxed)	D 3 431	D 7 432	D 6 433	D 5 434	D 2 435
IV	A 6 408	A 5 409	A 7 410	A 1 411	A 3 412	A 2 413	A 4 414 (boxed)	E 2 415	E 6 416	E 4 417 (boxed)	E 5 418	E 7 419	E 3 420	E 1 421
	D 3 329	D 6 330	D 7 331	D 4 332 (boxed)	D 1 333	D 5 334	D 2 335	B 5 401	B 4 402	B 6 403	B 1 404	B 2 405	B 3 406	B 7 407
III	A 5 315	A 4 316 (boxed)	A 7 317	A 2 318	A 3 319	A 6 320	A 1 321	E 4 322 (boxed)	E 2 323	E 5 324	E 7 325	E 1 326	E 6 327	E 3 328
	B 7 301	B 6 302	B 4 303	B 1 304	B 2 305	B 5 306	B 3 307	C 4 308	C 1 309	C 2 310	C 3 311	C 7 312	C 6 313	C 5 314
	E 7 222	E 3 223	E 6 224	E 4 225 (boxed)	E 2 226	E 5 227	E 1 228	B 3 229	B 7 230	B 2 231	B 6 232	B 4 233	B 1 234	B 5 235
II	D 3 208	D 2 209	D 1 210	D 6 211	D 5 212	D 4 213 (boxed)	D 7 214	A 7 215	A 5 216	A 3 217	A 4 218 (boxed)	A 1 219	A 2 220	A 6 221
	B 4 129	B 6 130	B 5 131	B 1 132	B 2 133	B 3 134	B 7 135	C 5 201	C 1 202	C 6 203	C 4 204	C 3 205	C 7 206	C 2 207
I	D 7 115	D 6 116	D 2 117	D 3 118	D 1 119	D 5 120	D 4 121 (boxed)	A 2 122	A 1 123	A 5 124	A 7 125	A 6 126	A 3 127	A 4 128 (boxed)
	C 3 101	C 5 102	C 4 103	C 7 104	C 1 105	C 2 106	C 6 107	E 3 108	E 6 109	E 7 110	E 4 111 (boxed)	E 1 112	E 5 113	E 2 114

MAIN PLOTS

A. Check-Low moisture-no irrigation,
B. One irrigation at initial burring,
C. One irrigation at initial coning,
D. High moisture, 0.8 atm.
E. Medium moisture, 2 atm.

[ ] = Plots with stakes installed. Four stakes per plot, 1 foot radius from each plant and all located on west side of plant.

SUB PLOTS

1. $N_0P_1K_1$
2. $N_1P_1K_1$ N_1 = 67# N or .29# (133g) ammonium nitrate per hill.
3. $N_2P_1K_1$ N_2 = 133# N or .59# (267 g) ammonium nitrate per hill.
4. $N_3P_1K_1$ N_3 = 200# N or .88# (400 g) ammonium nitrate per hill.
5. $N_1P_0K_1$ P_1 = 75# P_2O_5 or .25# (112 g) treble super phosphate per hill.
6. $N_2P_0K_1$ K_1 = 75# K_2O or .18# (84 g) muriate of potash per hill.
7. $N_2P_1K_0$

Four replications of 28-hill plots
Sub plots are 4 hills.

Experimental results.

The 1956 season was used to a large extent as a period of calibration of soil moisture tension determinations, a soil variability survey, and as a time during which the plants could get better established. Although considerable back-ground work of this nature had to be done, some relevant results were obtained.

Harvest weights were recorded on three replications, and alpha-acid determinations were made on the samples from two replications. In addition to these data, some information was gained regarding the soil moisture use pattern of a two-year old hop plant. These results are presented in the following graphs and tables.

Yields in the Irrigation-Fertility Experiment on Fuggles in 1957.

Lbs. per acre of dry hops

Irrigation treatment	$N_0P_1K_1$	$N_1P_1K_1$	$N_2P_1K_1$	$N_3P_1K_1$	$N_1P_0K_1$	$N_2P_0K_1$	$N_2P_1K_0$	Avg.
A-no irrigation	217	422	461	458	354	529	310	392
B-1 irrig.burring	215	764	560	571	604	643	370	531
C-1 irrig.coning	285	626	691	588	366	476	578	515
D-high moisture	275	761	667	500	674	626	815	616
E-med.moisture	196	371	458	472	502	298	415	401
Avg.	237	588	567	517	499	534	497	492

Analysis of variance of harvest wts.

Source of variation	DF	SS	MS	
Irrigation levels	4	416.14	104.035	NS
Replications	2	36.62	18.310	NS
Error a	8	494.90	61.862	
Subtotal a	14	947.66		
Fertilizer levels	6	684.06	114.010	**
I x F	24	403.66	16.819	NS
R x F	12	213.20	17.767	NS
I x R x F	48	838.81	17.475	
Subtotal b	90	2139.73		
Grand total	104	3087.39		

NS = no significant difference
** = significant difference at the .01 level.

Avg. percentages of alpha-acid (colorimetric) in the Fuggles Irrigation-Fertility Experiment in 1957.

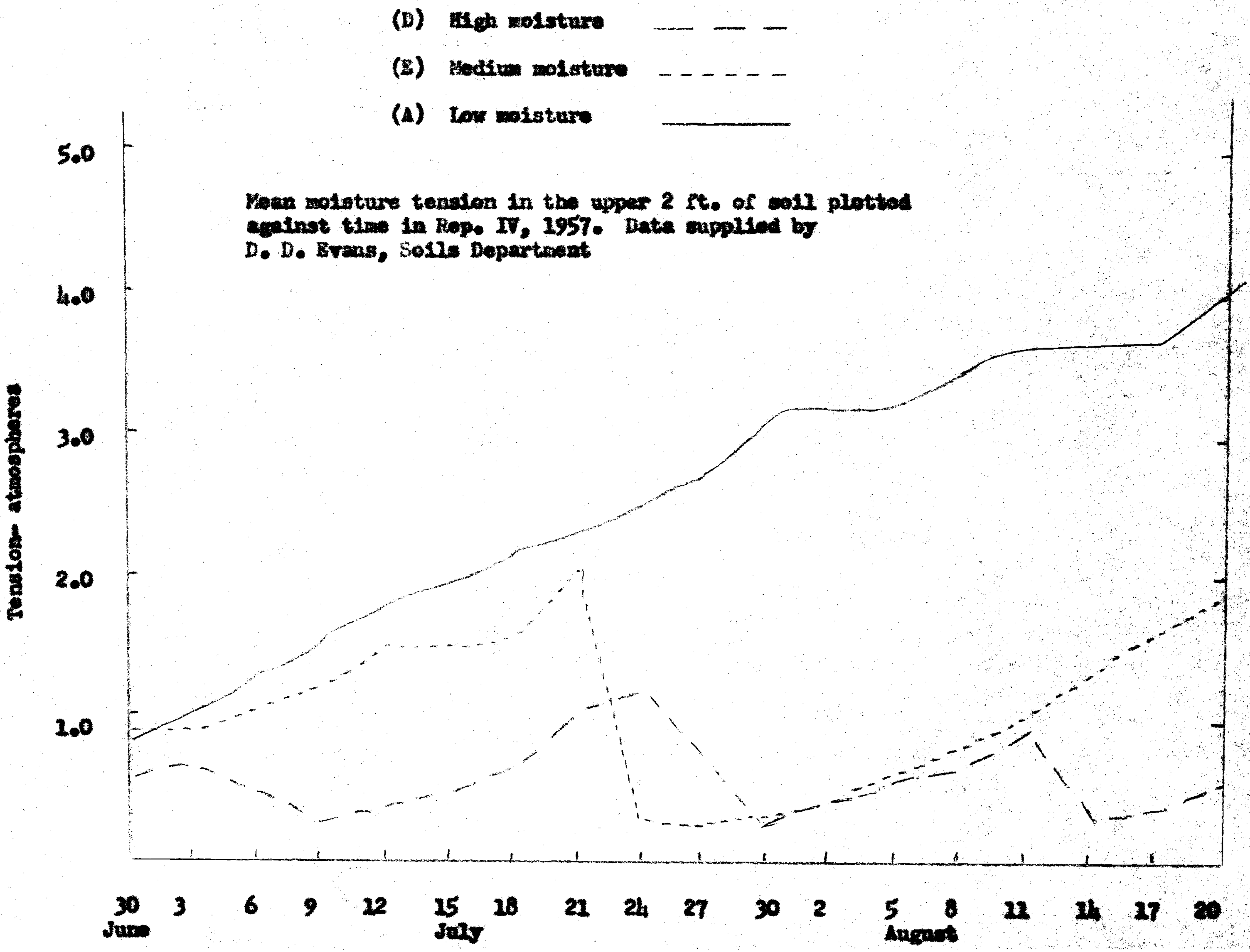
Data supplied by S. T. Likens.

Irrigation treatment	1 $N_0P_1K_1$	2 $N_1P_1K_1$	3 $N_2P_1K_1$	4 $N_3P_1K_1$	5 $N_1P_0K_1$	6 $N_2P_0K_1$	7 $N_2P_1K_0$	Avg.
A-no irrig.	4.86	5.30	5.06	5.22	5.33	5.20	5.33	5.18
B-irrig.burring	4.97	5.63	5.12	5.24	5.42	5.16	4.82	5.19
C-irrig.coning	5.42	5.30	4.80	5.17	5.07	5.00	5.60	5.19
D-high moisture	4.76	5.34	4.94	4.87	5.08	5.34	4.94	5.04
E-Med.moisture	4.91	5.14	5.20	5.12	5.00	5.14	4.66	5.02
Avg.	4.98	5.34	5.02	5.12	5.18	5.16	5.07	5.13

LSD (5%) for fertilizers = .07%

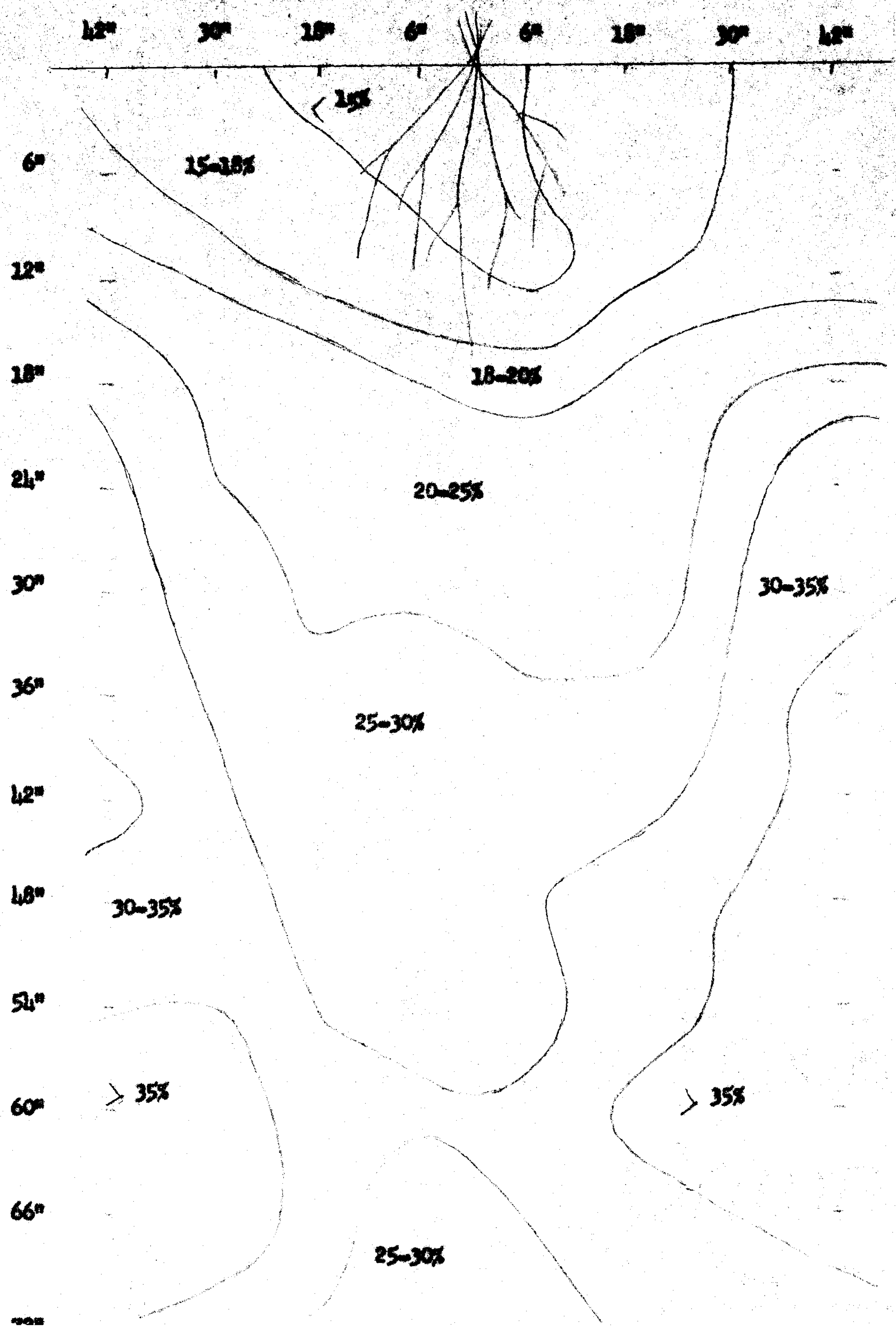
Analysis of Variance of alpha-acid percentages.

Source of Variation	DF	SS	MS
Irrigation treatments	4	.43327	.10832
Replications	1	.20304	.20304
Error a	4	1.66190	.41548
Fertilizers	6	.86770	.14462 **
I x F	24	4.81569	.20065 **
F x R	6	.03555	.00592
Error b	24	.14306	.00596
Grand total	69	8.16021	



Mean moisture tension in the upper 2 ft. of soil plotted against time in Rep. IV, 1957. Data supplied by D. D. Evans, Soils Department

Soil moisture distribution under a non-irrigated (treatment A) 2-yr. old hop plant, August 1, 1957. Values represent total moisture in the soil. Data supplied by D. D. Evans, Soils Department



Discussion and Conclusions:

The experimental results for 1957 were not expected to be too meaningful since the plants were young and had not reached maximum production. An additional complication became apparent during the season in the nature of many off-type plants in replication II. It is for this reason that yield data were obtained from only three replications. The off-type plants have been eliminated and substituted by the desired type.

Analysis of variance of yield data indicated that a significant difference was due only to fertilizer treatments. It appeared this difference could be attributed solely to applications of 67 or more lbs. of nitrogen per acre.

When the yield data for the three treatments, for which soil moisture records were kept (treatments A, D and E), were analyzed separately, significant differences were indicated for both irrigation treatment and fertilizer treatment. The irrigation response appeared to be caused primarily by the high moisture treatment. In addition, there appeared to be no irrigation x fertilizer interaction.

Significant differences in alpha-acid percentage were attributed to fertilizer treatment. The average percentages were rather erratic, however most of the treatments receiving nitrogen exceeded the no-nitrogen treatment in this respect.

Although the results were obtained on relatively young plants which were not completely established, there was evidence that they extracted moisture vertically to a depth of five feet and radially to a distance of over three and one-half feet in the upper 18 inches of soil. As these plants became older it is expected that a better picture of the volume of soil from which hops use water will be obtained.

The results from subsequent years should be much more meaningful than the 1957 results.

Fuggles Height of Stripping Trial

Objectives:

To determine the effects of stripping the basal portions of the vines to various heights on the yield and alpha-acid content of Fuggles hops.

Duration of experiment:

Intermittent, until three years of data have been obtained.

Reasons for undertaking the work:

There is a wide variation in grower practice with respect to stripping hops. Many growers do not strip at all. Others strip the basal portions of the vines to heights ranging from one up to five or six feet. It was considered worthwhile to investigate the effects of stripping on production.

Nature and extent of previous work:

In 1952 this variety of hops was stripped to heights up to eight feet. There appeared to be no effects on yield based on the single year's observation.

Procedure:

The trial was laid out in a randomized block design of four replications. The size of the plots was 1 x 5 hills. The hops were grown on a 14 ft. trellis.

Treatment consisted of stripping the lower portions of the vines to heights of 1.5, 3.0, 4.5 and 6.0 feet above ground level. One treatment was left as a check which was not stripped. Hand stripping was done at intervals when normal development of the plants indicated that stripping was needed. A total of three strippings were made during the season.

Other cultural practices were identical to those normally done on the other production plots.

Experimental results:

Data were obtained on harvest weight and alpha-acid content in 1957. The following table summarizes these results.

Yield and alpha-acid content in the Fuggles Height of Stripping Trial in 1957.

Treatment	Yield (lbs./a.)	Alpha-acid 1/ (% dry wt.)
No stripping	1150	5.69
1.5 feet	1110	5.20
3.0 feet	1200	5.90
4.5 feet	1150	5.96
6.0 feet	1100	5.77
Mean	1140	5.71
CV(%)	17	6

1/ Data supplied by S. T. Likens.

Discussion and conclusions:

No significant differences were indicated for either yield or alpha-acid content. These results for yield are in line with those obtained in 1952 which also showed no effect due to height of stripping. Foliage and flowering branches on the lower portions of the vines appear to contribute very little to the yield of cones from the plant as well as to the general vigor of the plant. Clean culture on the base of the plant does contribute to insect and disease control.

Time and Severity of Pruning Study.

Objectives:

See 1956 Annual Report, page 104.

Duration of Experiment:

See 1956 Annual Report, page 104.

Reasons for undertaking the work:

See 1956 Annual Report, page 104.

Procedure:

The procedure in 1957 was essentially the same as in 1956 (see Annual Report, page 104).

Experimental results:

Data were obtained on harvest weight, alpha-acid content, and sidearm length in 1957. There did not seem to be the great difference in flowering date this year as was experienced in 1956, and no observations were made on this characteristic. The following table has a summary of the 1957 data.

Data obtained in the Time and Severity of Pruning Trial in 1957.

Treatment	Yield(lbs./a.) 1957	Yield(lbs./a.) 1956-57	Alpha-acid 1/ (%) 1957	Sidearm length (inches) 1957
A not pruned	1330	1320	6.34	22
B mod. 4/11	1130	1330	6.33	20
C severe 4/11	1220	1380	6.06	18
D mod. 4/18	1310	1500	5.27	21
E mod. 4/25	1310	1380	5.67	25
Mean	1260	1380	5.93	21
LSD(5%)	150	NS	NS	4
CV(%)	11	12	13	34

1/ Data supplied by S. T. Likens

Discussion and conclusions:

Significant differences in yields and sidearm length were suggested in 1957. No significant difference in yield was indicated in the two-year summary. There was, however, a marked seasonal difference as well as a significant treatment x year interaction.

The two-year results on yield are rather peculiar considering that a significant difference was indicated in each year but not when the two-years' results were combined. In other words, the treatment averages over the two-year period were about the same, and some treatments were high one year and low the next.

The Cawthorn Institute (see their Hop Research Annual Report for 1955-56) reported that Fuggles hops in New Zealand yield well if October (same as April in this hemisphere) temperatures are unusually warm. If October is cold, training up to four weeks later can increase yield considerably. It has been found that Fuggles produces a more constant crop when the shoots chosen for training are those which appear between three and four weeks after it starts shooting in New Zealand. Fuggles is trained in England in the first part of May, but it is ready for training in New Zealand by October 10 (April 10). Pulling off the early appearing vines and training the later ones makes the vines start their development under conditions of length of day more similar to such conditions in England.

Perhaps the ratio of day-length to dark, with and without cloud cover, as well as the accumulative temperature effects prevalent after the shoot primordia start to develop influence the vigor of the vines which arise from them. Such conditions would vary from year to year.

No differences in alpha acid were indicated in 1957 nor in 1956.

Differences in sidearm length were significant again in 1957. These results were different from those of last year in that the ranking from high to low was different. There was some indication that later pruning caused longer sidearm development each year. In 1956 the no prune treatment had the shortest sidearm development but next to the longest sidearm development in 1957. In 1957, however, this particular treatment apparently caused reduced sidearm development on the lower portions of the vines.

Cultural Studies with Hallertau Hops

Objectives:

To study the performance of Hallertau hops when subjected to various cultural treatments for the purpose of improving the yield of this variety in the Willamette Valley.

Duration of experiments:

This series of studies is expected to continue for a 6 to 8-year period depending upon the speed with which all phases are put under way.

Reasons for undertaking the work:

In November, 1956 Oregon State College was requested by B.I.R.I. to initiate studies relative to increasing yields of domestically grown Hallertau hops. Hallertau hops have been grown on small acreages in the Pacific Northwest and found to be low producing. Cultural studies may provide information which will lead to increased production in the Willamette Valley of Oregon.

Agronomic studies conducted cooperatively by the U.S.D.A. and Oregon State College during the past several years have indicated that hop yields are influenced by irrigation, soil fertility, plant spacing and numbers of vines per plant. Limited data from England and New Zealand indicate that trellis height affects yield and chemical composition. Preliminary experiments at Oregon State College and in New Zealand indicate that time of spring pruning will influence yield.

Procedure:

A series of experiments has been organized from which it is hoped there will come information leading to improved cultural practices for this type of hop. The following list outlines the various cultural trials which have been established or which will be established as soon as sufficient planting stocks are available.

1. A height of trellis study involving three trellis heights (14, 16 and 18 ft.) in conjunction with varietal comparisons of Hallertau and five other commercially grown or experimental varieties (Fuggles, Late Cluster, Brewer's Gold, 135-I and 128-I.)

2. A date of pruning study consisting of five treatments. Hills will be pruned on each of five different dates, i.e. March 15, March 25, April 5, April 15, and April 25.

3. A number of vines and plant spacing study involving 4, 6, or 8 vines per hill in combination with spacing the plants 2.5, 5.0, or 7.5 ft. apart in 8 ft. rows.

4. A fertilizer and irrigation experiment involving rates of N, P, K and possibly other elements in combination with medium and high water application. The details of this study will not be completed until soil tests have been made.

5. Depending upon the availability of space after the above studies have been established, there will be a simple comparison made involving stripping and suckering vs. no stripping or suckering.

An experimental site of 3.14 acres has been selected and leased for a five to eight year period. This site is moderately convenient to the College East Farm and well protected on three sides by trees. The soil is a Newberg sandy loam well suited for hop production. It is almost certain that its location will provide for production of seedless hops because of the isolation provided by distance and wind protection from other hops.

Construction of the trellis is still in progress. Due to the amount of land needed for roadways, irrigation facilities, anchor rows and irregularity of the site, the experimental area will be confined to somewhat over two acres. Completion of the trellis and installation of irrigation facilities is expected during the spring of 1958.

Since only 200 Hallertau cuttings were received in the spring of 1957 it was impossible to establish a planting in the entire area. The height of trellis study and the date of pruning study were planted in 1957. Approximately 60 cuttings were planted in an increase row and planting material will be taken from it in 1958.

<u>Experimental results:</u>

No research results will become available until 1958 from the studies established in 1957.

CHEMICAL INVESTIGATIONS RELATIVE TO THE EVALUATION OF HOPS
(CRa5-5, OAES 36)

S. T. Likens

Objectives

1. See 1956 Annual Report, p. 108.

2. See 1956 Annual Report, p. 108.

3. See 1956 Annual Report, p. 108.

A. **Evaluation of Strobiles: Alpha and Beta Acids.**

Objectives:

See 1956 Annual Report, p. 109

Duration:

See 1956 Annual Report, p. 109

Reasons:

See 1956 Annual Report, p. 109

Nature and extent of previous work:

See 1956 Annual Report, p. 109

Procedure:

Sample collections in 1957 were the same as usual, however, samples from the Quality Trial were dried at 118°F in a forced draft laboratory drying cabinet while lying loose in wooden trays. All other samples were dried in the Farm Crops Experimental Dryer.

Analytical methods were:

α-acid: colorimetric method (1952 Annual Report, p. 109).

β-acids: none determined.

Experimental Results:

α-acid determinations were made on 7 experiments involving two line projects. Detailed data will be found with those line project results.

1. Chemical Defoliant Trial. 9 entries, 4 replications. Analysis of Variance showed neither treatment nor replication differences when tested

at the 5% level. (See CRe5-4)

2. Pruning Trial. 5 entries, 4 replications. Neither treatment nor replication effects were found to be significant at the 5% level. (See CRe5-4)

3. Height of Stripping Trial. 5 treatments, 4 replications. Analysis of variance showed no treatment effect but did show a significant (5%) replication difference. (See CRe5-4)

4. Irrigation-Fertility Trial. 5 irrigation levels (main plots), 2 replications and 7 fertility levels (sub plots). (See CRe5-4) Only "Fertilization" and the "Irrigation, Fertilization Interaction" showed significant differences, both at the 1% level.

5. Quality Trial. 18 entries, 4 replications. These data were not treated statistically, but are tabulated in summary form below. (See CRe5-1)

6. Seedless Yard. 19 entries, single samples. These data were not treated statistically, but are tabulated in summary form below. (See CRe5-1)

7. Corvallis-Prosser Experimental Yield Trial (Prosser samples). 15 entries, 3 replications. (See CRe5-1)

Summary of
α-acid production of Experimental Lines 1957
(Comparison of varieties grown in different trials)

Variety	% α-acid, dry weight basis, colorimetric method Quality(1) trial O.S.C.	Seedless(2) yard O.S.C.	Corvallis-(3) Presser (Presser)
Late Clusters	5.44	8.45	6.20
Fuggles	5.33	5.20	—
Brewers Gold	8.11	9.43	—
Bullion	7.60	—	—
Backa	—	6.17	—
Hallertau	—	5.92	—
103-I	3.34	3.41	2.47
104-I	3.47	—	2.04
107-I	3.97	5.61	3.99
108-I	4.28	8.56	5.52
109-I	6.30	6.93	4.31
112-I	—	7.05	5.95
123-I	6.33	8.92	6.70
124-I	3.98	6.82	2.90
127-I	5.72	6.28	3.54
128-I	—	10.30	—
129-I	—	6.25	—
132-I	3.51	3.10	3.00
135-I	2.38	2.35	2.45
138-I	5.47	—	4.91
139-I	3.78	3.54	3.63
144-I	4.90	5.94	2.35

(1) Average of 4 replications - single hill plots. (harvested when ripe, between 8/23 and 9/9)

(2) Single sample from 5 hill plots, not replicated. (harvested 9/11)

(3) Average of 3 replications - 5 hill plots. (harvested when ripe, between 9/4 and 9/11)

Summary

SD-1369 and diesel oil were not found to affect alpha-acid production in the variety Fuggles at the rates applied.

Alpha-acid production in the variety Fuggles was not found to be dependent upon any of the following factors.

1. Time or severity of pruning,
2. Height of stripping,
3. Irrigation levels.

The production of alpha-acid was shown to be related to fertility levels for the variety Fuggles. This observation was not consistent with previous fertilizer trials.

Alpha-acid production has been measured on 16 experimental varieties and various commercial varieties in 3 locations, (2 yards at Corvallis, one seedless, and 1 yard at Prosser, Wash.). The results indicate that α-acid production is quite variable from one location to another.

B. Evaluation of Strobiles: Oils.

Objectives:

See 1956 Annual Report, p. 111.

Duration:

See 1956 Annual Report, p. 111.

Reasons for undertaking the work:

See 1956 Annual Report, p. 111.

Nature and extent of previous work:

See 1956 Annual Report, p. 111.

Procedure:

See 1956 Annual Report, p. 111.

Experimental Results:

Evaluation of oils this season has been confined to experimental lines with emphasis on those varieties which are being considered for off-station testing.

Oil yields have been measured for the following trials:

1. Quality Trial, East Farm, Corvallis. 14 exp. var., 4 comm. var., 4 reps. single hill plots. Oil yields from both green and dry samples.
2. Seedless Trial, L. Brown Farm, Corvallis. 13 exp. var., 5 comm. var., 1 rep., 5 hill plots. Oil yields from dried hops only.
3. Corvallis-Prosser Yield Trial, Prosser, Wash. 14 exp. var., 1 comm. var., 3 reps., 5 hill plots. Oil yields from dried hops only.

Results in tabulated summary form are presented in the following table.

The work initiated in 1956 relative to the separation of hop oils into their components by gas-liquid Chromatography, (G L C), is being continued. To date experiments have been confined to developing and evaluating G L C columns. Two columns have been constructed which should give satisfactory separation of hop oil fractions. Details of this work will be found in this report under "Investigations into Chemical Methods."

Summary of Oil Production of Experimental Lines 1957
(Comparison of varieties grown in different trials)

	Oil content, mls/100 grams (moisture free)			
	Quality Trial		Seedless yard	Prosser yard
Variety	green	cured	(cured)	(cured)
Late Clusters	0.58	0.48	0.85	0.75
Fuggles	1.03	0.75	1.56	—
Brewers Gold	2.62	2.89	2.08	—
Bullion	3.49	2.48	—	—
Backa	—	—	1.59	—
Hallertau	—	—	1.49	—
103-I	2.49	1.38	0.92	0.55
104-I	1.97	1.48	—	0.49
107-I	—	1.04	1.40	0.76
108-I	1.03	0.70	1.85	1.22
109-I	1.77	1.13	0.88	1.34
112-I	—	—	1.59	1.06
123-I	0.72	0.72	1.17	0.92
124-I	1.03	0.84	1.32	0.53
127-I	1.46	1.25	—	0.79
128-I	—	—	1.44	—
129-I	—	—	1.42	—
132-I	0.94	0.48	0.31	0.31
135-I	1.69	1.20	1.43	0.60
138-I	0.63	0.69	—	0.90
139-I	0.83	0.60	0.60	0.44
144-I	2.10	1.66	1.28	0.58
18-S (128-I)*	2.84			

* Not actually in the quality trial.

Summary:

Oil yield has been measured on most varieties which are in advanced trials at Corvallis, Oregon and Prosser, Washington.

Samples of some of these have been saved for further analysis by gas-liquid-chromatography.

C. Evaluation of Strobiles: Storage.

Objectives:

See 1956 Annual Report, p. 114.

Duration:

See 1956 Annual Report, p. 114.

Reasons:

See 1956 Annual Report, p. 114.

Nature of Previous work:

See 1956 Annual Report, p. 114.

Procedure:

See 1956 Annual Report, p. 114.

Cooperation:

This work is being done in cooperation with the Department of Agricultural Chemistry, Oregon State College

Experimental Results:

Samples for these tests are provided by other trials. For additional information on these trials see section CRe5-1.

1957 Crop. Samples were taken from the Quality Trial, East Farm. A sample was taken from each replication of each variety and four subsamples prepared. These have been stored at 38°F. The first series were analyzed for α-acid and oil yield immediately to provide the initial data for the storage tests. (For these data see CRe-5-1.) A second series was analyzed in December. The third and fourth series will be analyzed in March and July respectively. The data for the four storage dates will appear in the 1958 Annual Report.

1956 Crop. The following table summarizes the data obtained during 1956-57. Detailed data by replication will be found in the appendix. Due to missing samples these data cannot be subjected to statistical treatment. However, in order to divide the varieties into "stability classes", the percentage loss

Summary of Results of Storage Tests
Quality Trial - O.S.C. Hop Yards - 1956 Crop

(see foot of table for explanations)

	Variety		Length of Storage at 38° F: 0	3 mo.	6 mo.	11 mo.	% of original lost in 11 mo.	Stability
1	Late Clusters	a-acid	5.9 (3)	6.0 (3)	5.5 (3)	5.4 ([illegible])	7	S
		oil	0.35(3)	0.42(3)	0.34(3)	0.29(3)	17	
2	Fuggles	a-acid	4.1 (3)	4.0 (3)	3.9 (3)	3.2 (3)	22	U
		oil	0.49(3)	0.36(3)	0.36(3)	0.18(3)	63	
3	Brewers Gold	a-acid	8.5 (3)	8.8 (2)	7.3 (3)	5.2 (1)	39	U
		oil	2.89(3)	2.72(2)	2.18(3)	1.47(1)	49	
4	Bullion	a-acid	5.2 (4)	3.3 (3)	4.0 (4)	2.2 (2)	58	U
		oil	0.84(4)	0.42(3)	0.58(4)	0.53(2)	37	
5	103-I	a-acid	4.0 (4)	3.8 (4)	3.6 (4)	2.3 (4)	42	U
		oil	1.43(4)	1.44(4)	1.31(4)	0.90(3)	39	
6	104-I	a-acid	4.2 (2)	3.7 (2)	3.7 (2)	3.3 (1)	21	A
		oil	1.51(2)	1.64(2)	1.58(2)	1.08(1)	29	
7	107-I	a-acid	4.6 (4)	4.6 (4)	4.4 (4)	3.9 (4)	15	A
		oil	0.91(4)	0.85(4)	0.85(3)	0.76(4)	16	
8	108-I	a-acid	4.6 (4)	4.7 (4)	4.3 (4)	3.6 (4)	22	A
		oil	0.89(4)	0.90(4)	0.86(4)	0.65(4)	27	
9	109-I	a-acid	5.3 (3)	4.7 (2)	4.4 (2)	3.9 (2)	26	A
		oil	1.50(2)	1.75(2)	1.58(2)	1.18(2)	21	
10	112-I	a-acid	6.4 (4)	6.4 (4)	5.6 (4)	4.9 (4)	23	A
		oil	1.15(4)	1.18(4)	1.18(4)	1.03(4)	10	
11	123-I	a-acid	6.9 (4)	6.7 (4)	6.4 (4)	5.2 (4)	25	A
		oil	0.92(4)	0.92(4)	0.99(4)	0.79(3)	14	
12	124-I	a-acid	4.4 (4)	4.3 (4)	4.1 (4)	3.6 (4)	18	A
		oil	0.60(4)	0.64(4)	0.64(4)	0.53(4)	12	
13	127-I	a-acid	5.8 (2)	-	5.6 (2)	-	—	
		oil	1.34(2)	-	1.36(2)	-	—	
14	132-I	a-acid	4.4 (3)	4.1 (3)	3.9 (3)	2.7 (1)	39	A
		oil	0.52(3)	0.49(3)	0.59(3)	0.40(2)	15	
15	135-I	a-acid	2.7 (4)	3.1 (3)	2.6 (3)	2.3 (3)	15	A
		oil	0.75(4)	0.78(3)	0.83(3)	0.57(3)	24	
16	138-I	a-acid	5.2 (4)	5.2 (4)	5.0 (4)	4.3 (3)	17	A
		oil	0.76(4)	0.85(4)	0.83(4)	0.65(3)	12	

Summary of Results of Storage Tests
Quality Trial - O. S. C. Hop Yards - 1956 Crop -- cont.

Variety		Length of Storage at 38° F: 0	3 mo.	6 mo.	11 mo.	% of original lost in 11 mo.	Stability
17 139-I	a-acid	4.1 (4)	4.2 (4)	4.1 (4)	3.5 (4)	15	A
	oil	0.57(4)	0.52(4)	0.58(4)	0.41(4)	28	
18 144-I	a-acid	4.8 (3)	4.7 (4)	4.4 (3)	3.6 (4)	25	A
	oil	1.49(3)	1.62(4)	1.48(4)	1.47(4)	1	
MISCELLANEOUS SAMPLES							
188-I	a-acid	10.5 (1)	10.9 (1)	10.1 (1)	8.8 (1)	22	A
	oil	2.13(1)	2.21(1)	2.16(1)	1.57(1)	26	
164-S	a-acid	5.2 (1)	5.5 (1)	-	-	—	
	oil	1.66(1)	1.74(1)	-	-	—	
214-S	a-acid	7.4 (1)	7.7 (1)	-	-	—	
	oil	1.76(1)	1.76(1)	-	-	—	
Fuggles[2]	a-acid	5.2 (1)	4.5 (1)	4.2 (1)	3.4 (1)	35	A
	oil	0.71(1)	0.69(1)	0.64(1)	0.49(1)	31	
Bullion[2] (Earliest Picked)	a-acid	6.9 (1)	5.3 (1)	4.9 (1)	2.7 (1)	61	U
	oil	1.36(1)	1.29(1)	1.15(1)	0.95(1)	30	
Seedless[3] Fuggles	a-acid	4.9 (1)	5.0 (1)	4.9 (1)	3.7 (1)	26	A
	oil	0.64(1)	1.08(1)	1.14(1)	0.86(1)	—	

σ = 14 (a-acid), 14 (oil)
$\bar{x}$ = 27 (a-acid), 25 (oil)

Explanation of Table:

a-acid is presented as % on a dry weight basis.
Oil is given as milliliters per 100 grams of dry hops.
Numbers in parentheses indicate the number of replications involved in the associated result.
Loss in a-acid or oil content is calculated on the basis of the original.
Stability is indicated as follows:

S = stable = $<(\bar{x}-\sigma)$
A = average = $<(\bar{x}+\sigma)$, but $>(\bar{x}-\sigma)$
U = unstable = $>(\bar{x}+\sigma)$

1. It is suspected that this variety is not pure Bullion.
2. Capitol Farms
3. Coleman Farms

of α -acid and of oil have been calculated on an eleven month basis. The means and standard deviation for α -acid losses and for oil losses for the entire group were calculated. Since these were very similar for both α -acids and for oils a general mean and standard deviation for both quality factors was used to provide an objective stability evaluation. Those varieties which had an average loss of less than $\bar{X} - \sigma$ were classed as stable (S). Those losing more than $\bar{X} + \sigma$ were classed as unstable (U). The remainder were classed as average (A).

Summary:

The 1957-58 storage tests are now under way. The results of the 1956-57 tests showed that the variety Late Clusters was the most stable and that the varieties Bullion and Brewer's Gold were least stable. The average loss of α -acid and oil during eleven months storage at 38°F was 26%. 103-I was the only experimental variety which was classed unstable. 128-I, a strong hop similar to Brewer's Gold or Bullion was found to be very superior to either of these. 144-I, a very fragrant variety showed essentially no oil loss and an average α -acid loss.

D. Evaluation of flowers:

Objectives: See 1956 Annual Report, p. 118.

Duration: See 1956 Annual Report, p. 118.

Reasons for undertaking the work: See 1956 Annual Report, p. 118.

Nature of previous work: See 1956 Annual Report, p. 118.

Experimental Results:

Flowers from 5 replications of 20 varieties of male hop plants have been collected. (See section

These samples are being stored at 32°F until chemical analyses for α -acid, β -acid and possibly cohumulone can be made.

Summary:

Flower samples have been collected and stored for chemical analyses.

E. Bullion Fertilizer Trial, 1957:

Objectives:

To determine the effect of two forms of inorganic nitrogen on growth, yield, quality and maturity of Bullion hops.

Duration:

One or two years' data, depending upon results of first year.

Reasons for cooperating in the work:

To clarify any relation between the form of inorganic nitrogen (used as fertilizer) and the resulting quality of hops produced. If a difference is found to exist growers can use this knowledge in selecting appropriate fertilizers. If no difference in quality (or other factors) is found, growers will be able to safely make their selection of fertilizers on the basis of other characteristics without concern about a resulting quality loss.

Cooperators:

1. P. Ballantine and Sons. Initiate and supervise the experiment.
2. Capitol Farms. Provide an experimental yard and to be responsible for management and sampling.
3. U.S.D.A., A.R.S. Aid in experimental design, aid in general supervision and sampling, provide laboratory space for hop oil separation, etc., collect leaf samples at flowering time and at harvest time for N, NO_3-N, P, PO_4-P, K, Ca and Mg determinations.

Procedure:

Two simultaneous approaches are to be taken. One, a production scale experiment with 4 levels of fertility and 3 replications. The second, an experimental group with 5 levels of fertility and 5 replications of 5 hill plots. These are called "the College Plots."

The production plots are to cover approximately 27 acres while the smaller College plots occupy only 125 hills.

Samples of strobiles are to be taken at intervals throughout the growing season and analyzed for green oil content, dry matter, dry oil content and α-acid content.

Leaf samples are to be taken at flowering time and at harvest. These are to be analyzed for the following components: NO_3-N, N, PO_4-P, K, Ca, Mg, Fe, Mn, B, Zn and Mo. The minor element group to be done for P. Ballantine and Sons by American Spectrographic Laboratories.

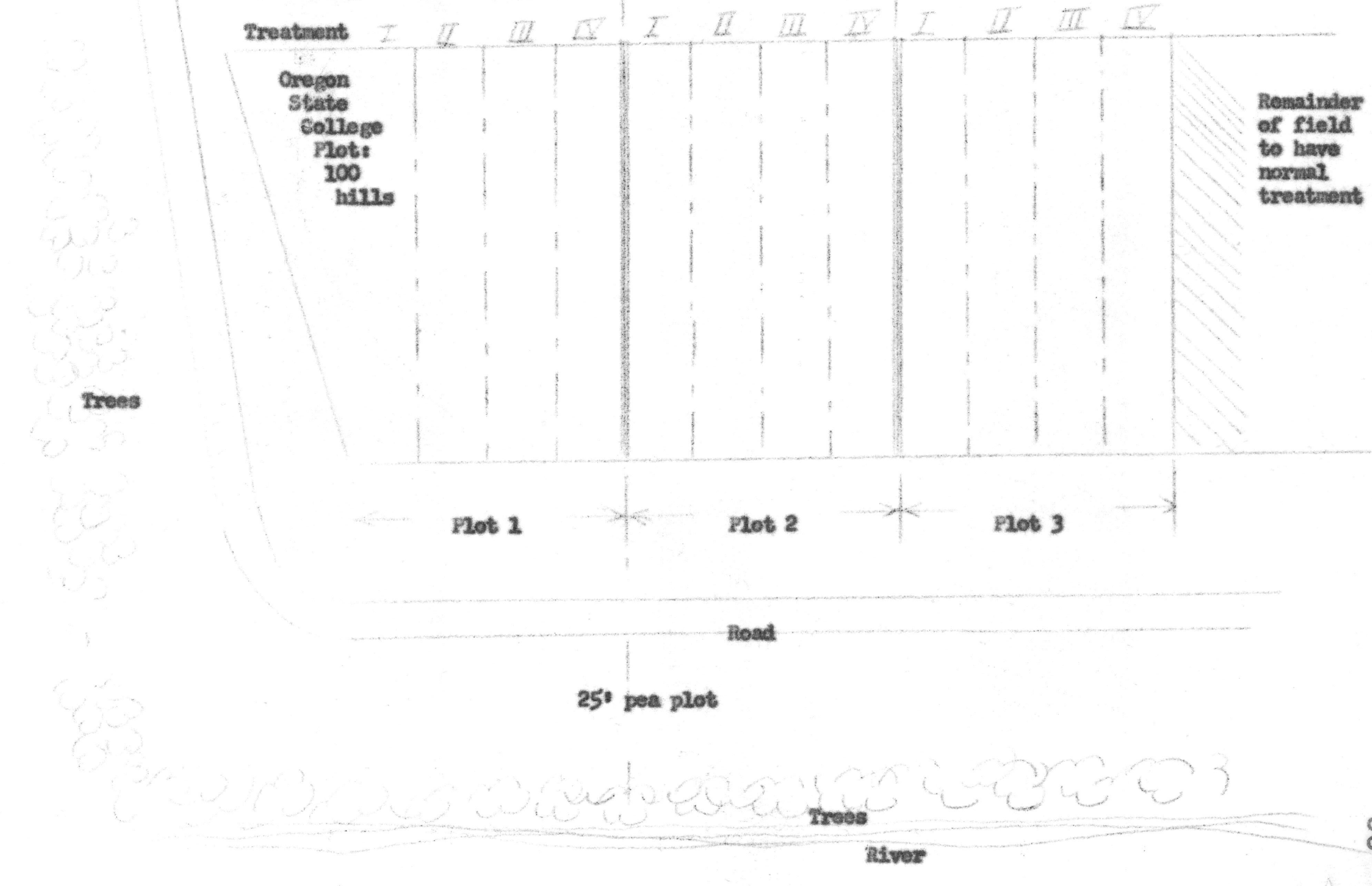
At harvest time (to be determined by maximum oil concentration), all plots are to be sampled and green and dry weights to be taken for the entire production plots. Plots of similar treatments are to be composited from the 3 blocks to provide yield data by treatment only.

The accompanying plot layout furnished by Mr. Frank Kenney of Ballantines, explains the experimental design agreed upon.

N ← Ray Kerr Bullion Field - Revised Layout 4-1-57

Pick center of each treatment and combine like treatments from each plot to make one kiln per treatment.

700 hills/A
1320 hills/treatment (I.B.A)



Bullion Fertiliser Trial
(Ray Kerr Yard)

College Plots:

Treatment	A	B	C	D	E
I 975# + 310# /A	103	203	302	402	505
II 1125# + 350# /A	101	202	301	403	501
III 615# (95# NH_3) + 100# (55# NH_3) /A	105	201	304	404	504
IV 1175# + 250# /A	102	204	303	405	502
V Check	104	205	305	401	503

Spacing 7'9" x 8'; 62 sq. ft. per hill; 702.6 hills per acre

	April 23, 1957	Flowering
I	1.39# per hill	.44# per hill, 199 grams
II	1.60# per hill	.50# per hill, 226 grams
III	.88# per hill; .14# NH_3 per hill	.14# per hill; .08# NH_3 per hill, 63 grams
IV	1.67# per hill	.36# per hill, 163 grams

Production Plots:

Treatment I	II	III	IV
400# treble superphos.	400# treble superphos.	400# treble superphos.	400# treble superphos.
360# Am. sulfate	510# Na. nitrate	95# NH_3-anh.	560# Na. nitrate
50# Mg. "	50# Mg. Cl	50# Mg. carb.	50# Mg. Cl
40# Na. "	40# Na. Cl	40# Na. sulfate	40# Na. Cl
100# K. "	100# K. Cl	100# K. "	100# K. Cl
25# FTE	25# FTE	25# FTE	25# FTE
975#	1125#	615# + NH_3	1175#
210# Am. sulfate	250# Na nitrate	55# NH_3-Anh.	150# Am. sulfate
50# Mg. sulfate	50# Mg. Cl	50# Mg. Carb.	50# Mg. "
25# Na. "	25# Na. Cl	25# Na. sulfate	25# Na. "
25# K "	25# K Cl	25# K "	25# K "
310#	350#	100# + NH_3	250#
120# N	123# N	123# N	121# N
75# (NH_4^+)	84# (NO_3^-)	78# (NH_3)	92# (NO_3^-)
45# (NH_4^+)	41# (NO_3^-)	45# (NH_3)	32# (NH_4^+)

Experimental Results:

Experiment 1. The Relation of Quality Factors and Maturity

A single fertility level (Ballantine's Standard Formula) was used for this experiment. Samples were hand-picked from three blocks of this treatment and composited. Drying was done at 118°F under laboratory conditions. Eleven samples were collected at intervals throughout the growing season from burring to harvest.

α-acid was determined colorimetrically and oil yield was determined by the Wright-Connery method.

Figure 1 shows graphically the results of the oil analyses, from both green and dried samples, while figure 2 shows graphically the results of the α-acid analyses.

The oil content of fresh hops was found to build up nearly logarithmically until about September 1, after which the rate dropped off until it reached a maximum at about September 6, or 48 days after flowering.

The oil content of the dried hops was found to follow this quite closely throughout the season. This indicates that highly volatile components appear at about the same rate as high boiling components. Substantiation of this depends on future experiments of similar nature, or direct analysis of the oils.

The alpha acid concentration built up rapidly after burring, to a maximum between August 15 and 20, where it remained until harvest on September 12.

Both green oil and alpha acid became very erratic toward the end of the season, indicating the need for better sampling techniques.

Table 1. The accumulation of quality factors in Bullion hops as maturity progresses.

Date	Days(1) after flowering	% Dry matter Exp.	% Dry matter Calc.(2)	% Alpha Acid	Mls Oil per 100 grams dry hops: Dry	Green(3)	Green(4)
Aug. 1	12	14.3	15.6	3.10	0.10	0.20	0.18
14	25	20.4	19.9	7.56	1.02	1.11	1.14
21	32	23.7	22.3	7.96	2.07	1.81	1.92
28	39	25.3	24.6	8.16	3.00	3.08	3.20
31	42	24.9	25.6	7.96	2.96	3.77	3.66
Sept. 3	45	27.7	26.7	7.37	3.60	3.50	3.64
5	47	29.5	27.3	8.10	3.52	3.73	4.03
8	50	25.9	28.3	7.52	3.44	4.20	3.85
10	52	28.3	29.0	7.58	3.24	3.27	3.19
12	54	29.5	29.7	8.02	3.54	3.57	3.57

(1) Flowering date: July 20, 1957
(2) Regression line: % D.M. (Calc.) = 0.336 x days + 11.54
(3) Using experimental dry matter
(4) Using claculated dry matter

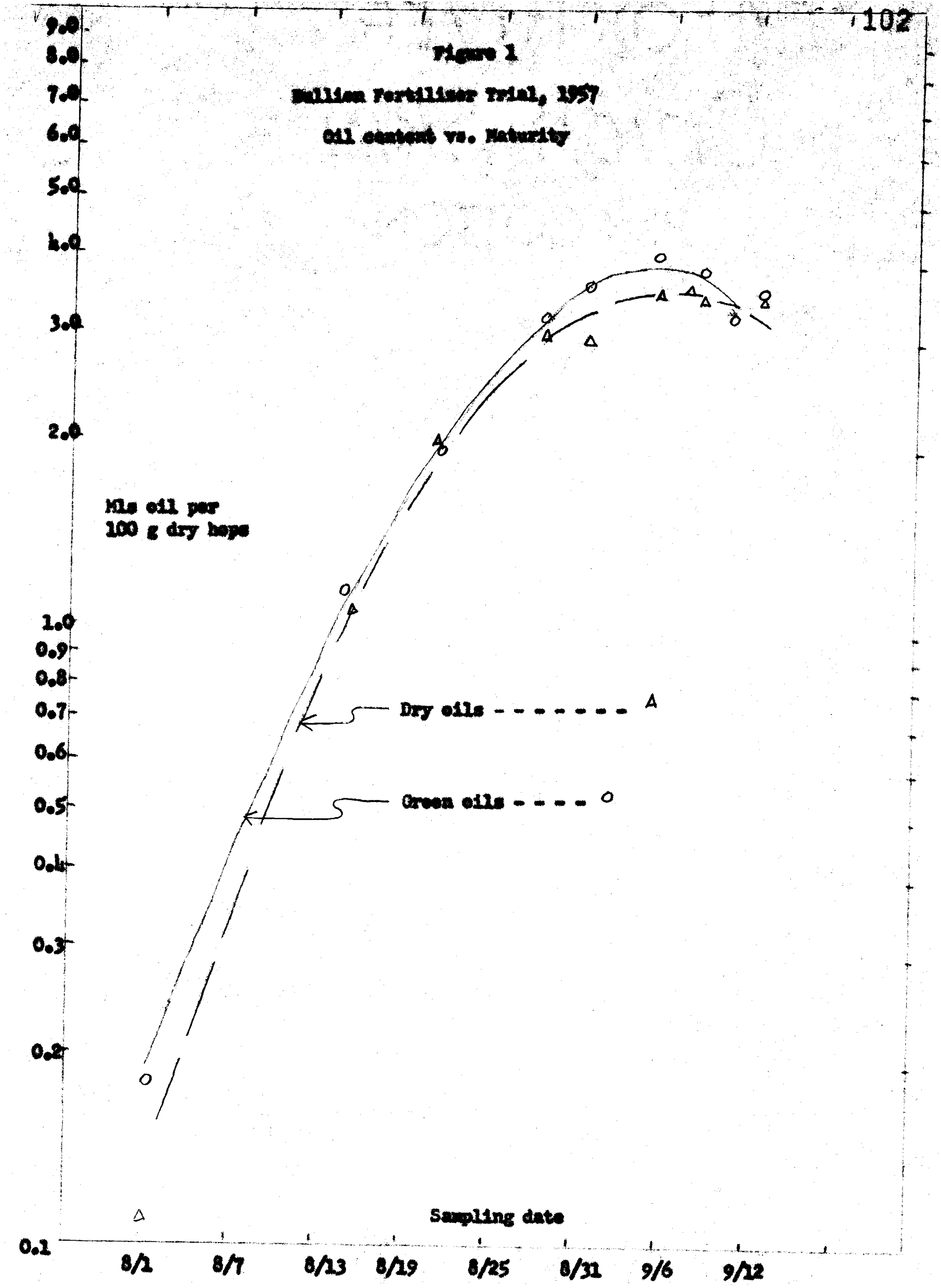


Figure 1
Bullion Fertilizer Trial, 1957
Oil content vs. Maturity
Mls oil per
100 g dry hops
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Dry oils
Green oils
Sampling date
8/1
8/7
8/13
8/19
8/25
8/31
9/6
9/12

Figure 2

Relation of Alpha Acid to Maturity

Variety: Bullion

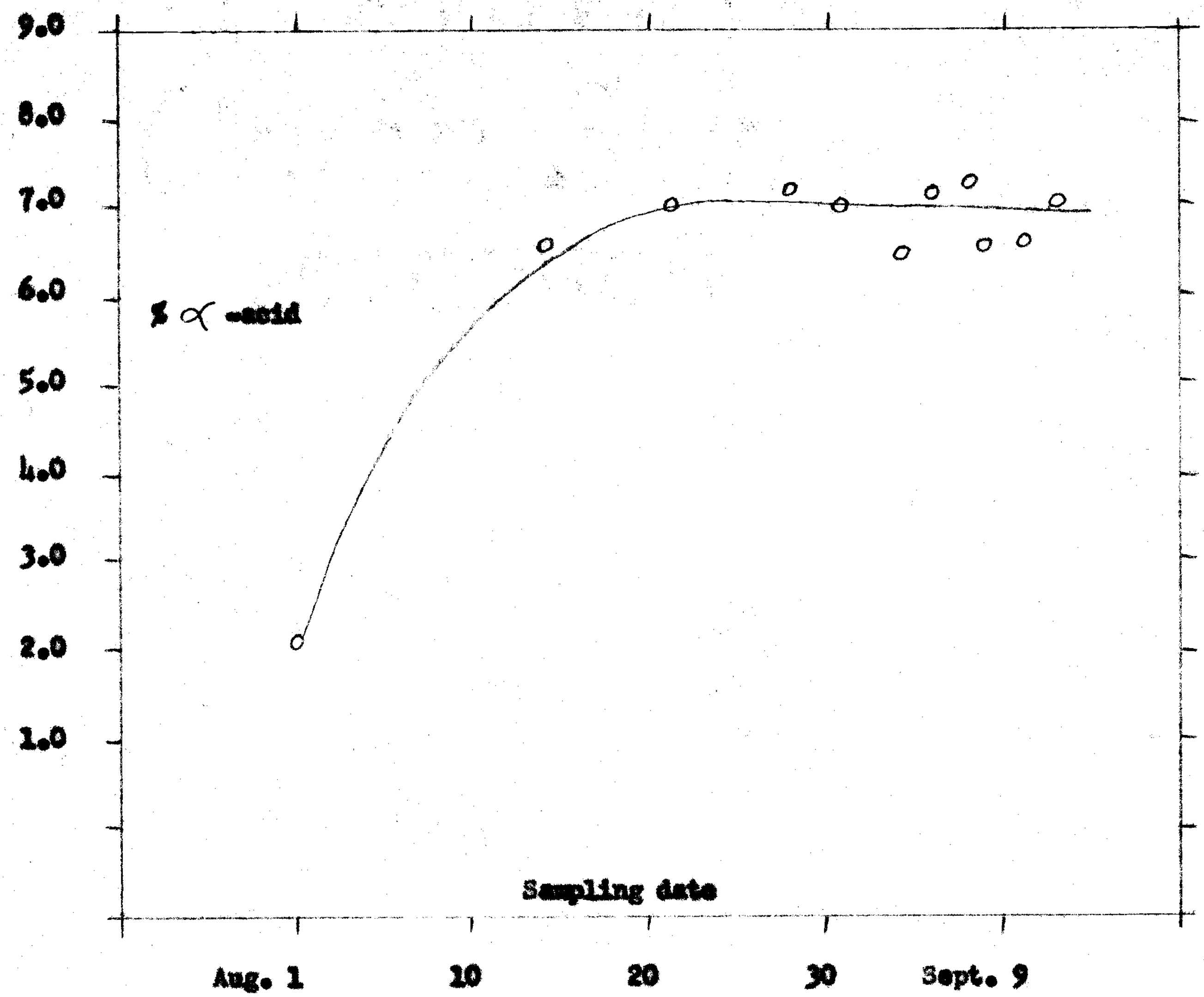
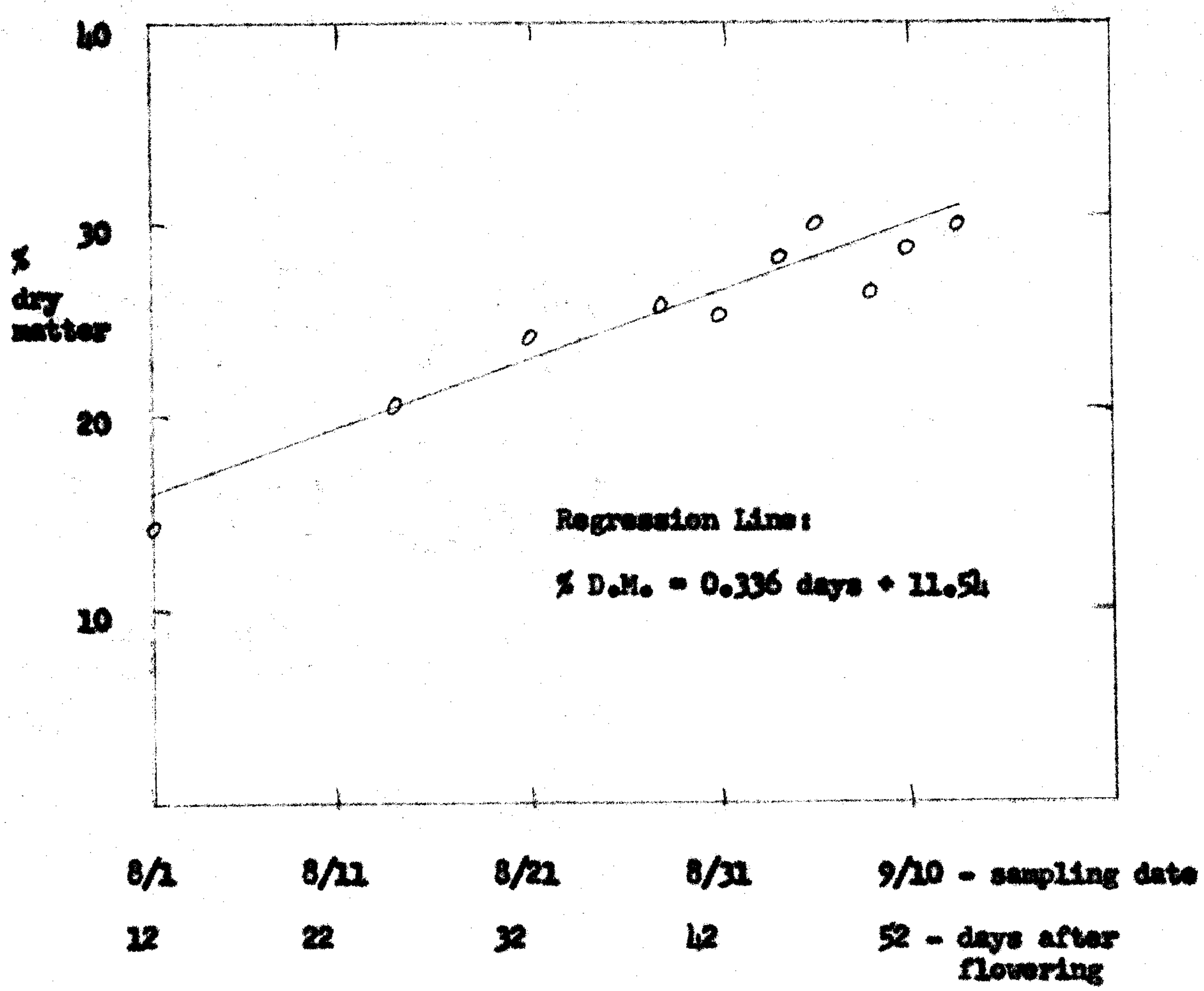


Figure 3

Bullion Fertiliser Trial 1957.

% dry matter vs. maturity



Experiment 2. Effect of Fertiliser Treatments on α-acid Content and Oil Yield of Production Plots.

Samples were taken from the production plots by three methods:

(1) Hand picking and laboratory drying at 115°F, (included 4 treatments and 3 replications).

(2) Machine picking and laboratory drying, (included 4 treatments and single samples, taken from conveyer after leaving picker).

(3) Complete commercial handling (included 4 treatments and triplicate samples which yielded 12 samples, each from a different bale).

Results of sampling method (1):

Table 1. % α-acid, dry weight basis, colorimetric method. Sampling method (1)

Treatment	1	2	3	4
Replication 1	7.33	7.74	7.86	7.71
" 2	7.98	7.42	7.87	7.42
" 3	7.42	7.03	6.97	7.56

Analysis of Variance of α-acids by method (1)

Source of Variation	Sum of Squares	D.F.	Mean Square	F
Treatment	0.06702	3	0.02234	0.2221
Replication	0.47351	2	0.23675	2.3536
Error	0.60356	6	0.10059	—
Total	1.14409	11	—	—

Table 2. Oil content of green hops. (Mls oil/100 g. dry weight basis). Sampling method (1)

Treatment	1	2	3	4
Replication 1	3.08	3.37	3.40	3.19
" 2	3.70	3.44	3.60	3.82
" 3	3.18	3.12	3.57	

Analysis of Variance of oil content of green hops by method (1).

Source of Variation	Sum of Squares	D.F.	Mean Square	F
Treatment	0.0901	3	0.03003	0.9119
Replication	0.3981	2	0.19905	6.0496 *
Error	0.1976	6	0.03293	—
Total	0.6858	11	—	—

Table 3. Oil content of dried hops (Mls oil/100 g. dry weight basis)
Sampling method (1)

Treatment	1	2	3	4
Replication 1	3.27	3.17	3.54	3.28
" 2	3.60	3.12	3.52	3.21
" 3	3.23	3.03	2.74	3.19

Analysis of variance of oil content of dried hops by method (1)

Source of Variation	Sum of Squares	D.F.	Mean Square	F
Treatment	0.10410	3	0.03470	0.7369
Replication	0.23072	2	0.11536	2.4498
Error	0.28255	6	0.04709	—
Total	0.61737	11	—	—

Analysis of variance of Table 1 does not indicate a significant difference due to either treatment or replication for the α-acid content of hops sampled by method (1). Analysis of variance of Tables 2 and 3 do not indicate a significant treatment difference in the oil content of either green or dry hops sampled by method (1). When tested at the 5% level, a significant replication difference is indicated for the oil content of green hops sampled by this method (Table 2), but this difference is not evident in the oil content of dry hops,(Table 3).

Results of sampling method (2).

Table 4 lists the data obtained from the samples collected by this sampling method.

Table 4. α-acid, oil from green and dried hops (dry weight basis)
Sampling method (2)

Treatment	% α-acid	oil content (Mls./100 g.) green hops	dried hops
1	8.02	3.71	3.54
2	7.88	3.61	3.52
3	7.30	3.82	3.44
4	7.68	3.74	3.56
Average	7.72	3.74	3.51

Since only single samples were collected by Method(2), no statistical interpretation is possible. However, since sampling method (1) shows no differences due to treatment these data can be averaged to provide mean values which will be used later to demonstrate drying effects.

Results of sampling method (3).

Samples taken by sampling method (3) were from hops which had been handled commercially throughout. An attempt was made to dry at a low temperature (135°F) in order to conserve oil. However it was not possible to maintain this temperature for the entire experiment and consequently the drying temperature for the first and second treatments was elevated (147°F). These samples were taken from bales and for this reason oil determinations for the green hops could not be made. Results of analyses for α-acid and oil content are given below.

Table 5. % α-acid, Production Plots, dry weight basis. Sampling method (3).

Drying temperature	147° F.		135° F.	
Treatment (Plots)	1	2	3	4
Samples 1-4	8.37	8.44	7.99	9.14
" 5-8	8.27	7.79	8.74	8.55
" 9-12	7.92	7.09	8.68	8.52
Average	8.19	7.77	8.47	8.80

Analysis of Variance

Source of Variation	Sum of Squares	D.F.	Mean Square	F
Treatment (Plots)	1.4672	3	0.48907	0.78409
Plots 1 & 2 vs. 3 & 4	1.0043	1	1.0043	1.61013
Error	4.9899	8	0.62374	—
Total	6.4571	11	—	—

Table 6. Oil content, Production Plots, Mls. per 100 grams, dry weight basis, Sampling method (3)

Drying temperature	147° F.		135° F.	
Treatment (Plots)	1	2	3	4
Samples 1-4	2.18	2.06	2.60	2.64
" 5-8	2.10	2.56	2.49	2.38
" 9-12	2.28	2.32	2.38	2.37
Average	2.19	2.31	2.49	2.46

Analysis of Variance

Source of Variation	Sum of Squares	D.F.	Mean Square	F
Treatment (Plots)	0.1973	3	0.05977	2.31129
Plot 1 vs. 2	0.02407	1	0.02407	0.93078
Plot 3 vs. 4	0.00107	1	0.00107	0.04137
Plots 1 & 2 vs. 3 & 4	0.15413	1	0.15413	5.96017 *
Error	0.2069	8	0.02586	--
Total	0.3917	11	--	--

As in the case of sampling method (1) treatment differences are not demonstrated for α-acid, either when tested collectively or when tested relative to their drying temperatures. The oil content of the commercially dried hops do not show treatment differences when tested collectively, but when broken into an orthogonal set of individual degrees of freedom, and tested at the 5% level of significance, a difference is indicated for treatments 1 and 2 vs. 3 and 4. This coincides with the two drying temperatures and is consistent with the belief that hop oil is conserved at lower drying temperatures.

Experiment 2 was sampled by three methods to determine treatment effect on α-acid and oil yield. None of these methods was able to demonstrate a treatment effect on either constituent.

Experiment 3. Effect of Fertilizer Treatments on α -acid Content and Oil Yield of College Plots.

The College Plots were sampled by hand picking and laboratory drying. The results of analyses for α-acid, green oils and dry oils for the 5 replications of the 5 treatments are presented below.

Table 1. Two way table of α -acid (1) contents (% D W B)

Rep\Treatment	1	2	3	4	5	Rep.Totals
1	7.13	7.29	7.17	7.51	7.55	36.65
2	7.26	7.57	7.20	7.65	7.30	36.98
3	7.29	7.15	7.04	7.56	7.20	36.24
4	7.31	7.68	6.25	7.84	6.92	36.00
5	7.30	6.95	7.90	7.40	7.45	37.00
Treat.totals	36.29	36.64	35.56	37.96	36.42	182.87

(1) Colorimetric method - 1949 formula. This is recognized as yielding a result for Bullion hops which is approximately 1-2% lower than gravimetric results.

Analysis of Variance

Source of Variation	Total of sqs.	Total sqs. per obs.	S.S.	D.F.	M.S.	Remarks
Correction	33,441.4369	1,337.65748	—	—	—	
Treatment	6,691.3453	1,338.26906	0.61158	4	0.15289	N.S.
Replication	6,689.0805	1,337.81610	0.15862	4	0.03965	N.S.
Error	—	—	1.94962	16	0.12185	
Total	1,340.3773	1,340.37730	2,71982	24	—	

Ballantine Experiments -- Capitol Farms

Experiment 3. College Plots, Oil yields from green hops.

Table 2. Two way table of oil yields from green hops (Mls/100 g. D W B)

Rep\Treatment	1	2	3	4	5	Rep.Totals
1	4.15	3.49	3.03	3.70	3.70	18.07
2	3.88	3.68	3.60	3.52	3.69	18.37
3	4.00	4.15	4.24	3.94	3.76	20.09
4	3.69	3.38	3.10	3.45	3.73	17.35
5	3.20	2.91	3.63	3.64	3.40	16.78
Treat.totals	18.92	17.61	17.60	18.25	18.28	90.66
			Average, fresh hops			3.62

Analysis of Variance

Source of Variation	Total of sqs.	Total sqs. per obs.	S.S.	D.F.	M.S.	Remarks
Correction	8,219.2356	328.76942	—	—	—	
Treatment	1,645.0594	329.01188	0.24246	4	0.060615	N.S.
Replication	1,650.1808	330.03616	1.26674	4	0.316685	*
Error	—	—	1.26998	16	0.079375	
Total	331.5486	331.54860	2.77918	24	—	

College Plots, Oil yields from dry hops

Table 3. Two way table of oil yields from dry hops (Mls/100 g. D W B)

Rep\Treatment	1	2	3	4	5	Rep.Totals
1	3.58	3.01	3.12	3.39	3.15	16.25
2	2.51	3.18	3.20	3.36	3.39	15.64
3	2.82	3.26	2.98	3.10	3.06	15.22
4	3.06	3.16	2.91	3.12	3.05	15.30
5	2.23	3.39	3.48	3.18	2.81	15.09
Treat.totals	14.20	16.00	15.69	16.15	15.46	77.50
			Average, dry hops			3.10

Analysis of Variance

Source of Variation	Total of sqs.	Totals sqs. per obs.	S.S.	D.F.	M.S.	Remarks
Correction	6,006.2500	240.25000	—	—	—	
Treatment	1,203.6502	240.73004	0.48004	4	0.12001	N.S.
Replication	1,202.1168	240.42336	0.17336	4	0.04334	N.S.
Error	—	—	1.42840	16	0.08927	
Total	242.3318	242.33180	2.08180	24	—	

Analysis of variance of the α-acid data did not indicate significant (5% level) treatment differences.

Analysis of variance of the green oil data did not indicate significant (5% level) treatment differences, but did show a significant replication variation.

Analysis of variance of the dry oil data did not indicate a significant (5% level) treatment difference.

Evaluation of the effects of the 4 fertilizers tested in the Bullion Fertilizer Trial on the production of α - acids, green and dry oils by use of 5-hill plots in a randomized block design failed to yield statistically significant differences. The inference to be drawn from this single year's data is that the two forms of nitrogen (NH_4^+ and NO_3^-) are equally suitable relative to the production of the above constituents.

Experiment 4: The Effect of Drying Temperature on the Oil Content of Dried Hops.

Three temperatures have been employed for the purpose of drying hop samples. When arranged in the order of drying temperatures, as in the table below, it is apparent that there exists a critical temperature in the vicinity of 118°F.

Table 1. Summary of oil loss under different conditions.

Group	Source of Samples	No. of samples	Drying temp. °F	Oil content (mean) green	dry	% loss
1	College Plots	25	118	3.63	3.02	17
2	Prod. Plots (hand picked)	12	118	3.34	3.25	3
3	Prod. Plots (machine picked)	4	118	3.67	3.48	5
4	Prod. Plots " "	6	135	(3.67)*	2.48	33
5	Prod. Plots " "	6	145-50	(3.67)*	2.25	39

* These samples from bales: green oil content of group 3 used for calculation of oil loss.

While it is presumed that such low temperature drying is not practical due to the longer time required, these data clearly indicate that a grower who is interested in preservation of oil should dry at the lowest possible temperature.

Experiment 5: Effect of Fertilizer Treatments on Composition of Leaves.

Leaf samples were taken at flowering time on July 10 and again at harvest on September 10. Separate samples were taken for routine analyses and for minor element analysis. Samples for major elements were dried and ground in a micro-Wiley mill to 40 mesh. Minor element samples were washed with a soft brush and Ivory soap, then rinsed well with distilled water and dried. Tables of results and results of analysis of variance (appendix) are presented below.

Major elements: Only flowering time samples have been completed to date. Total nitrogen was found to be significantly higher in leaves from ammonium sulfate plots than from nitrate plots. Fertilization raised the total nitrogen contents over the check in all treatments. Nitrate was a less sensitive indicator and neither of the above effects were demonstrated. A treatment difference was indicated for total phosphorous but was found to be due to higher values in the check plot rather than being due to the form of nitrogen applied as fertilizer. No differences could be demonstrated for the inorganic fraction of the total phosphorous. Potash showed both treatment and replication differences. The treatment difference included a highly significant difference between the ammonium fertilized plots and the nitrate plots. Calcium concentrations showed a significant treatment difference but this was not due to the check plots nor was a difference between treatments I and II demonstrated. Low magnesium values in the check plots were apparently responsible for a significant treatment mean square.

Minor elements: The iron content of Bullion leaves on both July 10 and September 10 was highly variable, ranging from 140 to 300 ppm on the first date and between 55 and 385 ppm on the second date. Neither treatment nor replication differences were indicated by analysis of variance. While manganese did not show a significant treatment difference on July 10, partitioning of the Treatment as into Treatment I vs. Treatment II showed a difference significant to the 5% level. At harvest time greater differences appeared which indicated that the manganese content of the check plots were lower than the others and that the manganese contents of Treatment II were lower than Treatment I. The data suggest that manganese accumulates to a greater extent in plants fertilized with ammonium sulfate. No significant differences were indicated for boron at flowering time but a treatment difference appeared at harvest, and was found to be a check plot difference. The zinc contents of leaves from the ammonium sulfate plots were much lower than those in the nitrate plots on July 10. On September 10 many samples were below the detection level (7 ppm) of the analytical method and consequently could not be statistically evaluated. At flowering only 3 samples had molybdenum concentrations greater than 1 ppm. At harvest all molybdenum concentrations were less than 0.9 ppm, the detection limit of the analytical method.

Results of Analyses of Hop Leaf Samples from O.S.C. Plots on the Ray Kerr Farm
Collected July 10, 1957

Bullion Fertilizer Experiment

Treat.1/	Rep.	% N	NO_3-N ppm	PO_4-P ppm	% P	% K	% Ca	% Mg
I	1	2.67	453	855	0.189	1.05	5.20	2.58
	2	2.79	402	944	0.189	1.35	4.55	1.80
	3	2.99	466	1040	0.192	1.65	4.50	1.56
	4	2.75	460	976	0.187	1.75	4.10	1.32
	5	3.08	973	1180	0.201	1.55	4.00	1.56
II	1	2.42	525	864	0.166	1.05	4.40	1.80
	2	2.69	376	886	0.180	1.15	4.95	1.80
	3	2.56	453	886	0.168	1.15	5.25	1.68
	4	2.60	680	960	0.186	1.50	5.25	1.65
	5	2.40	320	855	0.168	1.50	5.05	1.56
III	1	2.32	1.56	994	0.216	1.10	5.05	1.65
	2	2.29	136	903	0.175	1.00	5.20	1.50
	3	2.61	491	808	0.201	1.45	5.00	1.65
	4	2.61	316	885	0.209	1.55	5.00	1.56
	5	2.67	497	885	0.205	1.50	5.30	1.65
IV	1	2.54	463	758	0.197	1.05	5.25	2.01
	2	2.70	402	834	0.192	1.15	5.10	1.77
	3	2.80	1020	859	0.197	1.30	5.45	1.83
	4	3.18	1370	1000	0.231	1.55	4.55	1.83
	5	2.72	491	960	0.229	1.65	4.90	1.80
V	1	2.05	169	675	0.205	0.90	4.80	1.50
	2	2.18	171	893	0.315	1.00	5.40	1.56
	3	2.52	417	1140	0.235	1.40	4.40	1.29
	4	2.41	413	1070	0.225	1.60	4.65	1.26
	5	2.57	384	1010	0.214	1.35	4.60	1.47

1/ Forms of nitrogen used in Bullion Fertilizer Trial

Treatment	I	II	III	IV	V
Early application	75# (NH_4^+)	84# (NO_3^-)	78# (NH_3)	92# (NO_3^-)	0
Flowering application	45# (NH_4^+)	41# (NO_3^-)	45# (NH_3)	32# (NH_4^+)	0
Total	125# (NH_4^+)	125# (NO_3^-)	123# (NH_3)	124# (mixed)	Check

Results of Analyses of Hop Leaf Samples from C.S.C. Plots on
the Ray Kerr Farm
Collected July 10, 1957 cont.

Results of Analysis of Variance of July 10 Collection

Source of Variation	Total N	NO_3-N	Total P	PO_4-P	K	Ca	Mg
Treatment	**	*	*	N.S.	*	*	*
V vs. others	**	N.S.	**	N.S.	N.S.	N.S.	**
I vs. II	**	N.S.	N.S.	N.S.	**	N.S.	N.S.
Replication	*	N.S.	N.S.	N.S.	**	N.S.	N.S.

Results of Minor Element Analyses of Hop Leaf Samples from O.S.C. Plots on the Ray Kerr Farm

Bullion Fertilizer Experiment

		Fe		Mn		B		Zn		Mo	
Treat.	Rep.	7/10	9/10	7/10	9/10	7/10	9/10	7/10	9/10	7/10	9/10
I	1	300	110	100	240	58	54	9	8.5	< .9	< .9
	2	200	260	160	175	52	43	19	< 7	< .9	< .9
	3	220	195	160	190	58	45	17	< 7	< .9	< .9
II	1	255	120	165	63	39	33	31	< 7	1.4	< .9
	2	160	150	49	41	54	41	31	14	< .9	< .9
	3	220	130	125	36	53	38	42	7	1.8	< .9
III	1	200	135	140	55	75	64	24	9	1.0	< .9
	2	255	180	85	38	56	63	32	< 7	.9	< .9
	3	145	175	125	85	63	57	8.5	< 7	< .9	< .9
IV	1	230	385	92	50	42	45	10.5	11	< .9	< .9
	2	150	140	90	79	48	42	30	< 7	< .9	< .9
	3	140	140	49	28	46	47	10.5	7.5	< .9	< .9
V	1	160	55	39	26	42	57	21	9.5	< .9	< .9
	2	200	365	42	32	68	76	42	13.5	< .9	< .9
	3	180	240	26	23	55	61	26	9	1.4	< .9

Results of Analysis of Variance

7/10	Fe	Mn	B	Zn
Treatment	N.S.	N.S.	N.S.	*
V vs. others	N.S.	*	N.S.	N.S.
I vs. II	N.S.	N.S.	N.S.	**
Replication	N.S.	N.S.	N.S.	N.S.

9/10	Fe	Mn	B
Treatment	N.S.	**	**
V vs. others	N.S.	**	**
I vs. II	N.S.	**	N.S.
Replication	N.S.	N.S.	N.S.

Summary of Bullion Fertilizer Trial

In cooperation with P. Ballantine & Sons a trial was conducted to demonstrate the effect of the form of nitrogen used as fertilizer on quality factors in Bullion hops. It was also desirable to follow the seasonal progress of the quality factors. This information would allow growers to apply fertility amendments with knowledge of its effect on quality.

The data collected from this trial were grouped into five sections and presented by units.

(1) Effect of maturity. The percent dry matter increased throughout the season. The α-acid content reached a maximum value on about the twentieth of August and held fairly steady until harvest on September 12. The oil content increased until the first week in September, then appeared to decline gently until harvest.

(2,3) Effect of the form of nitrogen supplied as fertilizer. This experiment was conducted on both production sized plots replicated 3 times and on 5-hill plots replicated 5 times. No differences due to the form of nitrogen could be demonstrated for α-acid, green oils or dry oils.

(4) Effect of drying temperature on the preservation of hop oil. Laboratory drying at 118°F yielded oil losses of 3-17% while commercial drying at 135°F and 145°F produced losses of 33% and 39% respectively.

(5) Leaf samples were analyzed for 12 elements or compounds; total N, NO_3-N, total P, PO_4-P, K, Ca, Mg, Fe, Mn, B, Zn and Mo. Calculation of individual degrees of freedom for treatments I vs. II, (NH_4^+ vs. NO_3^-), indicated that the concentrations of total N, K, Mn and Zn were influenced by the form of nitrogen applied as fertilizer.

F. Form of Nitrogen used by Hop Seedlings.

Objectives:

To determine whether hop seedlings are capable of utilizing NH_4-N as a nitrogen source.

Duration:

1 or 2 seasons.

Reason for undertaking the work:

To establish whether ammonia or ammonium sulfate can be utilized directly or if nitrification by soil organisms is necessary. (This experiment is actually in conjunction with the "Bullion Fertilizer Trial," listed elsewhere in this report).

Nature of previous work:

Experiments of this type have been conducted for many other crops but no information is available covering hops specifically.

Procedure:

45 seedlings were divided into 3 groups and grown in dilute, (but complete), nutrient solution containing both forms of inorganic nitrogen for two weeks. At the end of this period the three trays were drained and seedlings were washed and sorted so that all trays appeared to have equally vigorous plants. The trays were supplied with (1) no nitrogen, (2) sodium nitrate and (3) ammonium sulfate. The solutions were changed weekly. The experiment continued from May 13 to June 27.

Experimental Results:

Plants which received no nitrogen grew chlorotic and by the end of the experiment were dead. Those receiving sodium nitrate grew abundantly. Those receiving ammonium nitrate ceased growing but maintained a dark green color.

pH measurements disclosed that this type of experiment requires a highly buffered media.

pH of unbuffered nutrient solutions:

(1) no nitrogen	6.3
(2) sodium nitrate	6.3
(3) ammonium nitrate	6.2

pH of unbuffered nutrient solution after 6 days growth:

	June 4	June 10	June 17
(1) no nitrogen	6.2	5.8	5.9
(2) sodium nitrate	7.8	6.8	7.2
(3) ammonium sulfate	2.9	3.4	3.8

On June 24 added sodium phosphate and citric acid buffer. This was felt to be unsatisfactory because of heavy bacterial growth. However it did control pH.

pH of buffered nutrient solution:

(1) no nitrogen	5.2
(2) sodium nitrate	5.2
(3) ammonium sulfate	5.2

pH of buffered nutrient solution after growth:

	2 days	3 days	4 days	7days	9 days
(1) no nitrogen	5.3	6.0	—	—	—
(2) sodium nitrate	6.8	7.1	—	—	—
(3) ammonium sulfate	5.8	5.8	5.8	5.9	5.3

No conclusions can be drawn regarding the ability of hop plants to utilize ammonium sulfate as a nitrogen source because of the lack of pH control.

It is an interesting observation that, while no growth occurred in the ammonium sulfate solutions, sufficient activity was present to reduce the pH of approximately 3 liters of nutrient solution to values near 3.0.

This experiment should be done again under conditions of controlled pH and analyses of the plants should be carried out.

A-C. Mineral Composition of Leaves and/or Other Plant Parts from Other Lime Projects.

Analytical work has been initiated on leaf samples taken in June 1957 from the "Quality Trial", but results are incomplete and will be reported later.

Results of leaf analyses on Bullion hops are included under "Bullion Fertilizer Trial".

D. Investigations into Chemical Methods:

Objectives: See 1956 Annual Report, p. 143.

Duration: See 1956 Annual Report, p. 143.

Reason for undertaking the work: See 1956 Annual Report, p. 143.

Nature of previous work: See 1956 Annual Report, p. 143.

Procedure: See 1956 Annual Report, p. 143.

Experimental results:

Gas Liquid Chromatography of the Quality Characteristics of Hops.

G.L.C. provides a method of separation applicable to two analyses in the hop research laboratory:

1. Separation of isobutyric and isovaleric acid in the determination of cohumulon and humulon plus adhumulone. Such separations and quantitative analyses have been reported by Howard and Tatchell.

2. Separation and characterization of hop oils. Pioneer work in this field has been done by Rigby and by Tatchell.

It is planned to construct several different types of columns for use with the instrument available (Reco Distillograph D-2000) and to evaluate these from the standpoint of the separations listed above.

To date two such columns have been constructed and evaluated. One type, 2-ethyl hexyl phthalate on 30-60 or 60-80 mesh Celite was found to give satisfactory separation of acetic acid, isobutyric acid and isovaleric acid. Retention volumes have been calculated and optimum operating parameters have been established for this column.

2-ethyl hexyl phthalate coating on 30-60 or 60-80 mesh Celite has also been found satisfactory for separation of hop oils. This column has been able to resolve 21 components.

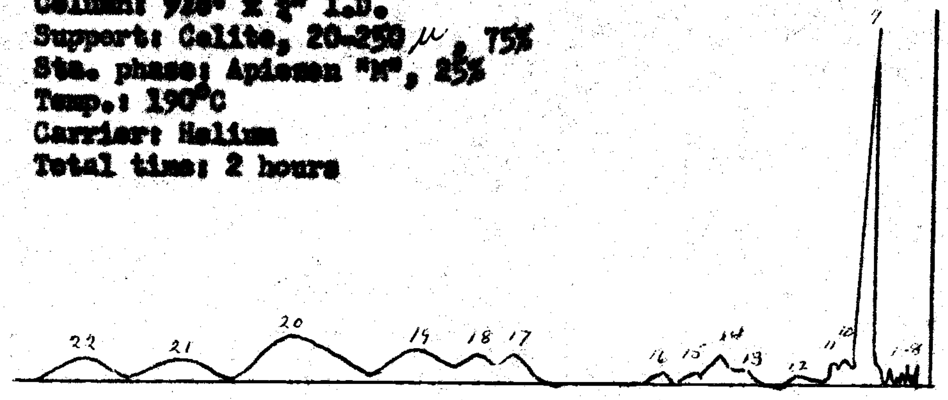
A second type of column, Apiezon M on Celite, has been constructed and evaluated for the separation of hop oil. Optimum operating parameters have been established and the column is also able to resolve 22 components of hop oils.

Samples of Myrcene, geraniol, methyl-nonyl-ketone α-caryophyllene and β-caryophyllene have been obtained and used as markers in both types of columns. Myrcene, methyl-nonyl-ketone and both caryophyllenes have been identified in the elution diagrams of hop oils but geraniol has not yet been located.

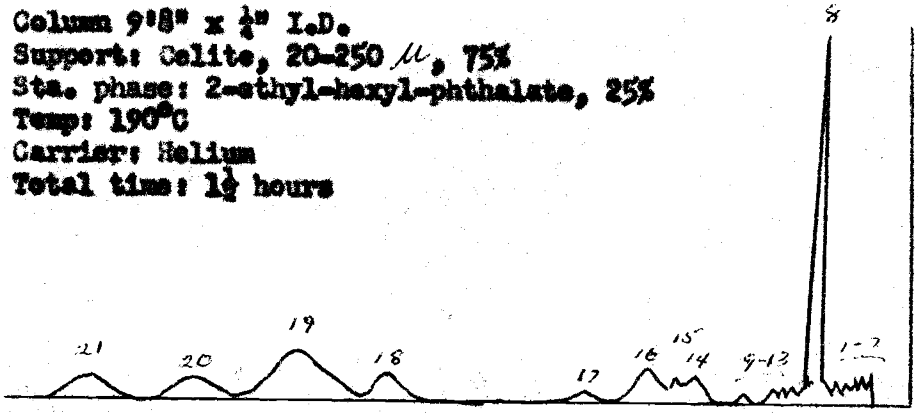
Of approximately 2 dozen oil samples which have been evaluated by G.L.C., none has been found which contains all the peaks shown in the accompanying charts.

ILLUSTRATION OF G.L.C. SEPARATION OF HOP OILS

Column: 9'8" x ¼" I.D.
Support: Celite, 20-250 μ, 75%
Sta. phase: Apiezon "M", 25%
Temp.: 190°C
Carrier: Helium
Total time: 2 hours



Column 9'8" x ¼" I.D.
Support: Celite, 20-250 μ, 75%
Sta. phase: 2-ethyl-hexyl-phthalate, 25%
Temp: 190°C
Carrier: Helium
Total time: 1½ hours



Identification of components of hop oils:

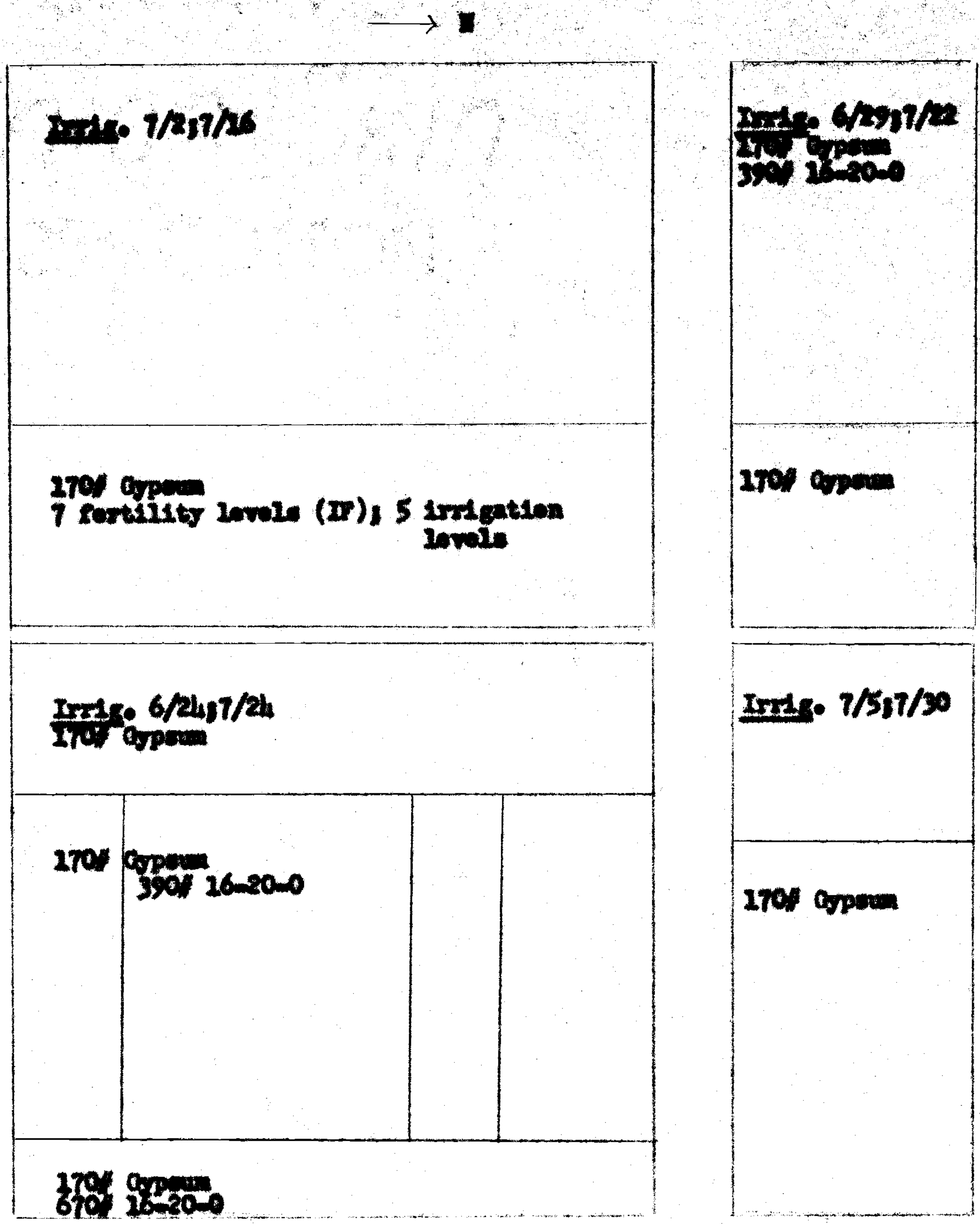
Peak number	Component: Apiezon	Component: 2-ethyl hexyl phthalate
1	?	?
2	?	?
3	?	?
4	?	?
5	?	?
6	?	?
7	?	?
8	?	Myrcene
9	Myrcene	?
10	?	?
11	?	?
12	?	?
13	?	?
14	Methyl nonyl ketone	?
15	?	?
16	?	Methyl nonyl ketone
17	?	?
18	?	β-caryophyllene
19	β-caryophyllene	α-caryophyllene
20	α-caryophyllene	?
21	?	?
22	?	—

Summary:

Two columns for the gas-liquid chromatographic separation of hop oils have been prepared and evaluated. One, Apiezon M on Celite has been found to give 22 peaks. The other, 2-ethyl-hexyl-phthalate on Celite produces 21 peaks. The Apiezon M column separates 3 components the 2-ethyl-hexyl-phthalate leaves unresolved and 2 ethyl-hexyl-phthalate separates 2 that Apiezon M leaves unresolved. Therefore the total number of components detectable is 24. Of these 4 peaks have been identified as Myrcene, Methyl-nonyl-ketone, α-caryophyllene and β caryophyllene.

A P P E N D I X

Cultural operations, College Hop Yard, 1957.



Stringing, yield trials, 5/10-5/16
First training, yield trials, 5/15-5/19
Lewis-Brown yard irrigated 7/10;8/7

Harvest Weights in the Corvallis-Prosser Yield Trial (Corvallis), 1957.

Entry		I	II	III	Total	Avg.	Lbs./A
1	LC	55.9	83.9	55.8	195.6	65.1	2210
2	103 I	60.2	73.8	54.6	188.6	62.8	2140
3	104 I	44.5	33.1	55.1	132.7	44.2	1500
4	107 I	74.7	74.8	94.0	243.5	81.1	2760
5	108 I	50.6	59.1	62.2	171.9	57.2	1940
6	109 I	86.7	60.4	38.5	185.6	61.8	2100
7	112 I	95.9	82.4	58.5	236.8	78.9	2680
8	123 I	80.2	51.0	69.0	200.2	66.7	2270
9	124 I	43.4	46.4	55.4	145.2	48.4	1650
10	127 I	30.7	25.8	43.7	100.2	33.4	1140
11	132 I	71.0	52.5	46.0	169.5	56.4	1920
12	135 I	47.8	53.9	52.4	154.1	51.3	1740
13	138 I	27.2	43.0	43.7	113.9	37.9	1290
14	139 I	60.1	62.1	52.2	174.4	58.1	1980
15	144 I	71.3	60.0	59.0	190.3	63.4	2160
16	B.G.	51.4	36.7	45.0	133.1	44.3	1510
Total		951.6	898.9	885.1	2735.6	57.0	1940
SX^2		62,244.68	54,840.39	51,482.29	491,800.52		

Harvest weights in the Corvallis-Freezer Yield Trial (Corvallis) 1956-1957.

Entry		Rep.I 1956	Rep.I 1957	Rep.I Total	Rep.II 1956	Rep.II 1957	Rep.II Total	Rep.III 1956	Rep.III 1957	Rep.III Total	Total
1	L.C.	58.5	55.9	114.4	48.4	83.9	132.3	29.0	55.8	84.8	331.5
2	103-I	31.2	60.2	91.4	40.9	73.8	114.7	28.3	54.6	82.9	289.0
3	104-I	38.0	44.5	82.5	26.5	33.1	59.6	39.9	55.1	95.0	237.1
4	107-I	49.1	74.7	123.8	39.1	74.8	113.9	28.5	94.0	122.5	360.2
5	108-I	46.1	50.6	96.7	47.6	59.1	106.7	60.7	62.2	122.9	326.3
6	109-I	43.3	86.7	130.0	21.6	60.4	82.0	31.5	38.5	70.0	282.0
7	112-I	37.7	95.9	133.6	30.9	82.4	113.3	21.6	58.5	80.1	327.0
8	123-I	54.8	80.2	135.0	66.1	51.0	117.1	78.9	69.0	147.9	400.0
9	124-I	35.9	43.4	79.3	59.6	46.4	106.0	36.3	55.4	91.7	277.0
10	127-I	21.4	30.7	52.1	36.2	25.8	62.0	29.9	43.7	73.6	187.7
11	132-I	39.6	71.0	110.6	33.1	52.5	85.6	26.1	46.0	72.1	268.3
12	135-I	27.1	47.8	74.9	26.2	53.9	80.1	23.7	52.4	76.1	231.1
13	138-I	34.4	27.2	61.6	48.9	43.0	91.9	35.3	43.7	79.0	232.5
14	139-I	31.4	60.1	91.5	28.6	62.1	90.7	25.2	52.2	77.4	259.6
15	144-I	35.2	71.3	106.5	23.1	60.0	83.1	48.8	59.0	107.8	297.4
16	B.G.	29.0	51.4	80.4	29.6	36.7	66.3	28.4	45.0	73.4	220.1
SX		612.7	951.6	1564.3	606.4	898.9	1505.3	572.1	885.1	1457.2	4526.8
SX^2		24973.63	62244.68	162717.35	25566.36	54840.39	148639.71	23938.39	51482.29	140445.16	1327989.96

Harvest weights in the Corvallis-Prosser Yield Trial (Corvallis) 1956-1957. Cont.

Lines x Years

Year	L.C.	103I	104I	107I	108I	109I	112I	123I	124I	127I	132I	135I	138I	139I	144I	B.C.	Total
1956	58.5	31.2	38.0	49.1	46.1	43.3	37.7	54.8	35.9	21.4	39.6	27.1	34.4	31.4	35.2	29.0	
	48.4	40.9	26.5	39.1	47.6	21.6	30.9	66.1	59.6	36.2	33.1	26.2	48.9	28.6	23.1	29.6	
	29.0	28.3	39.9	28.5	60.7	31.5	21.6	78.9	36.3	29.9	26.1	23.7	35.3	25.2	48.8	28.4	
	135.9	100.4	104.4	116.7	154.4	96.4	90.2	199.8	131.8	87.5	98.8	77.0	118.6	85.2	107.1	87.0	1791.2
1957	55.9	60.2	44.5	74.7	50.6	86.7	95.9	80.2	43.4	30.7	71.0	47.8	27.2	60.1	71.3	51.4	
	83.9	73.8	33.1	74.8	59.1	60.4	82.4	51.0	46.4	25.8	52.5	53.9	43.0	62.1	60.0	36.7	
	55.8	54.6	55.1	94.0	62.2	38.5	58.5	69.0	55.4	43.7	46.0	52.4	43.7	52.2	59.0	45.0	
	1 95.6	188.6	132.7	243.5	171.9	185.6	236.8	200.2	145.2	100.2	169.5	154.1	113.9	174.4	190.3	133.1	2735.6
	331.5	289.0	237.1	360.2	326.3	282.0	327.0	400.0	277.0	187.7	268.3	231.1	232.5	259.6	297.4	220.1	4526.8
	56728.17	45650.12	28508.65	72911.14	53388.97	43740.32	64210.28	80000.08	38454.28	17696.29	38491.69	29675.81	27039.17	37674.40	47684.50	25284.61	10691904.80

Length of Sidearm (inches) in the Corvallis-Prosser Yield Trial at Corvallis in 1957.

Entry	Line	Rep. I			Rep. II			Rep. III			Line Total
		1	2	Total	1	2	Total	1	2	Total	
1	L.C.	25	39	64	22	26	48	48	20	68	
		47	36	83	40	20	60	18	20	38	
		25	12	37	25	26	51	16	18	34	
		33	57	90	31	42	73	45	42	87	
				274			232			227	733
2	103-I	25	13	38	26	31	57	26	17	43	
		28	21	49	29	20	49	23	20	43	
		16	31	47	23	38	61	31	16	47	
		16	23	39	27	32	59	42	38	80	
				173			226			213	612
3	104-I	33	37	70	14	35	49	45	36	81	
		39	24	63	44	50	94	31	42	73	
		28	25	53	13	18	31	28	26	54	
		45	22	67	33	29	62	25	29	54	
				253			236			262	751
4	107-I	25	24	49	31	31	62	32	28	60	
		41	40	81	29	28	57	35	14	49	
		42	37	79	37	42	79	36	22	58	
		26	30	56	40	64	104	32	22	54	
				265			302			221	788
5	108-I	41	39	80	24	18	42	23	26	49	
		40	53	93	30	31	61	27	17	44	
		40	39	79	12	30	42	44	28	72	
		34	29	63	28	34	62	40	35	75	
				315			207			240	762
6	109-I	60	22	82	31	20	51	43	38	81	
		30	35	65	34	38	72	23	25	48	
		17	25	42	40	34	74	40	18	58	
		29	39	68	18	17	35	14	22	36	
				257			232			223	712
7	112-I	41	39	80	24	41	65	16	21	37	
		55	45	100	33	45	78	39	28	67	
		47	39	86	40	28	68	24	31	55	
		52	40	92	27	37	64	21	40	61	
				358			275			220	853

Length of Sidearm (inches) in the Corvallis-Prosser Yield Trial at Corvallis in 1957. cont.

Entry	Line	Rep.I 1	Rep.I 2	Rep.I Total	Rep.II 1	Rep.II 2	Rep.II Total	Rep.III 1	Rep.III 2	Rep.III Total	Line Total
8	123-I	53	45	98	42	33	75	41	41	82	
		55	38	93	42	43	85	43	62	105	
		40	32	72	32	25	57	34	30	64	
		30	35	65	17	25	42	27	26	53	
				328			259			304	891
9	124-I	35	32	67	39	43	82	16	32	48	
		36	16	52	42	28	70	28	37	65	
		20	41	61	35	27	62	39	15	54	
		48	47	95	40	35	75	24	42	66	
				275			289			233	797
10	127-I	17	20	37	40	35	75	16	22	38	
		23	28	51	39	18	57	33	38	71	
		12	15	27	38	16	54	16	26	42	
		41	38	79	45	20	65	20	39	59	
				194			251			210	655
11	132-I	51	58	109	24	50	74	27	36	63	
		26	50	76	33	29	62	37	20	57	
		29	42	71	23	37	60	28	12	40	
		35	14	49	28	19	47	40	32	72	
				305			243			232	780
12	135-I	18	22	40	28	35	63	27	15	42	
		17	30	47	37	26	63	33	40	73	
		32	40	72	35	33	68	20	17	37	
		34	38	72	28	30	58	35	24	59	
				231			252			211	694
13	138-I	18	20	38	50	22	72	12	20	32	
		20	25	45	31	30	61	31	25	56	
		44	17	61	21	19	40	12	34	46	
		37	14	51	22	26	48	20	15	35	
				195			221			169	585
14	139-I	42	38	80	33	35	68	29	35	64	
		34	37	71	39	35	74	17	27	44	
		34	39	73	40	40	80	30	19	49	
		36	40	76	41	33	74	38	40	78	
				300			296			235	831

Length of Sidearm (inches) in the Corvallis-Prosser Yield Trial at Corvallis, in 1957. cont.

Entry	Line	I	II	Total	I	II	Total	I	II	Total	Line Total
15	144-I	18	25	43	15	32	47	26	35	61	
		34	46	80	19	11	30	16	20	36	
		23	31	54	32	42	74	17	26	43	
		29	40	69	37	25	62	38	20	58	
				246			213			198	657
16	Br's Gold	14	38	52	16	14	30	35	32	67	
		39	37	76	37	19	56	17	23	40	
		27	45	72	6	13	19	21	13	34	
		33	20	53	11	12	23	14	24	38	
				253			128			179	560
SX		2114	2108	4222	1942	1920	3862	1824	1753	3577	11661
SX^2		75340	77000	1152458	64764	64234	958464	57982	53921	814293	8638161

Analysis of Variance table, Corvallis-Prosser Yield Trial

Source of Variation	DF	SS	MS
Harvest weight (lbs./plot) Corvallis, 1957.			
Total	47	12,660.957	
Reps.	2	153.958	76.9790
Lines	15	8,027.104	535.1403 **
Error	30	4,479.895	149.3298
Harvest weight (lbs./plot) Corvallis, 1956-57.			
Total	95	29,588.2584	
Reps.	2	179.8440	89.9220
Lines	15	7,874.1784	524.9452 **
L x R (error a)	30	4,389.6060	146.3202
Years	1	9,290.5350	9,290.5350 **
L x Y	15	5,090.6316	339.3754 **
Error b	32	2,763.4634	86.3582
Sidearm length (inches) Corvallis, 1957.			
Total	383	39,129.227	
Reps.	2	1,632.422	816.211
Lines	15	5,811.602	387.440 **
L x R	30	4,096.078	136.536 *
Error	336	27,589.125	82.110

% Alpha-acid (Colorimetric Method) for the Lines in the Quality Evaluation Trial and two additional lines in 1957.

Entry	Variety	α-acid content (% DMB) Rep.I	Rep.II	Rep.III	Rep.IV	Variety Totals	Variety Means	No. Reps. used
1	Late Clusters	5.18	5.54	5.62	—	16.34	5.44	3
2	Fuggles	5.62	5.28	5.42	5.00	21.32	5.33	4
3	Brewers Gold	7.59	—	8.88	7.86	24.33	8.11	3
4	Bullion	7.88	—	7.32	—	15.20	7.60	2
5	103-I	4.43	2.86	3.00	3.06	13.35	3.34	4
6	104-I	2.67	3.85	3.43	3.92	13.87	3.47	4
7	107-I	3.36	3.67	5.09	3.75	15.87	3.97	4
8	108-I	4.28	3.78	4.10	4.94	17.10	4.28	4
9	109-I	5.56	7.10	6.42	6.10	25.18	6.30	4
10	Unknown	5.78	5.80	—	4.50	16.08	5.36	3
11	123-I	6.68	6.17	6.25	6.22	25.32	6.33	4
12	124-I	5.00	2.65	5.12	3.13	15.90	3.98	4
13	127-I	5.26	6.88	—	5.01	17.15	5.72	3
14	132-I	3.72	2.27	2.72	5.33	14.04	3.51	4
15	135-I	2.31	2.53	2.31	2.35	9.50	2.38	4
16	138-I	4.78	5.51	6.23	5.35	21.87	5.47	4
17	139-I	3.36	3.84	3.99	3.91	15.10	3.78	4
18	144-I	3.74	4.63	5.45	5.77	19.59	4.90	4
		87.20	72.36	81.35	76.20	317.11		

Miscellaneous:

18-S(128-I)	8.00
164-S	3.89

Oil Contents (Distillation of Kiln-dried Samples) for the Lines in the Quality Evaluation Trial in 1957.

Entry	Variety	Oil content (mls/100g DWB) Rep.I	Rep.II	Rep.III	Rep.IV	Variety Totals	Variety Means
1	Late Clusters	0.39	0.48	0.56	—	1.43	0.48
2	Fuggles	0.91	0.79	0.71	0.58	2.99	0.75
3	Brewers Gold	2.80	—	2.47	3.40	8.67	2.89
4	Bullion	1.80	—	2.48	—	4.28	2.14
5	103-I	1.33	1.06	1.92	1.16	5.47	1.38
6	104-I	1.05	1.75	1.63	1.48	5.91	1.48
7	107-I	1.11	1.20	0.87	0.97	4.15	1.04
8	108-I	1.13	0.57	0.52	0.57	2.79	0.70
9	109-I	1.27	0.56	1.51	1.18	4.52	1.13
10	Unknown	1.26	1.20	—	0.53	2.99	1.00
11	123-I	0.57	0.59	1.34	0.36	2.86	0.72
12	124-I	0.87	0.71	0.90	0.87	3.35	0.84
13	127-I	1.36	1.08	—	1.32	3.76	1.25
14	132-I	0.38	0.29	0.26	0.97	1.90	0.48
15	135-I	1.04	1.15	1.35	1.25	4.79	1.20
16	138-I	0.78	0.89	0.55	0.54	2.76	0.69
17	139-I	0.49	—	0.58	0.73	1.80	0.60
18	144-I	1.75	1.68	1.95	1.25	6.63	1.66
Rep totals		20.29	14.00	19.60	17.16	71.05	

% Alpha-acid (Colorimetric Method) in the Corvallis-Prosser
Yield Trial at Prosser, Washington in 1957.

	Alpha-acid content (%, DWB)						
Variety	Rep.I	Rep.II	Rep.III	Rep.IV	Rep.V	Total	Avg.
Late Clusters		6.25	6.21		6.15	18.61	6.20
103-I			3.10	2.41	1.90	7.41	2.47
104-I	1.83	2.31		1.98		6.12	2.04
107-I	4.05	4.02	3.89			11.96	3.99
108-I			5.70	5.66	5.19	16.55	5.52
109-I	4.27	4.58		4.08		12.93	4.31
112-I	5.54		5.35	6.97		17.86	5.95
123-I	7.41	6.56	6.14			20.11	6.70
124-I		3.22	3.16		2.32	8.70	2.90
127-I	3.46	3.49			3.68	10.63	3.54
132-I		3.00		3.01	3.00	9.01	3.00
135-I	2.36	2.44			2.56	7.36	2.45
138-I	5.05	4.82	4.86			14.73	4.91
139-I		3.88		3.43	3.58	10.89	3.63
144-I		2.47	2.46		2.11	7.04	2.35
SX	33.97	47.04	40.87	27.54	30.49	179.91	4.00
SX^2	166.6277	206.4588	201.7751	127.8164	120.1155	2,455.3785	

Analysis of Variance

Source of variation	DF	SS	MS
Total	44	103.51332	
Among varieties	14	99.17932	7.084237 **
Within varieties	30	4.334	.14447

Oil Contents in the Corvallis-Prosser Yield Trial at Prosser, Washington in 1957.

	Mls. oil per 100 grams hops (dry basis)						
Variety	Rep.I	Rep.II	Rep.III	Rep.IV	Rep.V	Total	Mean
Late Clusters		0.75	0.71		0.80	2.26	0.75
103-I			0.49	0.62	0.55	1.66	0.55
104-I	0.39	0.64		0.44		1.47	0.49
107-I	0.59	0.72	0.97			2.28	0.76
108-I			1.21	1.10	1.36	3.67	1.22
109-I	1.34	1.40		1.30		4.04	1.34
112-I	1.09		1.07	1.01		3.17	1.06
123-I	0.97	1.03	0.76			2.76	0.92
124-I		0.54	0.56		0.50	1.60	0.53
127-I	0.74	0.74			0.88	2.36	0.79
132-I		0.30		0.32	0.31	.93	0.31
135-I	0.62	0.57			0.60	1.79	0.60
138-I	0.96	0.91	0.81			2.68	0.90
139-I		0.41		0.40	0.51	1.32	0.44
144-I		0.65	0.61		0.47	1.73	0.58
SX	6.70	8.66	7.19	5.19	5.98	33.72	0.75
SX^2	6.2784	7.1842	6.2135	4.7605	4.7536	86.7958	

These samples were taken between September 3 and 12, in their order of maturity. All were dried in a commercial dryer. After arrival at Corvallis they were put into cans and kept refrigerated until analysis.

Analysis of Variance

Source of Variation	DF	SS	MS
Total	44	3.92268	
Among varieties	14	3.66441	.261744 **
Within varieties	30	.25827	.008609

Harvest wts. (adj. 25% dry down), Experimental Yield Trial, 1957

Entry		Rep. I	II	IIII	IV	V	Total	Avg.	Lbs./A.
1	Fuggles	41.1	40.3	39.3	44.4	82.8	247.9	49.6	1690
2	L C	67.6	82.7	50.5	53.8	43.5	298.1	59.6	2030
3	101 I	34.5	33.6	44.8	66.4	54.2	233.5	46.7	1590
4	102 I	63.1	59.6	55.5	62.3	60.8	301.3	60.3	2050
5	103 I	58.7	99.2	60.7	92.5	100.5	411.6	82.3	2800
6	104 I	66.3	59.4	57.1	61.8	66.0	310.6	62.1	2110
7	106 I	44.3	52.3	64.8	66.9	49.9	278.2	55.6	1890
8	107 I	88.1	86.3	82.2	73.3	101.6	431.5	86.3	2930
9	108 I	69.3	71.7	55.7	71.0	58.3	326.0	65.2	2220
10	109 I	63.5	40.9	43.1	26.4	55.0	228.9	45.8	1560
11	112 I	88.4	106.1	87.0	79.0	99.9	460.4	92.1	3130
12	117 I	50.8	40.6	45.6	52.5	50.1	239.6	47.9	1630
13	118 I	81.9	64.1	66.8	83.4	69.4	365.6	73.1	2490
14	121 I	62.7	56.5	79.1	57.5	63.7	319.5	63.9	2170
15	122 I	66.4	81.2	57.2	58.3	78.1	341.2	68.2	2320
16	123 I	57.0	60.7	44.8	68.9	96.5	327.9	65.6	2230
17	124 I	55.9	63.7	41.0	30.9	39.5	231.0	46.2	1570
18	125 I	43.6	53.6	41.5	51.3	69.1	259.1	51.8	1760
19	126 I	33.1	37.8	17.7	31.3	56.9	176.8	35.4	1200
20	127 I	54.9	62.2	66.4	70.8	(69.2)	323.5	64.7	2200
21	128 I	86.8	48.9	81.0	94.5	78.7	389.9	78.0	2650
22	130 I	64.1	78.3	51.0	91.0	77.6	362.0	72.4	2460
23	131 I	47.1	37.9	30.2	58.4	46.2	219.8	44.0	1490
24	132 I	53.2	58.8	42.3	43.8	31.5	229.6	45.9	1560
25	135 I	53.3	73.9	68.7	68.4	72.7	337.0	67.4	2290
26	138 I	48.8	66.7	34.0	52.1	63.0	264.6	52.9	1800
27	139 I	73.0	54.1	83.0	75.6	83.9	369.6	73.9	2510
28	141 I	92.3	82.8	72.6	86.3	73.5	407.5	81.5	2770
29	144 I	46.9	55.7	56.3	35.2	20.1	214.2	42.8	1460
ΣX		1,756.7	1,809.6	1,619.9	1,808.0	1,912.2	8,906.4	61.4	2090
ΣX^2		113,620.43	122,434.26	98,883.17	122,437.30	137,654.22	2,885,446.08		

Harvest weights (lbs./plot) in the Experimental
Yield Trial, 1954-1957 inclusive

Entry		Rep.I 1954	Rep.I 1955	Rep.I 1956	Rep.I 1957	Rep.I Total	Rep.II 1954	Rep.II 1955	Rep.II 1956	Rep.II 1957	Rep.II Total
1	Fuggles	50.8	17.2	34.4	41.1	143.5	64.0	28.8	50.0	40.3	183.1
2	L C	91.7	14.8	53.0	67.6	227.1	100.6	36.8	78.0	82.7	298.1
3	101 I	36.5	42.8	48.6	34.5	162.4	40.5	28.4	40.5	33.6	143.0
4	102 I	49.2	50.4	56.8	63.1	219.5	39.1	35.2	51.3	59.6	185.2
5	103 I	105.2	44.0	66.5	58.7	274.4	91.8	56.4	78.8	99.2	326.2
6	104 I	48.4	24.4	37.7	66.3	176.8	67.9	33.6	44.9	59.4	205.8
7	106 I	54.4	34.8	47.9	44.3	181.4	62.2	38.8	56.8	52.3	210.1
8	107 I	95.2	34.4	63.7	88.1	281.4	119.8	44.0	55.3	86.3	305.4
9	108 I	109.8	8.8	42.9	69.3	230.8	115.2	30.8	70.6	71.7	288.3
10	109 I	91.4	16.0	38.8	63.5	209.7	129.1	44.4	80.9	40.9	295.3
11	112 I	116.6	37.2	74.6	88.4	316.8	128.2	40.0	70.9	106.1	345.2
12	117 I	46.2	31.2	45.1	50.8	173.3	59.1	34.8	45.1	40.6	179.6
13	118 I	99.0	72.0	48.7	81.9	301.6	103.0	43.6	62.7	64.1	273.4
14	121 I	78.4	36.0	63.4	62.7	240.5	60.2	42.0	72.1	56.5	230.8
15	122 I	88.4	43.2	56.8	66.4	254.8	82.0	33.6	65.7	81.2	262.5
16	123 I	83.5	29.2	80.5	57.0	250.2	83.5	24.0	67.8	60.7	236.0
17	124 I	76.2	51.6	71.5	55.9	255.2	109.0	53.2	58.5	63.7	284.4
18	125 I	74.0	41.6	58.0	43.6	217.2	65.6	37.6	39.3	53.6	196.1
19	126 I	83.2	32.0	63.8	33.1	212.1	92.8	4.0	34.6	37.8	169.2
20	127 I	101.2	17.6	32.6	54.9	206.3	86.2	56.4	39.6	62.2	244.4
21	128 I	83.5	54.8	51.1	86.8	276.2	73.6	43.2	68.3	48.9	234.0
22	130 I	89.2	34.4	62.9	64.1	250.6	67.1	28.0	61.9	78.3	235.3
23	131 I	46.7	26.8	43.1	47.1	163.7	69.0	25.6	45.4	37.9	177.9
24	132 I	81.3	24.0	40.9	53.2	199.4	89.8	24.8	62.5	58.8	235.9
25	135 I	73.6	36.8	53.3	53.3	217.0	88.0	48.0	57.0	73.9	266.9
26	138 I	75.0	12.4	43.8	48.8	180.0	86.8	66.4	62.0	66.7	281.9
27	139 I	89.4	50.8	44.8	73.0	258.0	73.0	84.0	46.8	54.1	257.9
28	141 I	73.2	59.6	70.6	92.3	295.7	76.8	47.2	61.1	82.8	267.9
29	144 I	91.0	4.0	47.7	46.9	189.6	103.4	9.2	38.7	55.7	207.0
SX		2282.2	982.8	1543.5	1756.7	6565.2	2427.3	1122.8	1667.1	1809.6	7026.8
SX^2		191887.94	40566.56	86,552.47	113620.43	1544263.42	218607.23	50524.64	100708.85	122434.26	1774618.06

Harvest weights (lbs./plot) in the Experimental
Yield Trial, 1954-1957 inclusive cont.

	Entry	Rep. III 1954	1955	1956	1957	Total	Rep. IV 1954	1955	1956	1957	Total	Line Total	Avg.
1	Fuggles	48.6	25.6	49.6	39.3	163.1	54.4	22.0	55.1	44.4	175.9	665.6	41.6
2	L C	100.5	15.6	90.7	50.5	257.3	92.6	20.8	79.5	53.8	246.7	1029.2	64.3
3	101 I	72.4	31.6	48.5	44.8	197.3	62.6	40.4	50.1	66.4	219.5	722.2	45.1
4	102 I	72.6	30.0	54.9	55.5	213.0	80.8	32.8	50.3	62.3	226.2	843.9	52.7
5	103 I	86.6	33.6	57.3	60.7	238.2	122.9	34.8	74.8	92.5	325.0	1163.8	72.7
6	104 I	73.8	26.8	67.0	57.1	224.7	87.5	23.2	50.0	61.8	222.5	829.8	51.9
7	106 I	61.8	27.2	48.8	64.8	202.6	55.3	26.4	49.0	66.9	197.6	791.7	49.5
8	107 I	124.5	22.0	46.1	82.2	274.8	114.6	25.6	57.5	73.3	271.0	1132.6	70.8
9	108 I	92.6	12.8	63.6	55.7	224.7	127.8	10.0	62.0	71.0	270.8	1014.6	63.4
10	109 I	97.5	10.0	52.1	43.1	202.7	131.0	0.8	(56.2)	26.4	214.4	922.1	57.6
11	112 I	122.0	28.8	60.7	87.0	298.5	126.2	38.0	62.2	79.0	305.4	1265.9	79.1
12	117 I	70.1	15.2	45.2	45.6	176.1	64.3	22.4	47.6	52.5	186.8	715.8	44.7
13	118 I	121.6	40.8	72.4	66.8	301.6	90.0	42.8	67.3	83.4	283.5	1160.1	72.5
14	121 I	69.2	26.4	70.6	79.1	245.3	87.6	20.4	62.3	57.5	227.8	944.4	59.0
15	122 I	52.2	35.2	45.8	57.2	190.4	53.8	29.2	37.7	58.3	179.0	886.7	55.4
16	123 I	103.0	8.4	81.0	44.8	237.2	74.1	8.0	51.0	68.9	202.0	925.4	57.8
17	124 I	110.8	19.6	58.2	41.0	229.6	79.4	8.0	33.0	30.9	151.3	920.5	57.5
18	125 I	51.2	24.8	48.2	41.5	165.7	76.6	8.8	48.7	51.3	185.4	764.4	47.8
19	126 I	90.6	21.2	64.6	17.7	194.1	108.2	25.2	71.5	31.3	236.2	811.6	50.7
20	127 I	72.5	12.8	48.0	66.4	199.7	99.6	26.0	59.4	70.8	255.8	906.2	56.6
21	128 I	60.8	32.4	62.7	81.0	236.9	81.8	60.4	65.9	94.5	302.6	1049.7	65.6
22	130 I	100.6	4.0	76.5	51.0	232.1	105.0	28.8	81.5	91.0	306.3	1024.3	64.0
23	131 I	72.0	18.4	49.2	30.2	169.8	83.2	12.4	52.6	58.4	206.6	718.0	44.9
24	132 I	73.9	7.2	35.2	42.3	158.6	72.2	13.6	34.6	43.8	164.2	758.1	47.4
25	135 I	71.6	50.8	65.4	68.7	256.5	84.0	29.6	68.4	68.4	250.4	990.8	61.9
26	138 I	81.8	41.2	78.2	34.0	235.2	95.6	62.4	54.4	52.1	264.5	961.6	60.1
27	139 I	98.2	24.8	54.6	83.0	260.6	120.6	20.4	65.4	75.6	282.0	1058.5	66.2
28	141 I	100.0	48.8	56.5	72.6	277.9	88.1	39.2	67.1	86.3	280.7	1122.2	70.1
29	144 I	110.0	4.0	43.5	56.3	213.8	127.6	2.4	37.6	35.2	202.8	813.2	50.8
SX		2,463.0	700.0	1,695.1	1,619.9	6,478.0	2,647.4	734.8	1,652.7	1,808.0	6,842.9	26,912.9	58.0
SX^2		222,414.22	21,223.04	103,792.43	98,883.17	1,489,901.88	257,080.94	24,934.56	98,650.09	122,437.30	1,676,965.21	25,663,694.95	

Harvest wts. (lbs./plot) in the Experimental Yield Trial, 1954-57.

Entry	1954	1955	1956	1957	Total
		Lines x Years			
Fuggles	217.8	93.6	189.1	165.1	665.6
Late Clusters	385.4	88.0	301.2	254.6	1029.2
101 I	212.0	143.2	187.7	179.3	722.2
102 I	241.7	148.4	213.3	240.5	843.9
103 I	406.5	168.8	277.4	311.1	1163.8
104 I	277.6	108.0	199.6	244.6	829.8
106 I	233.7	127.2	202.5	228.3	791.7
107 I	454.1	126.0	222.6	329.9	1132.6
108 I	445.4	62.4	239.1	267.7	1014.6
109 I	449.0	71.2	228.0	173.9	922.1
112 I	493.0	144.0	268.4	360.5	1265.9
117 I	239.7	103.6	183.0	189.5	715.8
118 I	413.6	199.2	251.1	296.2	1160.1
121 I	295.4	124.8	268.4	255.8	944.4
122 I	276.4	141.2	206.0	263.1	886.7
123 I	344.1	69.6	280.3	231.4	925.4
124 I	375.4	132.4	221.2	191.5	920.5
125 I	267.4	112.8	194.2	190.0	764.4
126 I	374.8	82.4	234.5	119.9	811.6
127 I	359.5	112.8	179.6	254.3	906.2
128 I	299.7	190.8	248.0	311.2	1049.7
130 I	361.9	95.2	282.8	284.4	1024.3
131 I	270.9	83.2	190.3	173.6	718.0
132 I	317.2	69.6	173.2	198.1	758.1
135 I	317.2	165.2	244.1	264.3	990.8
138 I	339.2	182.4	238.4	201.6	961.6
139 I	381.2	180.0	211.6	285.7	1058.5
141 I	338.1	194.8	255.3	334.0	122.2
144 I	432.0	19.6	167.5	194.1	813.2
SX	9,819.9	3,540.4	6,558.4	6,994.2	26,912.9
SX^2	3,494,933.63	490,009.76	1,521,340.52	1,783,624.30	25,663,694.95

Drydown percentages, Experimental Yield Trial, 1957

Entry		Rep. I	II	III	IV	Total	Avg.
1	Fuggles	27.0	25.7	28.6	29.4	110.7	27.7
2	L C	22.4	19.2	25.1	25.5	92.2	23.0
3	101 I	25.1	25.8	28.1	27.8	106.8	26.7
4	102 I	27.5	28.6	28.0	28.6	112.7	28.2
5	103 I	22.6	25.3	27.0	24.8	99.7	24.9
6	104 I	22.8	23.5	26.1	22.0	94.4	23.6
7	106 I	28.4	25.1	24.4	26.4	104.3	26.1
8	107 I	23.6	22.5	23.1	24.1	93.3	23.3
9	108 I	20.1	22.1	18.7	22.5	83.4	20.8
10	109 I	25.1	19.3	23.4	21.5	89.3	22.3
11	112 I	22.9	22.5	25.2	23.8	94.4	23.6
12	117 I	22.0	23.1	20.9	20.8	86.8	21.7
13	118 I	27.6	23.5	25.9	24.5	101.5	25.4
14	121 I	22.0	23.8	23.0	26.0	94.8	23.7
15	122 I	23.8	23.0	23.6	23.7	94.1	23.5
16	123 I	23.8	24.5	22.7	23.8	94.8	23.7
17	124 I	21.1	19.4	19.6	20.5	80.6	20.2
18	125 I	25.3	25.6	25.8	25.6	102.3	25.6
19	126 I	24.8	26.7	22.9	25.7	100.1	25.0
20	127 I	19.3	19.8	21.3	23.5	83.9	21.0
21	128 I	25.5	25.9	24.1	25.4	100.9	25.2
22	130 I	26.1	22.9	24.9	25.7	99.6	24.9
23	131 I	20.8	22.0	20.0	22.3	85.1	21.3
24	132 I	23.2	24.1	22.2	21.7	91.2	22.8
25	135 I	22.9	21.6	25.1	23.2	92.8	23.2
26	138 I	23.9	23.1	24.3	25.9	97.2	24.3
27	139 I	28.3	29.0	24.1	25.4	106.8	26.7
28	141 I	23.4	23.3	28.0	26.5	101.2	25.3
29	144 I	22.9	25.4	23.3	23.5	95.0	23.8
SX		694.2	686.3	699.3	710.1	2,789.9	24.1
SX^2		16,775.86	16,415.93	17,047.03	17,525.07	270,218.13	

Analysis of Variance table, Experimental Yield Trial, 1957.

Source of Variation	DF	SS	MS
Harvest weight (lbs./plot), 1957			
Total	(144) 143	47,967.580	
Reps.	4	1,562.197	390.549 *
Lines	28	30,027.416	1,072.408 **
Error	(112) 111	16,377.967	147.549
Harvest weight (lbs./plot), 1954-1957			
Lines	28	42,980.53	1,535.019 **
Reps.	3	1,650.75	550.250 *
Error a	84	15,805.46	188.160
Subtotal a	115	60,436.74	
Years	3	170,864.36	56,954.787 **
L x Y	84	47,631.76	567.045 **
R x Y	9	6,201.99	689.110 **
L x R x Y	(252) 251	28,182.88	112.282
Subtotal b	(348) 347	252,880.99	
Grand total	(463) 462	313,317.73	
Dry-down percentages, 1957			
Total	115	664.390	
Reps.	3	10.287	3.4290
Lines	28	455.032	16.2511 **
Error	84	199.071	2.3699

Streptomycin Dusts vs. Sprays, Varied Time of Application

Tip and lateral spike, basal spike, and transformation data.

		Date 1			Date 2			Date 3			Date 4		
Rep.	Treat.	Tip Lat.	Basal	Trans.	Tip Lat.	Basal	Trans.	Tip Lat.	Basal	Trans.	Tip Lat.	Basal	Trans.
I	D	-	41	—	64	271	—	28	208	—	23	178	—
	S	-	10	25	23	138	92	9	98	59	6	52	113
	C	-	46	-	70	418	-	41	339	-	49	208	-
II	D	-	59	-	55	276	-	26	213	-	25	194	-
	S	-	11	59	29	128	86	14	111	66	6	50	128
	C	-	47	-	68	396	-	37	361	-	54	213	-
III	D	-	50	-	66	296	-	30	243	-	20	187	-
	S	-	9	50	35	159	55	9	112	79	8	41	143
	C	-	48	-	63	402	-	47	312	-	43	243	-
IV	D	-	39	-	62	332	-	27	259	-	20	224	-
	S	-	4	53	31	133	76	12	108	81	6	30	139
	C	-	46	-	76	383	-	31	302	-	27	259	-
V	D	-	38	-	46	312	-	21	237	-	24	233	-
	S	-	10	62	31	124	82	9	106	54	8	42	96
	C	-	47	-	57	396	-	27	346	-	41	273	-
VI	D	-	48	-	61	326	-	24	213	-	15	216	-
	S	-	4	35	18	157	61	11	126	72	4	38	137
	C	-	48	-	63	354	-	58	297	-	21	244	-
VII	D	-	49	-	41	256	-	22	273	-	25	314	-
	S	-	5	37	26	173	53	8	104	73	5	30	120
	C	-	46	-	51	337	-	41	367	-	43	273	-
VIII	D	-	38	-	47	293	-	27	244	-	15	210	-
	S	-	3	34	36	131	80	7	94	85	5	26	116
	C	-	47	-	74	367	-	44	279	-	27	253	-

Streptomycin Spray vs. Dust. Varied Time of Application

No. of infected hills, total spike data

		Date 1		Date 2		Date 3		Date 4	
Rep.	Treat.	No. inf. hills	Total spikes	No. inf. hills	Total spikes	No. inf. hills	Total spikes	No. inf. hills	Total spikes
I	D	10	41	73	335	59	236	54	201
	S	4	10	44	161	45	107	27	58
	C	12	48	92	488	86	380	65	257
II	D	11	59	82	331	66	239	57	219
	S	6	11	56	157	51	125	28	56
	C	16	47	86	464	79	398	56	267
III	D	21	50	83	362	79	273	58	207
	S	3	9	55	194	51	121	25	49
	C	14	46	87	465	81	369	83	286
IV	D	12	39	78	394	81	286	52	244
	S	2	4	55	164	54	120	21	36
	C	19	47	85	459	72	383	51	286
V	D	16	38	76	358	72	258	56	257
	S	7	10	56	155	46	115	25	50
	C	18	48	76	453	81	373	77	314
VI	D	13	48	82	387	73	237	62	231
	S	2	4	61	175	58	137	29	42
	C	21	47	81	417	76	355	75	265
VII	D	19	49	72	297	85	295	62	339
	S	1	5	53	199	48	112	25	35
	C	17	46	74	388	83	408	60	316
VIII	D	11	38	80	340	85	271	60	225
	D	1	3	43	167	46	101	21	31
	C	19	47	81	435	76	323	72	280

D - Phytomycin dust, 1000 ppm. strep.
S - AgriStrep., 1000 ppm., plus 1% glycerol
C - Untreated Check

Dust-Spray Crown Treatment Trial

Plots - 100 hills.
Treatment dates Apr. 23, May 29, June 13, and June 29.
Results determined 13-15 days after treatment.

Rep.	Treat.	% Reduction of Spikes in Plot Compared to Check: Date 1	Date 2	Date 3	Date 4
I	D	14.6	31.4	37.8	21.8
	S	79.2	67.0	73.8	77.4
II	D	0.0	28.7	39.6	18.0
	S	76.6	66.2	68.6	79.0
III	D	0.0	22.2	26.1	27.6
	S	80.5	58.4	67.2	82.4
IV	D	17.0	14.2	25.3	14.6
	S	91.4	64.4	68.8	64.6
V	D	20.8	21.0	30.7	18.2
	S	79.2	65.8	69.1	83.8
VI	D	0.0	7.2	33.2	12.8
	S	91.4	58.8	61.3	84.3
VII	D	0.0	23.5	27.7	0.0
	C	89.4	48.8	70.2	89.2
VIII	D	19.2	21.8	16.1	19.6
	S	93.7	61.5	68.6	89.0
Mean disease reduction per date	D	9.0	21.3	29.6	16.6
	S	85.2	61.4	68.4	81.2

Comparison of Commercial Formulations of Streptomycin

Streptomycin preparations – glycerol effectiveness
Trial, Goulet Yard. 1957,
10 hill plots,
Treatments June 4, 5, 7,
Results June 16.

	Spikes per 10-hill plot remaining infected												
	Rep.1			Rep.2			Rep.3			Rep.4			
Treat.	No. Treat.	No. Inf.	%	No. Treat.	No. Inf.	%	No. Treat.	No. Inf.	%	No. Treat.	No. Inf.	%	% Totals
1	166	11	6.63	100	14	14.0	134	1	0.75	113	3	2.65	24.03
2	82	2	2.44	91	8	8.79	143	3	2.09	139	5	3.59	16.91
3	144	32	22.2	112	22	19.64	135	23	17.04	104	41	39.42	98.30
4	129	25	19.38	100	17	17.00	136	15	11.03	141	30	21.28	68.69
5	166	3	1.81	83	2	2.41	82	1	1.22	144	7	4.86	10.30
6	166	4	2.41	137	10	7.30	100	10	10.0	121	3	2.48	22.19
7	120	4	3.33	177	4	2.26	85	13	15.29	161	9	5.60	26.48
8	161	2	1.24	63	3	4.76	148	12	8.11	153	6	3.92	18.03
9	189	28	14.81	128	9	7.03	80	6	7.50	129	15	11.63	40.97
10	150	5	3.33	111	7	6.31	135	12	8.89	112	11	9.82	28.35
11	101	18	17.82	126	15	11.90	130	39	30.0	88	26	29.54	89.26
12	117	17	14.53	139	32	23.02	130	25	19.23	123	16	13.01	69.79
13	157	8	5.10	99	7	7.07	124	4	3.23	118	11	9.32	24.72
14	123	4	3.25	126	2	1.59	126	—		123	4	3.25	(8.09)
15	50	10	20.0	70	12	17.14	113	19	16.81	171	57	33.33	87.28
16	97	13	13.4	158	36	22.78	111	9	8.11	131	53	40.46	84.75
17	147	126	85.71	179	136	75.97	148	123	83.11	150	110	73.33	318.12
18	145	127	87.58	120	103	85.83	121	85	70.25	165	113	68.48	312.14
19	100	76	76.0	132	105	79.55	131	103	78.62	175	94	53.71	287.88
20	113	81	71.68	103	59	57.28	116	91	78.45	117	97	82.91	290.12

Comparison of Commercial Formulations of Streptomycin

Streptomycin preparations - glycerol effectiveness
Trial, Goulet Yard. 1957,
10 hill plots,
Treatments June 4, 5, 7,
Results June 16.

	Spikes per 10-hill plot dead after treatment							
	Rep.1		Rep.2		Rep.3		Rep.4	
Treat.	No. Treat.	No. Dead	No. Treat.	No. Dead	No. Treat.	No. Dead	No. Treat.	No. Dead
1	166	38	100	43	134	54	113	43
2	82	17	91	17	143	34	139	60
3	144	55	112	22	135	63	104	44
4	129	55	100	41	136	62	141	82
5	166	42	83	14	82	15	144	54
6	166	66	137	51	100	43	121	25
7	120	29	177	59	85	31	161	62
8	161	62	63	16	148	67	153	55
9	189	98	128	38	80	20	129	21
10	150	52	111	35	135	56	112	27
11	101	24	126	52	130	65	88	44
12	117	41	139	60	130	44	123	43
13	157	52	99	33	124	41	138	68
14	123	32	126	26	126	10	123	41
15	50	14	70	17	113	51	171	69
16	97	20	158	63	111	68	131	60
17	147	21	179	43	148	25	150	40
18	145	18	120	17	121	36	165	52
19	100	24	132	27	131	28	175	81
20	113	32	103	44	116	25	117	14

Comparison of Commercial Formulations of Streptomycin

Streptomycin preparations - glycerol effectiveness
Trial, Goulet Yard, 1957,
10 hill plots,
treatments June 4, 5, 7,
Results June 16.

	Spikes per 10-hill plot transformed to healthy shoots.							
	Rep.1		Rep.2		Rep.3		Rep.4	
Treat.	No. Treat.	No. Trans.	No. Treat.	No. Trans.	No. Treat.	No. Trans.	No. Treat.	No. Trans.
1	166	117	100	43	134	79	113	67
2	82	63	91	67	143	106	139	74
3	144	57	112	47	135	49	104	19
4	129	59	100	42	136	59	141	29
5	166	121	83	67	82	66	144	83
6	166	96	137	76	100	47	121	93
7	120	87	177	114	85	41	161	90
8	161	97	63	44	148	69	153	92
9	189	63	128	81	80	54	129	93
10	150	93	111	69	135	67	112	74
11	101	59	126	59	130	26	88	18
12	117	59	139	47	130	61	123	64
13	157	97	99	59	124	79	138	39
14	123	87	126	98	126	116	123	78
15	50	31	70	41	113	43	171	45
16	97	64	158	59	111	34	131	18
17	147	—	179	—	148	—	150	—
18	145	—	120	—	121	—	165	—
19	100	—	132	—	131	—	175	—
20	113	—	103	—	116	—	117	—

1957 Data on
Hop Soil Treatments

Rep.	Treatment	No. vines	Avg. wt. Per vine	No. hills	Total weight (lbs.)
	Crag	19	3.5	9	67.1
	Piefume	26	4.2	9	108.2
I	Vapam	26	2.6	10	67.6
	Ck	28	2.6	10	73.3
	Terraclor	29	2.9	10	86.0
	Piefume	30	3.4	9	101.3
	Vapam	33	3.2	10	106.3
II	Terraclor	28	4.1	10	116.0
	Crag	35	3.3	10	115.4
	Ck	31	3.4	10	104.5
	Vapam	23	3.1	8	72.6
	Crag	31	4.5	9	141.1
III	Ck	35	4.7	10	163.8
	Piefume	36	4.9	10	175.2
	Terraclor	26	3.8	10	98.8
	Crag	29	4.6	9	132.3
	Vapam	30	3.3	9	98.2
IV	Piefume	29	3.1	10	90.1
	Ck	31	5.0	10	155.2
	Terraclor	20	5.0	8	101.0

Hop Soil Treatment Data in Replication

Treatments	Total crop and vine weights in replications				Rep. Totals	Rep. Averages
	1	2	3	4		
Chloropicrin	108.2	101.3	175.2	90.1	474.8	118.7
Vapam	67.6	106.3	72.6	98.2	344.7	86.2
Crag Mylone	67.1	115.4	141.1	132.3	455.9	114.0
Terraclor	86.0	116.0	98.8	101.0	401.8	100.4
Check	73.3	104.5	163.8	155.2	496.8	124.2

Average Weight per Vine in Replication

Material	Vine weight in replication 1	2	3	4	Mean vine weight
Crag	3.5	3.3	4.5	4.6	3.97
Picfume	4.2	3.4	4.9	3.1	3.90
Vapam	2.6	3.2	3.1	3.3	3.05
Terraclor	2.9	4.1	3.8	5.0	3.95
Check	2.6	3.4	4.7	5.0	3.92

Harvest Weights in the Chemical Stripping and Suckering Trial, 1957.

Entry	Rep.I	Rep.II	Rep.III	Rep.IV	Totals	Avg.
1 Ck (hand)	35.7	39.2	39.0	31.3	145.2	36.3
2 Ck (none)	39.6	44.0	39.0	43.5	166.1	41.5
4 End 3#/100	36.6	27.4	34.6	28.2	126.8	31.7
5 End 5#/100	29.0	34.8	29.2	37.3	130.3	32.6
6 End 7#/100	34.7	35.5	37.3	30.8	138.3	34.6
7 S-D-1369 1#/100	34.5	34.5	30.0	35.4	134.4	33.6
8 S-D-1369 2#/100	36.4	34.9	42.4	32.1	145.8	36.4
9 S-D-1369 3#/100	25.2	22.6	40.6	42.4	130.8	32.7
SX	271.7	272.9	292.1	281.0	1,117.7	34.9
SX^2	9,377.55	9,613.71	10,829.21	10,088.44	157,285.11	

Analysis of Variance

Source of Variation	DF	SS	MS
Total	31	869.745	
Reps.	3	33.173	11.0578
Treatments	7	282.112	40.3017
Error	21	554.459	26.4028

Harvest Weights in the Chemical Stripping Trial, 1956-57.

Treatment	I 1956	I 1957	I Total	II 1956	II 1957	II Total	III 1956	III 1957	III Total	IV 1956	IV 1957	IV Total	Treatment Total
1 Check (hand)	41.1	35.7	76.8	36.2	39.2	75.4	40.3	39.0	79.3	43.7	31.3	75.0	306.5
2 Check (none)	52.7	39.6	92.3	40.7	44.0	84.7	46.7	39.0	85.7	37.7	43.5	81.2	343.9
4 Endo. 3#/100 gal.	42.3	36.6	78.9	21.8	27.4	49.2	28.8	34.6	63.4	37.2	28.2	65.4	256.9
5 Endo. 5# "	32.0	29.0	61.0	49.0	34.8	83.8	36.8	29.2	66.0	45.1	37.3	82.4	293.2
6 Endo. [illegible]# "	43.6	34.7	78.3	35.1	35.5	70.6	34.9	37.3	72.2	35.9	30.8	66.7	287.8
SX	211.7	175.6	387.3	183.8	180.9	363.7	187.5	179.1	366.6	199.6	171.1	370.7	1,488.3
SX^2	9,180.75	6,227.30	30,494.63	7,075.18	6,694.69	27,286.69	7,206.67	6,483.09	27,221.38	8,037.64	6,007.11	27,734.25	447,082.15

Analysis of Variance

Source of Variation	DF	SS	MS	
Total	39	1,536.508		
Reps.	3	33.381	11.1270	
Treatments	4	499.347	124.8368	*
Error a (T x R)	12	459.825	38.3188	
Years	1	140.250	140.2500	*
T x Y	4	59.149	14.7872	
Error b	15	344.556	22.9704	

Two-way table (T x Y)

Treat.	1956	1957
1	161.3	145.2
2	177.8	166.1
4	130.1	126.8
5	162.9	130.3
6	149.5	138.3
SX	781.6	706.7
SX^2	123,443.20	100,855.47

% Alpha-acid in the Chemical Stripping and Suckering Trial, 1957.

Treatment	Reps. I	II	III	IV	Total	Avg.
1 Check (stripped)	5.54	5.59	5.70	5.45	22.28	5.57
2 Check(not stripped)	6.34	6.20	5.12	6.03	23.69	5.92
4 Endothal 3#/100 gal	6.23	5.98	6.10	4.12	22.43	5.61
5 " 5# " "	5.29	5.56	6.00	5.92	22.77	5.69
6 " 7# " "	5.63	6.46	6.37	6.42	24.88	6.22
7 SD-1369 1# " "	6.75	6.48	6.50	4.42	24.15	6.04
8 " 2# " "	6.06	6.38	6.80	5.81	25.05	6.26
9 " 3# " "	5.45	6.77	6.59	6.60	25.41	6.35
SX	47.29	49.42	49.18	44.77	190.66	5.96

Analysis of Variance

Source of Variation	Total of squares	Total squares per obs.	SS	DF	MS	
Correction	36351.2356	1135.97611				
Treatment	4554.5998	1138.6499	2.6738	7	0.3819	NS
Replication	9101.7058	1137.7132	1.7371	3	0.5790	NS
T x R			8.1666	21	0.3889	
Total	1148.5536	1148.5536	12.5775	31		

Harvest wts. in the Irrigation-fertility experiment in 1957.
(adj. to 25% dry-down)

	1	2	3	4	5	6	7	Total
				Rep.I				
A	1.9	6.6	4.8	6.4	5.2	10.9	6.0	41.8
B	4.2	19.6	10.0	14.5	15.3	24.0	5.4	93.0
C	8.5	16.2	13.9	10.5	10.4	15.6	21.0	96.1
D	4.3	14.9	12.2	18.1	12.1	15.0	14.9	91.5
E	5.7	11.4	17.1	11.2	20.2	16.2	11.7	93.5
	24.6	68.7	58.0	60.7	63.2	81.7	59.0	415.9
				Rep III				
A	10.9	12.4	13.1	18.2	15.3	14.0	5.0	88.9
B	7.4	24.5	19.9	13.1	11.2	11.0	17.5	104.6
C	5.3	8.3	15.5	18.2	5.6	3.5	10.3	66.7
D	7.5	19.0	14.9	10.2	16.0	19.2	21.8	108.6
E	5.3	8.2	5.7	15.0	5.0	7.2	7.9	54.3
	36.4	72.4	69.1	74.7	53.1	54.9	62.5	423.1
				Rep.IV				
A	2.5	10.8	14.6	7.7	4.5	12.4	10.9	63.4
B	3.6	9.8	9.6	12.7	16.1	10.4	3.2	65.4
C	6.3	19.7	19.4	12.8	9.8	14.5	9.5	92.0
D	7.6	19.8	20.0	7.0	19.5	10.0	20.8	104.7
E	2.8	6.6	9.5	7.1	10.2	4.7	9.7	50.6
	22.8	66.7	73.1	47.3	60.1	52.0	54.1	376.1
SX	83.8	207.8	200.2	182.7	176.4	188.6	175.6	1215.1
SX^2	554.98	3329.64	2991.80	2461.47	2455.42	2769.60	2586.08	

% Alpha-acid (Colorimetric Method) in the Irrigation-fertility Experiment in 1957.

Irrigation level		Fertilizer levels 1	2	3	4	5	6	7	Totals
A	Rep.I	4.69	5.46	(5.09)	5.08	(5.09)	4.81	5.42	35.64
	Rep.III	5.03	5.14	5.02	5.37	5.57	5.58	5.24	36.95
	Total	9.72	10.60	10.11	10.45	10.66	10.39	10.66	72.59
B	Rep.I	4.39	5.48	4.72	5.36	5.12	4.78	4.50	34.35
	Rep.III	5.55	5.78	5.53	5.13	5.71	5.54	5.13	38.37
	Total	9.94	11.26	10.25	10.49	10.83	10.32	9.63	72.72
C	Rep.I	5.61	5.04	4.72	5.19	5.29	5.39	5.98	37.22
	Rep.III	5.22	5.56	4.87	5.15	4.85	4.60	5.22	35.47
	Total	10.83	10.60	9.59	10.34	10.14	9.99	11.20	72.69
D	Rep.I	4.96	5.36	4.46	4.63	4.96	5.37	4.68	34.42
	Rep.III	4.55	5.33	5.41	5.11	5.21	5.31	5.20	36.12
	Total	9.51	10.69	9.87	9.74	10.17	10.68	9.88	70.54
E	Rep.I	5.04	5.19	5.61	5.06	5.22	5.17	4.62	35.91
	Rep.III	4.78	5.10	4.79	5.17	4.77	5.10	4.69	34.40
	Total	9.82	10.29	10.40	10.23	9.99	10.27	9.31	70.31
	Total of totals	49.82	53.44	50.22	51.25	51.79	51.65	50.68	358.85
	SX^2	249.6462	286.0698	253.5390	263.0299	269.0051	267.7965	258.6926	

% Alpha-acid (Colorimetric Method) in the Irrigation-fertility Experiment in 1957.

Two way table of totals: Irrigation x Fertility

Irrigation	Fertility 1	2	3	4	5	6	7	Totals
A	9.72	10.60	10.11	10.45	10.66	10.39	10.66	72.59
B	9.94	11.26	10.25	10.49	10.83	10.32	9.63	72.72
C	10.83	10.60	9.59	10.34	10.14	9.99	11.20	72.69
D	9.51	10.69	9.87	9.74	10.17	10.68	9.88	70.54
E	9.82	10.29	10.40	10.23	9.99	10.27	9.31	70.31
Totals	49.82	53.44	50.22	51.25	51.79	51.65	50.68	358.85

Two way table of totals: Irrigation x Replication

Replication	Irrigation levels A	B	C	D	E	Totals
I	35.64	34.35	37.22	34.42	35.91	177.54
III	36.95	38.37	35.47	36.12	34.40	181.31
Totals	72.59	72.72	72.69	70.54	70.31	358.85

Two way table of totals: Fertility x Replication

Replication	Fertility 1	2	3	4	5	6	7	Totals
I	24.69	26.53	24.60	25.32	25.68	25.52	25.20	177.54
III	25.13	26.91	25.62	25.93	26.11	26.13	25.48	181.31
Totals	49.82	53.44	50.22	51.25	51.79	51.65	50.68	358.85

Analysis of Variance

Variation due to:	SS	DF	MS	F	Remarks
Irrigation	.43327	4	.10832	0.2607	N.S.
Replication	.20304	1	.20304	0.4887	N.S.
Error (a) (RxI)	1.66190	4	.41548	—	—
Fertilizers	.86770	6	.14462	24.2651	**
I x F	4.81569	24	.20065	33.6661	**
F x R	.03555	6	.00592	0.9933	N.S.
Error (b) (IxFxR)	.14306	24	.00596	—	—
Total	8.16021	69	—	—	—

Harvest Weights in the Height of Stripping Study on Fuggles,1957.

Entry	Rep.I	Rep.II	Rep.III	Rep.IV	Totals
No	25.2	32.9	43.0	34.1	135.2
1.5	33.2	25.3	32.1	40.2	130.8
3.0	28.0	34.2	48.0	30.9	141.1
4.5	31.3	39.7	32.7	31.4	135.1
6.0	30.7	28.2	36.3	34.8	130.0
SX	148.4	160.3	192.1	171.4	672.2
SX^2	4,443.46	5,263.47	7,570.39	5,930.66	90,448.90

Analysis of Variance

Source of Variation	DF	SS	MS
Total	19	615.338	
Reps.	3	207.162	69.0540
Treatments	4	19.583	4.8958
Error	12	388.593	32.3828

% Alpha-acid in the Height of Stripping
Trial on Fuggles, 1957.

Height	Reps. I	II	III	IV	Totals	Avg.
1.5'	5.05	4.66	6.11	5.00	20.82	5.20
3.0'	5.02	5.94	6.43	6.23	23.62	5.90
4.5'	5.74	5.72	6.16	6.23	23.85	5.96
6.0'	5.58	5.52	5.75	6.23	23.08	5.77
No stripping	5.55	5.52	6.11	5.58	22.76	5.69
SX	26.94	27.36	30.56	29.27	114.13	5.71

Analysis of Variance

Source of Variation	Total of squares	Total squares per obs.	SS	DF	MS	
Treatment	2610.9033	652.7258	1.4430	4	.36075	NS
Replication	3264.9797	652.9959	1.7131	3	.57103	*
T x R			1.4012	12	.11677	
Total	655.8401	655.8401	4.5573			
Correction	13025.6569	651.2828				

Harvest Weights in the Date and Severity of Pruning Study, 1957.

Entry	Rep. I	Rep. II	Rep. III	Rep. IV	Rep. V	Rep. VI	Rep. VII	Rep. VIII	Totals.	Avg.
A No	40.8	32.5	35.4	42.4	40.8	36.3	45.6	38.1	311.9	39.0
B Mod 4/11	36.3	33.7	23.4	30.9	34.1	31.7	38.7	37.4	266.2	33.3
C Sev 4/11	31.4	35.5	33.0	33.5	37.1	37.7	41.6	38.4	288.2	36.0
D Mod 4/18	38.9	35.9	31.6	40.3	32.5	39.9	43.1	46.0	308.2	38.5
E Mod 4/25	36.0	43.2	31.9	27.4	29.8	43.9	45.9	50.0	308.1	38.5
SX	183.4	180.8	155.3	174.5	174.3	189.5	214.9	209.9	1482.6	
SX^2	6777.50	6607.24	4905.89	6249.67	6148.15	7263.09	9272.03	8940.93	441116.14	

Analysis of Variance

Source of Variation	DF	SS	MS
Total	39	1211.931	
Reps.	7	532.091	76.0130 **
Treatments	4	189.948	47.4871 *
Error	28	489.892	17.4961

Harvest weights in the Time and Severity of Pruning Study, 1956-1957.

Treatment	Rep.I			Rep.II			Rep.III			Rep.IV		
	1956	1957	Total	1956	1957	Total	1956	1957	Total	1956	1957	Total
A NoPruning	45.6	40.8	86.4	38.1	32.5	70.6	43.9	35.4	79.3	26.4	42.4	68.8
B Mod.4/11	48.9	36.3	85.2	44.0	33.7	77.7	32.5	23.4	55.9	32.9	30.9	63.8
C Sev.4/11	43.9	31.4	75.3	53.3	35.5	88.8	44.5	33.0	77.5	39.4	33.5	72.9
D Mod.4/18	47.0	38.9	85.9	54.0	35.9	89.9	40.5	31.6	72.1	47.3	40.3	87.6
E Mod.4/25	36.1	36.0	72.1	46.1	43.2	89.3	44.2	31.9	76.1	47.5	27.4	74.9
SX	221.5	183.4	404.9	235.5	180.8	416.3	205.6	155.3	360.9	193.5	174.5	368.0
SX^2	9909.99	6777.50	32971.31	11269.71	6607.24	34963.59	8557.60	4905.89	26409.17	7825.27	6249.67	27402.06

Treatment	Rep.V			Rep.VI			Rep.VII			Rep.VIII		
A NoPruning	32.3	40.8	73.1	37.4	36.3	73.7	45.7	45.6	91.3	40.5	38.1	78.6
B Mod.4/11	51.4	34.1	85.5	44.0	31.7	75.7	54.1	38.7	92.8	53.3	37.4	90.7
C Sev.4/11	45.4	37.1	82.5	45.3	37.7	83.0	48.4	41.6	90.0	41.7	38.4	80.1
D Mod.4/18	49.4	32.5	81.9	56.9	39.9	96.8	60.5	43.1	103.6	41.8	46.0	87.8
E Mod.4/25	33.4	29.8	63.2	43.0	43.9	86.9	41.9	45.9	87.8	51.4	50.0	101.4
SX	211.9	174.3	386.2	226.6	189.5	416.1	250.6	214.9	465.5	228.7	209.9	438.6
SX^2	9302.33	6148.15	30161.96	10,473.46	7263.09	34973.03	12773.72	9272.03	43489.33	10609.23	8940.93	38811.26

Treatment	Treatment total	Average
A No Pruning	621.8	38.9
B Mod.4/11	627.3	39.2
C Sev.4/11	650.1	40.6
D Mod.4/18	705.6	44.1
E Mod.4/25	651.7	40.7
SX	3256.5	
SX^2	2125354.79	

Harvest weights in the Time and Severity of Pruning Study, 1956-1957 cont.

Analysis of Variance

Source of Variation	DF	SS	MS
Total	79	4325.9069	
Reps.	7	867.3339	123.9048 **
Treatments	4	274.7712	68.6928
T x R (error a)	28	888.8468	31.7445
Years	1	1060.6961	1060.6961 **
T x Y	4	417.9658	104.4914 **
Error b	35	816.2931	23.3227

Treatment x Years 2-way table

	A	B	C	D	E	Total
1956	309.9	361.1	361.9	397.4	343.6	1,773.9
1957	311.9	266.2	288.2	308.2	308.1	1,482.6
SX	621.8	627.3	650.1	705.6	651.7	3,256.5
SX^2	193,319.62	201,255.65	214,030.85	252,914.00	212,986.57	

Length of Sidearm (inches) in the Time and Severity of Pruning Study in 1957.

Treatment	Rep.I 1	Rep.I 2	Rep.I Total	Rep.II 1	Rep.II 2	Rep.II Total	Rep.III 1	Rep.III 2	Rep.III Total	Rep.IV 1	Rep.IV 2	Rep.IV Total
A Not pruned	28	10	38	9	11	20	14	16	30	16	13	29
	16	18	34	9	15	24	15	18	33	17	19	36
	30	20	50	11	13	24	13	19	32	18	28	46
	20	41	61	25	16	41	35	16	51	25	15	40
			183			109			146			151
B Mod. prune 4/11	20	15	35	28	15	43	15	14	29	17	24	41
	32	20	52	26	18	44	18	14	32	20	14	34
	22	10	32	15	10	25	13	14	27	17	20	37
	18	16	34	17	19	36	15	21	36	26	28	54
			153			148			124			166
C Sev. prune 4/11	15	11	26	17	12	29	22	16	38	25	16	41
	11	9	20	24	13	37	17	15	32	21	16	37
	10	14	24	16	15	31	18	15	33	16	13	29
	13	9	22	11	9	20	13	12	25	18	14	32
			92			117			128			139
D Mod. prune 4/18	15	14	29	20	16	36	19	14	33	31	19	50
	13	12	25	30	20	50	20	19	39	25	33	58
	11	16	27	15	19	34	19	22	41	13	18	31
	31	15	46	22	28	50	34	16	50	18	17	35
			127			170			163			174
E Mod. prune 4/25	25	39	64	14	17	31	38	20	58	18	22	40
	25	29	54	22	14	36	15	27	42	17	14	31
	15	12	27	33	15	48	20	23	43	22	25	47
	30	16	46	30	19	49	11	16	27	21	15	36
			191			164			170			154

Treatment	Rep.V 1	Rep.V 2	Rep.V Total	Rep.VI 1	Rep.VI 2	Rep.VI Total	Rep.VII 1	Rep.VII 2	Rep.VII Total	Rep.VIII 1	Rep.VIII 2	Rep.VIII Total	Treat. totals.	Avg.
A Not pruned	30	14	44	40	52	92	11	24	35	45	11	56		
	23	28	51	30	38	68	21	12	33	25	12	37		
	19	25	44	28	17	45	20	18	38	35	33	68		
	14	30	44	42	12	54	21	36	57	19	18	37		
			183			259			163			198	1392	22
B Mod. prune 4/11	28	22	50	17	8	25	27	17	44	16	20	36		
	16	18	34	20	14	34	22	23	45	12	21	33		
	18	11	29	19	17	36	38	25	63	30	17	47		
	10	26	36	34	18	52	40	31	71	29	14	43		
			149			147			223			159	1269	20
C Sev. prune 4/11	25	20	45	14	13	27	18	14	32	42	25	67		
	19	21	40	20	19	39	16	31	47	19	17	36		
	15	19	34	16	13	29	37	18	55	18	27	45		
	17	20	37	23	28	51	19	28	47	19	16	35		
			156			146			181			183	1142	18
D Mod. prune 4/18	15	24	39	18	30	48	25	10	35	20	34	54		
	16	15	31	35	23	58	37	10	47	28	26	54		
	19	23	42	40	20	60	18	28	46	17	21	38		
	22	15	37	13	22	35	30	18	48	24	26	50		
			149			201			176			196	1356	21
E Mod. prune 4/25	27	15	42	43	25	68	31	40	71	17	31	48		
	27	16	43	35	30	65	42	32	74	42	50	92		
	18	15	33	35	24	59	21	25	46	43	34	77		
	20	30	50	34	37	71	19	20	39	29	20	49		
			168			263			230			266	1606	25
														21

Length of Sidearm (inches) in the Time and Severity of Pruning Study in 1957

Cont.

		ΣX	ΣX^2
Rep.I	1	400	9,898
	2	346	7,548
	Total	746	117,972
Rep.II	1	394	8,802
	2	314	5,272
	Total	708	103,270
Rep.III	1	384	8,492
	2	347	6,287
	Total	731	108,545
Rep.IV	1	401	8,411
	2	383	7,965
	Total	784	123,670
Rep.V	1	398	8,458
	2	407	8,873
	Total	805	130,451
Rep.VI	1	556	17,408
	2	460	12,720
	Total	1,016	219,576
Rep.VII	1	513	14,715
	2	460	11,966
	Total	973	192,935
Rep.VIII	1	529	15,979
	2	473	12,869
	Total	1,002	207,146
Treat. Totals		6,765	9270,161

Analysis of Variance

Source of Variation	DF	SS	MS
Total	319	21,786.6719	
Reps.	7	2,928.9469	418.4210 **
Treatments	4	1,829.9375	457.4844 **
T x R	28	2,670.4125	95.3719
Error	280	14,357.3750	51.2763

% Alpha-acid in the Time and Severity of Pruning Trial, 1957.

Treatment	Reps. V	VI	VII	VIII	Totals	Avg.
A (no pruning)	6.42	6.69	6.11	6.12	25.34	6.34
B (mod. early)	6.32	6.18	6.67	6.16	25.33	6.33
C (severe, early)	6.58	6.26	5.31	6.08	24.23	6.06
D (Mod. med.)	4.96	5.61	6.47	4.03	21.07	5.27
E (Mod. late)	4.03	6.18	6.11	6.35	22.67	5.67
SX	28.31	30.92	30.67	28.74	118.64	5.93

Analysis of Variance

Source of Variation	Total of squares	Total squares per obs.	SS	DF	MS	
Correction	14075.4496	703.7725				
Treatment	2828.6912	707.1728	3.4003	4	0.8501	NS
Replication	3524.1390	704.8278	1.0553	3	0.3518	NS
T x R			7.0101	12	0.5842	
Total	715.2382	715.2382	11.4627	19		

Chemical Evaluation of Strobiles: Storage (at 38°F) Quality Evaluation Trial, 1956.

% alpha acid. Dry weight basis

Variety	Months stored	Rep.1	Rep.2	Rep.3	Rep.4	Approx. loss in α in 11 mo.	Total	Mean
1 Late Clusters	0	5.83	5.55	6.25	—		17.63	5.87
	3	6.37	5.57	6.08	—	8%	18.02	6.00
	6	5.25	5.31	5.93	—		16.49	5.49
	11	5.17	5.24	5.83	—		16.24	5.41
2 Fuggles	0	3.62	—	3.58	4.98		12.18	4.06
	3	3.57	—	3.77	4.65		11.99	3.99
	6	3.32	—	3.50	4.78		11.60	3.86
	11	—	—	2.38	4.00		6.38	3.19
3 Brewers Gold	0	8.97	—	7.74	8.95		25.66	8.54
	3	9.44	—	—	8.10	40%	17.54	8.77
	6	7.75	—	6.75	7.50		22.00	7.33
	11	—	—	—	5.15		5.15	5.15
4 Bullion	0	8.30	3.73	5.06	3.53		20.62	5.16
	3	—	3.43	3.18	3.42	23%	10.03	3.34
	6	5.12	3.56	4.07	3.20		15.95	3.99
	11	—	—	2.04	2.49		4.53	2.22
5 103-I	0	4.87	3.65	3.54	3.78		15.84	3.96
	3	5.28	3.26	3.27	3.44	42%	15.25	3.81
	6	4.34	3.09	4.13	2.98		14.54	3.64
	11	3.72	1.40	1.95	2.12		9.19	2.30
6 104-I	0	—	—	3.88	4.57		8.45	4.22
	3	—	—	3.77	3.69	22%	7.46	3.73
	6	—	—	3.49	3.90		7.39	3.70
	11	—	—	—	3.29		3.29	3.29
7 107-I	0	4.35	4.72	4.70	4.76		18.53	4.63
	3	4.67	4.46	4.77	4.62	15%	18.52	4.63
	6	4.33	4.14	4.68	4.27		17.42	4.36
	11	3.87	3.81	4.22	3.76		15.66	3.92
8 108-I	0	6.15	4.00	4.21	3.88		18.24	4.56
	3	6.62	4.08	4.56	3.51	22%	18.77	4.69
	6	5.65	3.93	3.93	3.55		17.06	4.26
	11	4.60	3.24	3.38	3.08		14.30	3.58
9 109-I	0	5.07	6.26	—	4.56		15.89	5.29
	3	4.93	—	—	4.42	30%	9.35	4.68
	6	4.46	—	—	4.27		8.73	4.36
	11	3.98	—	—	3.87		7.85	3.92

Chemical Evaluation of Strobiles: Storage (at 38°F) Quality Evaluation Trial, 1956. cont.

% alpha acid. Dry weight basis

Variety	Months stored	Rep.1	Rep.2	Rep.3	Rep.4	Approx. loss in α in 11 mo.	Total	Mean
10 112-I	0	6.15	6.87	4.98	7.62		25.62	6.40
	3	6.02	6.26	5.60	7.64		25.52	6.38
	6	5.33	6.07	4.50	6.64		22.54	5.64
	11	4.68	4.77	4.11	5.95		19.51	4.88
11 123-I	0	6.47	6.38	6.75	8.18		27.78	6.94
	3	6.77	6.58	6.44	7.08		26.87	6.72
	6	5.80	6.64	6.14	7.04		25.62	6.41
	11	5.04	5.09	5.22	5.40		20.75	5.19
12 124-I	0	5.28	3.29	5.15	3.85		17.57	4.39
	3	5.03	3.63	5.13	3.56		17.35	4.34
	6	4.84	3.32	4.70	3.46		16.32	4.08
	11	3.75	2.89	4.46	3.18		14.28	3.57
13 127-I	0	5.54	—	—	6.07		11.61	5.80
	3	—	—	—	—		—	—
	6	5.27	—	—	6.03		11.30	5.65
	11	—	—	—	—		—	—
14 132-I	0	4.03	—	3.14	6.18		13.35	4.45
	3	3.54	—	2.93	5.78		12.25	4.08
	6	2.77	—	3.04	6.00		11.81	3.93
	11	—	—	2.77	—		2.77	2.77
15 135-I	0	2.76	3.15	2.31	2.61		10.83	2.71
	3	3.31	3.22	2.81	—	12%	9.34	3.11
	6	2.51	2.98	2.26	—		7.75	2.58
	11	2.27	2.50	2.02	—		6.79	2.26
16 138-I	0	5.98	4.94	4.95	5.03		20.90	5.22
	3	5.86	5.02	5.00	5.07		20.95	5.24
	6	5.46	4.74	4.58	5.25		20.03	5.01
	11	4.82	3.92	—	4.25		12.99	4.32
17 139-I	0	4.48	3.94	4.14	4.00		16.56	4.14
	3	4.49	4.19	4.08	4.22		16.98	4.24
	6	4.21	4.07	3.96	4.14		16.38	4.10
	11	3.61	3.32	3.60	3.46		13.99	3.50
18 144-I	0	4.66	4.38	5.23	4.86		19.13	4.78
	3	—	4.61	4.81	4.76		14.18	4.72
	6	4.73	4.45	4.58	—		13.76	4.44
	11	3.65	3.43	3.47	3.71		14.36	3.59

Chemical Evaluation of Strobiles: Storage (at 38°F) Quality Evaluation Trial, 1956.

% alpha acid. Dry weight basis

Miscellaneous Varieties - one replication only.

Months stored	128-I	164-S	214-S	Fuggles[1]	Seedless[2] Fuggles	Early Pick[1] Bullion
0	10.47	5.20	7.40	5.17	4.89	6.87
3	10.89	5.50	7.66	4.54	4.96	5.32
6	10.05	—	—	4.20	4.93	4.89
11	8.77	—	—	3.43	3.74	2.72

1. Capitol Farms
2. Coleman Farms

Chemical Evaluation of Strobiles: Storage (at 38°F) Quality Evaluation Trial, 1956.

mls. oil per 100 grams dry strobiles

Variety	Months stored	Rep.1	Rep.2	Rep.3	Rep.4	Total	Mean
1 Late Clusters	0	.40	.31	.34	—	1.05	.35
	3	.37	.55	.33	—	1.25	.42
	6	.39	.31	.31	—	1.01	.34
	10	.29	.30	.29	—	.88	.29
2 Fuggles	0	.60	—	.46	.41	1.47	.49
	3	.40	—	.33	.34	1.07	.36
	6	.39	—	.36	.33	1.08	.36
	10	—	—	.20	.15	.35	.18
3 Brewers Gold	0	3.09	—	2.64	2.94	8.67	2.89
	3	2.40	—	—	3.04	5.44	2.72
	6	2.18	—	1.99	2.37	6.54	2.18
	10	—	—	—	1.47	1.47	1.47
4 Bullion	0	1.17	.64	.91	.62	3.34	.84
	3	—	.46	.31	.50	1.27	.42
	6	.61	.55	.70	.47	2.33	.58
	10	—	—	.63	.44	1.07	.53
5 103-I	0	1.57	1.56	1.35	1.25	5.73	1.43
	3	1.55	1.34	1.38	1.47	5.74	1.44
	6	1.49	1.29	1.17	1.28	5.23	1.31
	10	1.13	—	.98	.59	2.70	.90
6 104-I	0	—	—	1.46	1.56	3.02	1.51
	3	—	—	1.56	1.69	3.29	1.64
	6	—	—	1.75	1.41	3.16	1.58
	10	—	—	—	1.08	1.08	1.08
7 107-I	0	.98	.79	.96	.92	3.65	.91
	3	.93	.88	.74	.83	3.38	.85
	6	.99	.81	—	.82	2.56	.85
	11	.80	.74	.74	.74	3.02	.76
8 108-I	0	1.26	.74	.79	.72	3.51	.89
	3	1.22	.73	.89	.77	3.61	.90
	6	1.19	.78	.79	.70	3.46	.86
	11	.98	.49	.64	.49	2.60	.65
9 109-I	0	1.72	—	—	1.27	2.99	1.50
	3	1.79	—	—	1.70	3.49	1.75
	6	1.58	—	—	1.58	3.16	1.58
	11	1.38	—	—	.99	2.37	1.18

Chemical Evaluation of Strobiles: Storage (at 35°F) Quality Evaluation Trial, 1956.

mls. oil per 100 grams dry strobiles

Variety	Months stored	Rep.1	Rep.2	Rep.3	Rep.4	Total	Mean
10 112-I	0	1.12	1.12	1.07	1.30	4.61	1.15
	3	1.20	1.06	1.13	1.32	4.71	1.18
	6	1.11	1.20	1.05	1.36	4.72	1.18
	11	.93	1.03	.99	1.17	4.12	1.03
11 123-I	0	.86	1.00	.85	.97	3.68	.92
	3	.96	1.02	.96	1.01	3.95	.99
	6	.90	1.08	.91	1.08	3.97	.99
	11	.81	—	.78	.78	2.37	.79
12 124-I	0	.59	.70	.45	.68	2.42	.60
	3	.68	.77	.44	.68	2.57	.64
	6	.66	.71	.47	.74	2.58	.64
	11	.59	.54	.39	.59	2.11	.53
13 127-I	0	1.40	—	—	1.27	2.67	1.34
	3	—	—	—	—	—	—
	6	1.36	—	—	1.37	2.73	1.36
	11	—	—	—	—	—	—
14 132-I	0	.39	—	.24	.93	1.56	.52
	3	.29	—	.29	.89	1.47	.49
	6	.45	—	.35	.97	1.77	.59
	11	.30	—	.20	—	.50	.40
15 135-I	0	.76	.77	.81	.66	3.00	.75
	3	.80	.69	.85	—	2.34	.78
	6	.90	.71	.89	—	2.50	.83
	11	.53	.49	.69	—	1.71	.57
16 138-I	0	.76	.86	.55	.87	3.04	.76
	3	.82	.76	.75	1.07	3.40	.85
	6	.84	.79	.63	1.04	3.30	.83
	11	.70	.60	—	.65	1.95	.65
17 139-I	0	.55	.57	.58	.58	2.28	.57
	3	.39	.57	.58	.53	2.07	.52
	6	.51	.59	.65	.59	2.34	.58
	11	.20	.40	.50	.55	1.65	.41
18 144-I	0	1.58	1.63	1.38	1.39	5.98	1.49
	3	—	1.64	1.71	1.50	4.85	1.62
	6	1.60	1.65	1.43	1.24	5.92	1.48
	11	1.29	1.38	1.32	1.89	5.88	1.47

Chemical Evaluation of Strobiles: Storage (at 38°F) Quality Evaluation Trial, 1956.

mls. oil per 100 grams dry strobiles
Miscellaneous Varieties - one replication only.

Months stored	128-I	164-S	214-S	Fuggles*	Seedless* Fuggles	Bullion*
0	2.13	1.66	1.76	.71	.64	1.36
3	2.21	1.74	1.76	.69	1.08	1.29
6	2.16	—	—	.64	1.14	1.15
11	1.57	—	—	.49	.86	.95

* Samples from commercial yards.

Bullion Fertiliser Trial - Leaf Analysis Data
July 10 collection

Treatment	% Ca Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Total
I	5.20	4.55	4.50	4.10	4.00	22.35
II	4.40	4.95	5.25	5.25	5.05	24.90
III	5.05	5.20	5.00	5.00	5.30	25.55
IV	5.25	5.10	5.45	5.55	4.90	26.25
V	4.80	5.40	4.40	4.65	4.60	23.85
	24.70	25.20	24.60	24.55	23.85	122.90

Analysis of Variance

Source of Variation	SS	DF	MS	F	
Treatment	1.8676	4	.466900	3.51647	*
Replication	.1866	4	.046650	.003528	NS
Error	2.1244	16	.132775		
Total	4.1786	24			

Individ D.F.	$(\Sigma MT)^2$	$n \Sigma M^2$	MS	F	
ck. vs. treatments	13.3225	100	.1332	1.0032	NS
NH_4^+ vs. NH_3^-	5.0625	10	.5062	3.8124	NS

Treatment	% P Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Total
I	.189	.189	.192	.187	.201	.958
II	.166	.180	.168	.186	.168	.868
III	.216	.175	.201	.209	.205	1.006
IV	.197	.192	.197	.231	.229	1.046
V	.205	.315	.235	.225	.214	1.194
	.973	1.051	.993	1.038	1.017	5.072

Analysis of Variance

Source of Variation	SS	DF	MS	F	
Treatment	.011588	4	.0028970	4.713	*
Replication	.000815	4	.0002038	0.332	NS
Error	.009834	16	.0006146		
Total	.022237	24			

Individ. D.F.	$(\Sigma MT)^2$	$n \Sigma M^2$	MS	F	
ck. vs. treatments	.806	100	.0086	13.1142	**
NH_4^+ vs. NO_3^-	.0081	10	.00081	1.3179	NS

Bullion Fertilizer Trial - Leaf Analysis Data
July 10 collection

ppm PO_4-P

Treatment	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Total
I	885	944	1040	976	1180	5025
II	864	886	886	960	855	4451
III	994	903	808	885	885	4475
IV	758	834	859	1000	960	4411
V	675	893	1140	1070	1010	4788
	4176	4460	4733	4891	4890	23150

Analysis of Variance

Source of Variation	SS	DF	MS	F	
Treatment	57004	4	14251	1.34203	NS
Replication	76270	4	19067	1.79556	NS
Error	169910	16	10619		
Total	[illegible]				

Individ. D.F.	$(\Sigma MT)^2$	$n \Sigma M^2$	MS	F	
Ck. vs. Treat.	624100	100	6241	.5877	NS
NH_4^+ vs. NO_3	329476	10	32948	3.102	NS

% Mg.

Treatment	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Total
I	2.58	1.80	1.56	1.32	1.56	8.82
II	1.80	1.80	1.68	1.65	1.56	8.49
III	1.65	1.50	1.65	1.56	1.65	8.01
IV	2.01	1.77	1.83	1.83	1.80	9.24
V	1.50	1.56	1.26	1.26	1.47	7.05
	9.54	8.43	7.98	7.62	8.04	41.61

Analysis of Variance

Source of Variation	SS	DF	MS	F	
Treatment	.566856	4	0.141714	3.302086	*
Replication	.436896	4	0.109224	2.545035	NS
Error	.686664	16	0.0429165		
Total	1.690416	24			

Individ. D.F.	$(\Sigma MT)^2$	$n \Sigma M^2$	MS	F	
Ck. vs. Treat.	40.4496	100	.4045	9.4253	**
NH_4^+ vs. NO_3^-	.1089	10	.0109	.2540	N.S.

Bullion Fertilizer Trial - Leaf Analysis Data
July 10 collection

% N

Treatment	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Total
I	2.67	2.79	2.99	2.75	3.08	14.28
II	2.42	2.69	2.56	2.60	2.40	12.67
III	2.32	2.29	2.61	2.61	2.67	12.50
IV	2.54	2.70	2.80	3.18	2.72	13.94
V	2.05	2.18	2.52	2.41	2.57	11.73
	12.00	12.65	13.48	13.55	13.44	65.12

Analysis of Variance

Source of Variation	SS	DF	MS	F	
Treatment	.89818	4	.224545	9.8050	**
Replication	.36922	4	.092305	4.0306	*
Error	.36642	16	.022901	—	
Total	1.63382	24	—	—	

Individ. D.F.	$(\Sigma MT)^2$	$n\Sigma M^2$	MS	F	
Ck. vs. treat.	41.8609	100	.41861	18.2791	**
NH_4^+ vs. NO_3^-	2.5921	10	.25921	11.3187	**

% K

Treatment	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Total
I	1.05	1.35	1.65	1.75	1.55	7.35
II	1.05	1.15	1.15	1.50	1.50	6.35
III	1.10	1.00	1.45	1.55	1.50	6.60
IV	1.05	1.15	1.30	1.55	1.65	6.70
V	0.90	1.00	1.40	1.60	1.35	6.25
	5.15	5.65	6.95	7.95	7.55	33.25

Analysis of Variance

Source of Variation	SS	DF	MS	F	
Treatment	.1490	4	.037250	3.3483	*
Replication	1.1680	4	.292000	26.2472	**
Error	.1780	16	.011125		
Total	1.4950	24			

Individ. D.F.	$(\Sigma MT)^2$	$n\Sigma M^2$	MS	F	
Check vs. treat.	4.00	100	.0400	3.5965	NS
NH_4^+ vs. NO_3	1.00	10	.100	8.9887	**

Bullion Fertilizer Trial - Leaf Analysis Data
July 10 collection

ppm NO_3-N

Treatment	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Total
I	453	402	466	460	937	2718
II	525	376	453	680	320	2354
III	156	136	491	316	497	1596
IV	463	402	1020	1370	491	3746
V	169	171	417	413	384	1554
	1766	1487	2847	3239	2629	11968

Analysis of Variance

Source of Variation	SS	DF	MS	F	
Treatment	655376.7	4	163844.18	3.48419	*
Replication	438298.3	4	109574.58	2.33013	NS
Error	752400.1	16	47025.01		
Total	1846075.1	24			

Individ. D.F.	$(\Sigma MT)^2$	$n\Sigma M^2$	MS	F	
Ck. vs. treats.	17623204	100	1762320	3.7476	NS
NH_4^+ vs. NO_3	132496	10	13250	.2818	NS

Bullion Fertilizer Trial - Leaf Analysis Data
1957 Crop

Boron, (collected 7/10).

T\R	1	2	3	Tt
I	58	52	58	168
II	39	54	53	146
III	75	56	63	194
IV	42	48	46	136
V	42	68	55	165
Tr	256	278	275	809

Boron, (collected 9/10).

T\R	1	2	3	Tt
I	54	43	45	142
II	33	41	38	112
III	64	63	57	184
IV	45	42	47	134
V	57	76	61	194
Tr	253	265	248	766

Analysis of Variance: Boron: 7/10

Source of Variation	SS	DF	MS	F	
Treatments	666.9	4	166.72	2.0547	NS
Replications	56.9	2	28.45	1	NS
Error	649.1	8	81.14		
Total	1,372.9	14			

Analysis of Variance: Boron: 9/10

Treatments	1,601.59	4	400.397	10.240	**
Replications	30.53	2	15.265	1	NS
Error	312.81	8	39.101		
Total	1,944.93	14			

Individ. D.F.	$(\sum MT)^2$	$n \sum M^2$	MS	F	
7/10					
check vs. others	256.	60	4.267	1	NS
I vs II	484.	6	80.667	1	NS
9/10					
check vs. others	41,616.	60	693.600	17.780	**
I vs II	900.	6	150.000	3.836	NS

Bullion Fertiliser Trial - Leaf Analysis Data
1957 Crop

Iron, (collected 7/10).

T\R	1	2	3	Tt.
I	300	200	220	720
II	255	160	220	635
III	200	255	145	600
IV	230	150	140	520
V	160	200	180	540
Tr	1145	965	905	3015

Iron, (collected 9/10).

T\R	1	2	3	Tt.
I	310	260	195	765
II	120	150	130	400
III	135	180	175	490
IV	385	140	140	665
V	55	365	240	660
Tr	1005	1095	880	2980

Analysis of Variance: Fe: 7/10

Source of Variation	SS	DF	MS	F	
Treatments	8,526.67	4	2,131.67	1.0845	NS
Replications	6,210.00	2	3,105.00	1.5798	NS
Error	15,724.00	8	1,965.50		
Total	30,460.00	14			

Analysis of Variance: Fe: 9/10

Source of Variation	SS	DF	MS	F	
Treatments	29,023.34	4	7,255.83	1	NS
Replications	4,663.34	2	2,331.67	1	NS
Error	92,336.66	8	11,542.08		
Total	126,023.34	14			

Individ. D.F.	$(\Sigma MT)^2$	$n\Sigma M^2$	MS	F	
7/10					
check vs. others	99,225.	60	1,653.750	1	NS
I vs. II	7,225.	6	1,204.167	1	NS
9/10					
check vs. others	6,400.	60	106.667	1	NS
I vs. II	133,225.	6	22,204.167	1.924	NS

Bullion Fertilizer Trial - Leaf Analysis Data
1957 Crop

Manganese (collected 7/10).

T\R	1	2	3	Tt
I	100	160	160	420
II	165	49	125	339
III	140	85	125	350
IV	92	90	49	231
V	39	42	26	107
Tr	536	426	485	1447

Manganese, (collected 9/10).

T\R	1	2	3	Tt
I	240	175	190	605
II	63	41	36	140
III	55	38	85	178
IV	50	79	28	157
V	26	32	23	81
Tr	434	365	362	1161

Analysis of Variance: Mn: 7/10

Source of Variation	SS	DF	MS	F	
Treatments	19,956.40	4	4,989.10	3.6051	NS
Replications	1,212.14	2	606.07	1	NS
Error	11,071.20	8	1,383.9		
Total	32,239.74	14			

Analysis of Variance: Mn: 9/10

Treatments	57,457.93	4	14,364.48	17.0580	**
Replications	663.60	2	331.20	1	NS
Error	6,736.07	8	842.09		
Total	64,857.60	14			

Individ. D.F.	$(\Sigma MT)^2$	$n \Sigma M^2$	MS	F	
7/10					
check vs. others	620,944.	60	10,349.066	7.4782	*
I vs. II	6,561.	6	1,093.500	1	NS
9/10					
check vs. others	571,536.	60	9,525.600	11.3009	**
I vs. II	216,225.	6	36,037.500	42.750	**

Bullion Fertilizer Trial - Leaf Analysis Data

1957 Crop

Zinc, (collected 7/10).

T\R	1	2	3	Tt
I	9	19	17	45
II	31	31	42	104
III	24	32	8.5	64.5
IV	10.5	30	10.5	51
V	21	42	26	89
Tr	95.5	154	104	353.5

Analysis of Variance: Zinc: 7/10

Source of Variation	SS	DF	MS	F	
Treatments	843.600	4	210.900	4.0489	*
Replications	399.634	2	199.817	3.8361	NS
Error	416.700	8	52.088		
Total	1,759.934	14			

Individ. D.F.	$(\Sigma MT)^2$	$n \Sigma M^2$	MS	F	
7/10					
check vs. others	8,372.25	60	139.5375	2.679	NS
I vs. II	3,481.00	6	580.1667	11.138	**