Report

of

COOPERATIVE HOP BREEDING PROJECT

1933

E. N. Bressman

36

REPORT OF

HOP BREEDING PROJECT

January 1, 1933 to December 31, 1933

By

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Division of Drug

and Related Plants

U.S.D.A.

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Figure I

General view of hop yards in the vicinity of Independence, Oregon, at picking time, 1933.

Table No. 1

WEATHER DATA FOR 1933

Corvallis, Oregon

Furnished By
Soils Department
Oregon State College

Month	Temperature			Total Precipitation
	Mean Maximum	Mean Minimum	Extreme Minimum	
January	44.1	33.9	19	7.93
February	45.9	32.0	11	5.14
March	53.3	35.5	30	4.03
April	63.5	39.6	31	.76
May	60.4	43.7	38	3.70
June	71.3	50.3	44	.84
July	81.9	52.5	45	0
August	82.9	53.6	46	.69
September	68.6	48.6	42	1.68
October	67.5	38.6	24	2.67

INTRODUCTION

This is the third annual report on the project outlined to develop a high quality, high-yielding and mildew-resistant type of hop. This report covers the period from January 1st to December 31st, 1933, and particularly the 1933 crop. All material which may be of value in writing publications or answering inquiries is included so that it will be in handy reference form.

Data on trials that were continued from previous years are included and new studies are also reported. This report includes information on weather conditions during 1933, general observations in regard to hop growing and curing, susceptibility of varieties to mildew, stomatal studies of various varieties, yielding ability of varieties, yield of various seedling plants, effect of x-rays, cover crop trials, hybridization studies, mildew infection, methods of growing seedlings, and studies on the sex character. In addition new material, such as the effect of copper from copper-lime dusting on the soil, fertilizer trials, new types of driers, effect of stripping on growth of the plant, effect of cutting back in the spring, hybrids between hop species, studies of the winter spore, mildew on hop cones, aphis and mold attacks, and methods of planting hops. Also, some of the articles contributed to "The Oregon Hop Grower," a new publication at Mt. Angel, Oregon, and the official publication of the Hop Growers' Association, are included.

Since the last annual report when it was shown that hops had increased up to as high as 28¢ per pound, the price steadily increased

up to as high as 75¢ per pound in June. Since that month the price has fallen somewhat until the general price level during the fall of 1933 was about 40¢ per pound. Naturally this high price of hops and the publicity that went with it caused a large amount of interest in the crop. Hundreds of inquiries from nearly every state in the union have been received in regard to hop growing. In practically all of these cases the inquirer was furnished with Farmers' Bulletin No. 304 and Oregon Station Bulletin No. 288. No one was encouraged to grow hops unless they were well financed, well located, and had some experience in growing the crop. Hop growers' associations also attempted to prohibit the sale of root cuttings. Still there was a considerable increase in the hop acreage. It has been estimated that there was an increase of about 4000 acres in Oregon in 1933, 2500 in California and 1500 acres in Washington. Also there were some indications of a few hundred new acres in New York and possibly a few acres in Wisconsin. Undoubtedly hop growing will spread to some of the former growing territories and possibly some new ones. This whole situation should receive some attention.

The hop breeding program is proceeding as outlined at its beginning only two and a half years ago. Satisfactory progress has been made and many new seedlings of value have been developed. In fact, the point has been reached where it is necessary to make a choice between outstanding seedlings and possibly distribute some to growers for additional tests under various hop growing conditions. Various growers have requested root cuttings of our best seedlings. As yet none have been released. It is hoped that an orderly and

satisfactory method of distributing the new varieties may be worked out.

In spite of lack of laboratory and office space and equipment, it was possible to obtain some outstanding results on the germination of the winter spore of the downy mildew organism. The positive results obtained in this study complete the life history of this organism and give the information needed in regard to the source of infection in the spring. With proper equipment similar work could be done on other phases of the problem. To keep up with the expanding industry and its increasing problems, more funds and time, and office, laboratory and experimental yard space must be furnished. Both our problems and our material are increasing and our funds for taking care of them are shrinking.

Figure II

Three outstanding seedlings 70-11, 70-12, and 70-13 growing in the experimental yard, Corvallis, 1933.

General Observations

In general the 1933 hop growing season was a productive one. In Oregon it has been estimated that the production was between 90,000 and 100,000 bales of hops as compared to about 65,000 bales in 1932. This great increase in yield was due almost entirely to three factors: Better growing conditions, wide use of fertilizers, and less damage from downy mildew. Early in February some growers reported winter damage due to the several cold spells during the winter months. Close examination showed this was true only in a limited number of yards and in particular where the crowns were old and not well protected.

We were surprised to note the growth of seedlings of the Japanese hop as early as February 24 in the experimental yard. These were found in large numbers at the base of Japanese hop plants grown the previous season. Apparently these seeds sprout at a lower temperature than the seeds of the common hop species. The latter were not noted growing in the field until March 7, and all seedlings of the common species appeared more yellow and weakened than the Japanese ones.

The month of March was characterized by cool and wet weather with the exception of a few days. These few days, however, allowed many growers to get into their yards and complete most of the hoeing operations. In general most growers practiced early working in the yard this year and attempted to complete hoeing, at least, during the month of March.

The month of April, on the other hand, was rather dry and cool. Many cases of mildew were reported but no actual mildew was seen until April 12, when scattering spikes were found in various yards. The first actual mildew found in the experimental yard was found on April 24 when one seedling, 19-4, showed four spikes. Later in the week, mildew was prevalent in many places.

May was an unusual month from the standpoint of weather conditions. It was characterized by cool, cloudy, wet weather, and the rainfall was double the normal amount. The moisture was conducive to good growth and apparently it was too cool for mildew spread. This year the month of May found practically all of the yards trained, and many yards were fully a month ahead of their previous year's activities. Mildew was present in practically all yards but as yet not epidemic in nature. Growers were hoping for better growing conditions and if it got warmer that it would also get drier and not develop into typical mildew weather.

The month of June was cool and wet. Beginning on June 21 there was the first real mildew spread. For the entire period until the end of the month there were some serious losses. In fact, Mr. Walker, President of the First National Bank at Independence, Oregon, estimated that there was a loss of 10,000 bales valued at $1,000,000 in the Independence district alone during this period. This loss was due chiefly to the spiking of arms and putting them out of production.

Hop yards in California were inspected during one week of the month of June. Much was learned about the hop production practices in that section. Yards in the three chief districts, Mendocino,

Sonoma, and Sacramento, were inspected. Various hop growers and state officials were interviewed in regard to hop growing conditions and the possibilities of the downy mildew disease in that section. In general, no mildew was found in California and at that particular time they had no other hop troubles. The hops were in excellent condition and baby hops planted in February were up to the wire by the middle of June. It was estimated that their crop on babies would be at least 1000 pounds per acre during the first year of growth. Later reports, particularly from the Hearst Company, stated that their baby crop at Sacramento yielded 12.6 bales per acre. This indicates the enormous production possibilities on good soil in that section.

The entire month of July was hot and dry and the downy mildew organism passed out of the picture. Estimates on the crop were increased and the pessimists of June turned to optimists in July. Practically all growers sprayed their yards for aphids this month. Two types of sprays, Black-Leaf 40 and Quassia, were used. Our experimental yard was sprayed on July 14 and 15, using chiefly Black-Leaf 40 and a spreader of the fish oil-resin type.

Some cool and moist weather in August, together with the green vigorous growth of the hop vine gave conditions that were suitable for another aphis attack. Most growers neglected this condition and paid for it rather heavily at the end of the picking season when mold became prevalent. The picking season was characterized by some extremely cool, wet weather and the quality of the hops, particularly toward the end of the picking season, was rather poor due to discolor-

ation and mold. The importance of spraying or dusting for aphids late in August or just ahead of picking was emphasized this season. Another thing noted by most growers was the importance of carefully watching the trellises for weaknesses as the crop developed. Several yards fell down and some losses were obtained.

The picking season for early hops began the week of August 21 and was terminated by the first of September. The picking of late hops began generally on September 4 and continued three weeks until September 25, when the last late hops were picked. The last week or ten days of picking was done chiefly by the larger growers and they obtained most of the losses due to inferior quality.

Individual plants in the experimental yard were picked as they matured, particularly the outstanding ones. The varietal trials and remaining plants were picked during the last days of August and the first of September by pickers furnished by the Seavey Hop Company. The hops were delivered to the kilns of the above named company about two miles distant. Appropriate samples for shrinkage tests were dried on the experimental kiln at the College. A total of 9,178 pounds of green hops were picked in the experimental yard.

The price of picking hops was generally $1.00 per hundred at the beginning of the season. This was raised to $1.50 per hundred as strikes and difficulties occurred in the yards toward the end of the season. Apparently growers would be much better off if they would use the bonus system, allowing pickers who stayed throughout the season a higher price than those who quit or changed about.

More than in previous seasons growers were interested in cutting down the vines after picking, removing them and burning them and getting the yards in shape with a cover crop. In general good practices such as green manuring, replanting missing hills in the fall, and removing vines with mildew infection are becoming more prevalent. It is hoped that this is the result of much persuasion on the part of experimentalists.

Figure III

A general view of the Seavey hop yard at Corvallis, Oregon.

Figure IV

Another view of the Seavey hop yard at Corvallis, Oregon, 1933. In the foreground note pickers' baskets, weather recording apparatus, and Ford truck used in hop breeding work.

GERMINATION OF OOSPORES OF DOWNY MILDEW OF HOPS

The downy mildew of hops organism is characterized by both summer and winter spores. Thelatter are termed oospores and their importance has not been clearly shown.

It was the general idea that the winter spore was the means by which the organism lived over the winter and was ready to infect hops after the latter began to grow in the spring. Very little success, however, has been obtained in germination trials with this spore. Fortunately, the writer had material collected in the fall of 1930 from the Horst yard near Independence, Oregon. Germination studies of this material showed that the spore germinates readily under proper conditions, and possibly if it is of the proper age.

Undoubtedly this work completes the study of the life history of this organism and is of importance in all studies of this disease. Because of the importance of this contribution, the results were published immediately and they are given in the following manuscript which was published in "Phytopathology" for the month of May, 1933.

GERMINATION OF THE OOSPORES OF PSEUDOPERONOSPORA HUMULI (MIY. AND TAK.)

Prompt germination of the oospores of the hop disease, downy mildew, Pseudoperonospora Humuli (Miy. and Tak), and infection of hop seedlings with inoculum was obtained in connection with trials to determine the disease resistance of new hop varieties. The only other report of oospore germination was made by Arens.[1] His results are substantiated by those reported herein and the importance of the oospore in the study of this destructive disease is established.

Mildew-infected leaves full of oospores, obtained two years before, in the fall of 1930 and kept as dry herbarium specimens in the laboratory, were finely ground with a mortar and pestle. The method of germination suggested by Hiura[2] was used. Briefly, the method was as follows: Moist layers of cotton were placed in the upper and lower halves of petri dishes and a layer of absorbent paper was crumpled to give a corrugated effect on the lower layer of cotton. A small quantity of the powdered leaf was sprinkled on this paper. The contents of the dish were kept moistened and the dishes in all these trials were kept at room temperatures, about 20 degrees C. Germination was also obtained by soaking the mildew-infected leaves in water for several days.

The work began on December 20, 1932, and numerous trials were undertaken and observations were made several times each day. In a microscopic preparation made from a culture handled in the first method described and prepared at 11 A.M. on December 27, there was evidence of germination at

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1. Arens, K. Untersuchungen uber Pseudoperonospora Humuli (Miyabe u. Takah.), den Erreger der neuen Hopfenkrankheit. Phytopath. Zeits. Band I, Heft 2, pp. 169-93. 1929.
2. Hiura, Makato. A Simple Method for the Germination of Oospores of Sclerospora Graminicola. Sci. Vol. LXXII, No. 1856. p. 95. July 25, 1930.

9:30 P.M. on the next day, December 28. Two sporangia had formed and were emitting zoospores, but in the last stages, for the zoospores were moving about feebly and soon rounded up. Most of the zoospores had already escaped, for only seven swimming spores were observed to come from one of the sporangia and eight from the other. Immediately six young Late Cluster seedlings growing in the greenhouse were inoculated with this zoospore material. On the first day of January, 1933, there was evidence of conidiophores on four of the seedlings, and on the second of January there was unmistakable evidence of mildew infection.

On January 1 some evidence of zoospore formation was found in the leaf material which had been soaking in water. Eight seedlings of the Fuggles variety were inoculated on this date and on January 4 all of the seedlings were found heavily infected with downy mildew. The seedlings died from the effects of the mildew within a few days.

In subsequent work an excellent section of tissue containing numerous oospores was found in the leaf material soaking in water. Germination was plainly observed in these cases. The oospores germinated by means of a germ tube, perhaps twice the diameter of the oospore in length, which rounded up at its outer extremity into a sporangium similar to the conidia formed in the summer. Germination of this sporangium by zoospores was hastened by slightly warming the glass slide with a lighted match. It was difficult to obtain exact accounts, but more than 30 swimming spores emerged from each of the sporangia. Eight seedlings of the Fuggles variety were inoculated with this material on January 18, and on January 21 all of them showed unmistakable mildew infection.

Measurements showed that the oospores were approximately 30 μ in diameter. The sporangia measured about 26 x 31 μ. The zoospores were bean-shaped and were from 5 to 7 μ in size. The zoospores, after swimming around briskly for about 20 minutes at room temperatures, rounded up and came to rest.

Knowledge of oospore germination is not only of value in studying the life history of the fungus but also in controlling the disease. Also, it has been necessary to carry the inoculum on live plants, as this disease is an obligate parasite. Now the problem of carrying the disease for laboratory and greenhouse study is simplified. For example, the plant breeder may collect oospore material in the fall, germinate the spores when he chooses, and inoculate hop plants. Whether newly formed oospores must go through a dormant period before they are capable of germination is not known at present. The two-year-old material used in these trials, however, germinated promptly. Additional studies are being conducted.[3]

Oregon State Agricultural College
and U. S. Department of Agriculture.

E. N. Bressman
and
R. A. Nichols

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3. Published as Technical Paper No. 192 with the approval of the Director of the Oregon Agricultural Experiment Station.

INOCULATING HOP PLANTS WITH DOWNY MILDEW BY MEANS OF A HYPODERMIC NEEDLE

Arms of hop plants have been successfully inoculated with downy mildew by means of a hypodermic needle in trials conducted at Corvallis, Oregon, during the summer of 1933. This method of inoculation is not only more direct and positive than methods formerly employed but also gives typical reactions in a shorter length of time. In addition, the method gives information which may help to determine the nature of resistance in resistant varieties of hops.

Heretofore, spore suspensions of inoculum of the downy mildew organism have been sprayed on the under side of hop leaves. In susceptible varieties infection could be obtained if environmental conditions were correct. During the hot, dry days of the summer, however, inoculations by this method have not been successful. The use of the hypodermic needle, therefore, was attempted. This method of inoculation, as far as the writer knows, has never been reported on this important and destructive disease. Typical "spikes" have been obtained within forty-eight hours after the inoculum has been injected into the vine.

The vines of the hop plant are hollow and afford a good chamber for injecting the spore suspension. Hypodermic needles of various sizes have been employed. Chambers holding as much as 20 cc. of inoculum have been used with good success, and small chambers holding as much as 1 cc. have also been used. In general, the method has consisted of piercing a small hole with the needle at the upper end of an internode to allow air to escape and then injecting as much inoculum as the stem would hold. The holes were immediately sealed with Duco

Household Cement. However, this is not necessary. The method is well illustrated in the accompanying illustration.

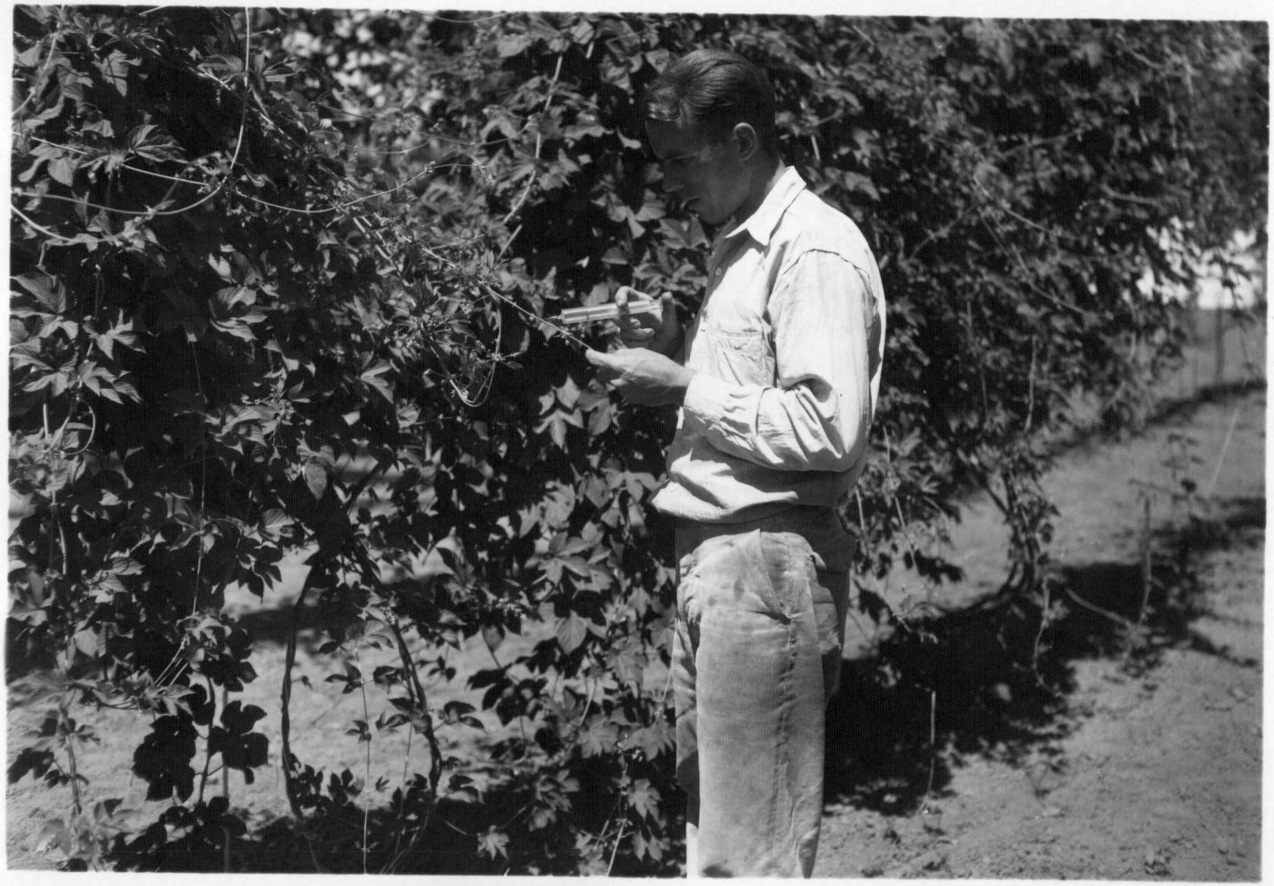
This method insures favorable conditions for the spore suspensions until the zoospores have penetrated the tissue. Inside the young stems there is considerable moisture and the inoculum is protected from the evaporation which occurs quickly on a hot day.

The writer is of the opinion that this method will not only give direct results but extend the period of inoculating plants. Also, it gives some indications as to the type of resistance in resistant varieties. From the limited results obtained this year, there is indication that resistance is physiologic rather than morphologic and that entrance is more than likely gained by the organism even in resistant varieties.

The value of this method was discovered too late in the growing season to be thoroughly tested. Conditions unfavorable to mildew developed soon after the method was employed. The writer hopes to test the method in a large way next season and publish the results, if any.

Figure V

The hypodermic needle injection method of inoculating hop plants with the downy mildew organism. This method was developed by the writer in 1933.



INTRODUCTION OF FOREIGN HOP VARIETIES

Some new foreign varieties were obtained this year, but unfortunately not as many as the writer desired. Two shipments were received in Washington, D. C. in such bad condition that they were not even forwarded to Corvallis. These shipments were from Mr. Petricsek of Jugoslovakia and from Professor Cursi of Italy.

Three shipments, however, were received in fair condition. These shipments are listed herein. The first was from the director of the Central Station of Plant Pathology at Versailles, France. The shipment received from him was as follows:

10 roots	Hops - Alsace Urbamm	FPI No.	102849
10 "	" - Burgunder (Simon)	" "	102850
10 "	" - Landhopfen (Simon)	" "	102851
10 "	" - Semling (Saimon)	" "	102852
10 "	" - Semling (Urbamm)	" "	102853
10 "	" - Spelt (Urbamm)	" "	102854
10 "	" - Spelter (Rohmer)	" "	102855
10 "	" - Spelter (Simon)	" "	102856
7 "	" - Tigo blanche (Jagger)	" "	102857
1 "	" - Verte (Jagger)	" "	102858

From J. Binder & Company, Neufelden, Austria, two varieties were received as follow:

7 roots	Hops - Auschaer Rote	FPI No.	102749
6 roots	Hops - Kuhlvirtler grune	" "	102750

From Dr. Ing. Ctibor Blattny of the Institution of Phytopathology at Pregue, Czechoslovakia, 25 roots were received as follow:

25 sets (roots) Early green hop from Duba FPI No. 102908

The roots from France were in excellent condition, and practically all of them survived. All of the roots from Austria died and but part of the shipment from Czechoslovakia was saved. The plants, however, that survived did fine and most of them reached the wire and some

produced a few single hops.

Of course, the hops that were received in previous years, and grew, made additional strides this year. Practically all of the foreign hops, however, do not arm out as well as the cluster type and in addition seem to produce single cones rather than clusters. None of them appear to be much worth while from the standpoint of yield, but some of them have mildew resistance. The yields of those hops which produced this year is given in an accompanying table.

The work of introducing new hop varieties has been done through Mr. Knowles A. Ryerson, Principal Horticulturist in Charge of the Division of Foreign Plant Introduction of the United States Department of Agriculture at Washington, D. C. Mr. Ryerson has been very helpful in all of this work.

Parts of letters from Mr. Ryerson are of information and are included. On January 30 he wrote as follows: "Dr. Vavilov has been here in Washington for a few days, and sails tomorrow on his return. I took up with him again the matter of obtaining hops from Russian investigators, and he will follow it up in Russia when he returns. We have already written to the Head of the Department of New Cultures and Introduction, U. S. S. R. Institute of Plant Industry, Leningrad, in regard to obtaining material from Dr. Archangelsky at the Plant Breeding Station, Moscow.

"We have also written to J. Bindor & Company, Neufeldon, Germany, requesting that he send us another shipment of the two varieties which he sent last spring, as well as material of any other resistant varieties he may be growing."

In regard to the shipment from Italy, Mr. Ryerson wrote on March 3 as follows: "We received a shipment of three varieties of hops--Saaz, Spalt, and Alsaziana--from Prof. Mario Curzi, Station for Plant Pathology, Rome, Italy. Unfortunately, the cuttings were all dead on arrival. I am asking Prof. Curzi to duplicate the shipment and I trust we may be able to get living material of these varieties for your work."

On March 14, Mr. Ryerson sent the following in regard to the shipment from France: "I have just received a letter from the Central Pathology Station at Versailles stating that they will send us cuttings of the varieties we asked for in accordance with your request. At the same time they ask that these varieties be compared with known named varieties in your collection so that if any of them are the same as other varieties under a different name the matter can be straightened out. Apparently they are not sure of the nomenclature and think that a comparison from here may help. These cuttings will be sent along in April and we will forward them to you as soon as they are received."

On July 26 Mr. Ryerson wrote as follows: "We have finally received a shipment of root cuttings of hops from Mr. Petricek, Chief of the Cooperative Hop Society, Zalec, Yugoslavia, but they were all dead when they arrived at the Inspection House. I am very sorry, as we have been endeavoring to get this material over a long period of time; in fact, we took it up through the Yugoslavia Legation here last fall. I don't believe they are very anxious for us to have this material anyway, but we will try to get another lot of cuttings."

HYBRIDS MADE IN 1933

Time and funds in 1933 did not permit the making of as many hybrids under controlled conditions as were made in the previous season. In 1932 more than fifty different hybrids between outstanding male and female plants were made. Because several seeds were obtained in each case it was not necessary to duplicate many of these hybrids in 1933. This season, however, about 20 hybrids between various males and female plants were made.

Similarly to last year, two methods of hybridization were used. In the first case, the most sought after hybrids were carried out by means of covering the female plants from the wire to the ground with large bags made of sheeting. At the proper time the arms bearing shedding pollen were introduced under these sacks. In most every case several seeds were developed and the methods were satisfactory.

In cases where just a few seeds were desired, special arms of female plants were covered with glassine bags and the pollen material introduced at the proper time. In some cases where plants were developing both flowers the arms were covered with glassine bags so that the female flowers would be selfed. Several seeds, particularly on neuter plants which exhibited both sexes, were obtained.

Practically all of this seed was planted in greenhouse flats in September. Seeds obtained from this method last year were grown the previous season and many of the resulting seedlings were set out in the experimental yard in the spring of 1932. Many of these made a fair growth and practically all of them should bear hops in 1934.

Illustrations of these bags and methods of making hybrids are shown in the accompanying pictures and the data on the hybrids are given in the accompanying table.

Table No____

Crosses Made in 1933

Corvallis, Oregon

Female - Male	Female - Male	Female - Male
Semseh x 15-31	27-27 x 32-32	18-26 x 15-31
Semseh x 15-31	16-24 x 18-32	16-11 x 15-31
Klnasser x 15-31	15-12 x 13-12	16-10 x 15-31
Klnasser x 15-31	36-7 x 36-3	17-6 x 8-31
Spalter x 15-31	36-8 x 36-3	17-6 x 15-31
Spalter x 15-31	36-7 x 22-7	21-6 x 15-31

Figure VI

This illustration shows three different female plants bagged so as specific hybrids can be made between these female plants and certain males. Also note the excellent condition of the yard. The ground on the left has just been worked with a planker.

SPECIES HYBRIDS

Preliminary trials have shown that the hop species Humulus japonicus is highly resistant to the downy mildew disease. In fact, the writer has only seen a few small mildew flecks on plants of this species, even though they have been heavily inoculated with the organism. It was hoped that this mildew resistance would be carried by some seedlings that were segregates of hybrids between the Japanese and common species of hops. In the experimental yard, therefore, in 1932 hybrids were made between these two species, using the Japanese hop as the female parent. Seedlings from this hop were grown in the greenhouse in the winter of 1932-33, and transferred out of doors in the spring of 1933.

Many of these seedlings were grown to maturity in 1933, and both male and female plants were obtained. In general, practically all of the plants looked much like the female parent. The striking difference was in the maturity of them this year as compared to last year. In 1932 practically all of the plants of the Japanese species matured along with the Late Cluster variety of hops. This year the supposedly hybrids between the two species did not mature until at least two months later. They were still green the latter part of October when cut to harvest seed for the next generation.

It is hoped that the next generation will show more of the characteristics of the common hop variety. At any rate, the attempt will be made to continue to grow seedlings of the Japanese hop, and if possible to obtain hybrids.

In 1933 the following hills in the experimental yard contained plants which were hybrids between the two species:

Table No. ___

Hybrids - H. japonicus x H. lupulus

Experimental Yard
Corvallis - 1933

Plant No.	Sex	Remarks
1 - 4	Female	Vigorous and late
1 - 5	"	" " "
2 - 3	"	" " "
2 - 7	Male	Eliminated
19 - 2	Female	Medium
23 - 4	"	Vigorous and late
23 - 5	Male	Eliminated
24 - 31	"	Vigorous
24 - 33	"	"
0 - 34	Female	Small and dark
1 - 34	"	" " light
91 - 27	Male	Eliminated
91 - 30	"	"
98 - 29	"	"
100 - 14	Female	Small and medium early
102 - 6	"	Vigorous and very late

It is not believed that hybrids from these two species will yield segregates that will be of commercial value, but possibly if resistant segregates can be obtained, they may be used as parents in subsequent breeding trials. The Japanese species has some characteristics of value and others not so valuable. It is an annual plant that has no resin in the cone. As yet, no information has been

obtained as to whether or not these segregates are annual or perennial, and none of the hop cones have shown any apparent resin. Many segregates should be obtained in the next generation, andthese should yield plants of interest and value.

Figure VII

The two hop plants in the left center of the illustration are hybrids between the two hop species Humulus japonicus X Humulus lupulus. This is the first generation hybrid, Corvallis, 1933.

OUTSTANDING HOP SEEDLINGS

It is beyond the scope of this report to describe each plant that was grown during the year. Notes, however, were taken on each plant and are included in the field books. Fifty of the outstanding plants, both from the standpoint of economic value and uniqueness, are listed. Ordinarily visitors were shown this group of plants together with others that might be observed as one journeyed about the yard.

The following table gives information in regard to plant numbers, sex and remarks of some of these plants.

Table No____

Outstanding Seedlings in Experimental Yard

Corvallis, 1933

Plant No.	Sex	Remarks
2-30	Female	Mildew resistant and vigorous
3-33	Female	Mildew resistant and vigorous
4-33	Female	Mildew resistant and vigorous
6-33	Female	Mildew resistant and vigorous
15-31	Male	Vigorous and early (June 1st)
16-31	Female	Unusual vine type
36-31	Female	Vigorous but very late
46-29	Female	Many hops, few leaves and vine
49-28	Female	Exceptionally vigorous
51-31	Female	Vigorous but late
56-28	Female	High yielding Fuggles type
60-32	Neuter	From seed
61-28	Female	Peculiar leaf
62-27	Female	High yielding and resistant
63-31	Female	Excellent growth
65-13	Female	Ligh colored cones
77-29	Female	Excellent growth
86-28	Female	Excellent growth
84-3	Female	Light colored cones
53-9	Female	Good growth
53-10	Female	Vigorous
46-4	Female	Vigorous
46-5	Female	Vigorous

Plant No.	Sex	Remarks
43-5	Female	Vigorous
40-4	Female	Vigorous
38-7	Female	Vigorous
36-8	Female	Vigorous
33-7	Female	Vigorous Fuggles type
30-8	Female	Peculiar cones
24-7	Female	Red cones
22-7	Male	Early and vigorous
21-7	Female	Peculiarly stripod
21-6	Female	High yielding
44-24	Female	Red cones
55-31	Female	Good yield, red cones
64-27	Female	Reverting to male
93-18	Female	Dark glossy green cones
99-17	Female	Peculiar fruit and leaves
17-31	Female	Peculiar type
73-8	Female	Peculiar cones and arms
55-13	Female	Light colored cones
41-31	Female	Excellent yield and cones
44-30	Female	Fuggles type but long armed
60-29	Female	Good yields
73-12	Female	Light colored, excellent yields
72-11	Female	Excellent pointed cones
98-12	Female	Vigorous, resistant
32-31	Female	Resistant type
28-13	Female	Resistant type
20-12	Female	Excellent grower

Table No. ___

Seedlings Picked and Weighed
For Analysis

Corvallis, 1933

Plant No.	Parentage	Green Weight	Dry Weight
62 - 27	L. C. - Unknown	2.5	.6
53 - 9	F. - Ross Wood	5.0	1.2
36 - 7	F. - Ross Wood	8.0	2.0
53 - 10	F. - Murphy	7.5	1.8
36 - 8	F. - Murphy	4.0	1.0
20 - 31	R. V. - Werline	3.5	.8
19 - 33	C. S. C.	6.0	1.5
30 - 8	L. C. - Linn & Linn	5.0	1.3
73 - 11	F. - Gil Benson	2.5	.7
56 - 28	F. - Ross Wood	4.0	1.2
43 - 5	Cal.	14.5	3.5
49 - 28	F. - McLaughlin	6.0	1.7
63 - 31	E. K. - Golding	3.0	1.0
43 - 22	F. - Needham	3.5	1.2
38 - 7	F. - Murphy	3.0	.8
72 - 11	E. C. - Linn & Linn	6.0	1.5
73 - 12	F. - Romeo Goullet	4.5	1.7
70 - 13	E. C. - McCarthy	3.0	.8
2 - 30	F. x L. C.	10.0	2.1
2 - 33	F. x L. C.	10.5	2.9

Figure VIII

A leading hop grower and dealer stated that this was the finest hop that he had seen in over 40 years of hop growing experience. This is a seedling developed by the writer.

Figure IX

Another view of the above outstanding hop seedling.

Experimental yard, Corvallis, 1933.

Figure X

Several outstanding seedlings in one portion of the experimental yard, Corvallis, 1933.

INDIVIDUAL PLANT SELECTIONS

In the fall of 1930, certain individual plants were staked in grower's yards because of their apparent mildew resistance or exceptional vigor. In the spring of 1931, root cuttings were obtained from these plants and transferred to the experimental yard which was established that spring. For the past three years, certain of these individual plants have been harvested separately for information on yielding ability and samples have been tested for resin value. These plants were from various varieties including Late Cluster, Early Cluster, Fuggles, Red Vine and German Grape. This year, also, some individual plants of two foreign varieties obtained from Germany were included.

The accompanying tables give information on the yielding ability of these plants in 1933. The first table following gives the green weight and dry weights of the plants this year.

The second table gives the plant number, parentage and 1930-31-32 and average weights of plants that have been harvested separately for the three seasons.

The yielding ability of these plants is of interest. As a three year average the Clusters types yield almost the same. The German Grape plants have the highest average yields. The two plants of Red Vines average nearly the same, and also do the Fuggles which are the lowest in yielding ability. Samples of all of the plants listed have been forwarded to Washington, D. C. for resin tests this season. Resin values in 1931 and 1932 are given in a separate portion of this report.

Table No____

Weights of Individual Plants

Experimental Yard

1933

Plant No.	Parentage	Green Weight	Dry Weight
6-3	Late Cluster	10.5	2.5
6-4	Late Cluster	11.0	2.7
8-10	Early Cluster	11.5	2.9
8-13	Early Cluster	14.0	3.5
11-6	Fuggles	12.0	3.0
12-2	Fuggles	9.0	2.3
14-4	Red Vine	8.5	2.1
15-6	Red Vine	9.5	2.4
17-7	German Grape	11.5	2.9
17-8	German Grape	14.0	3.5
Spalter	Spalter	2.5	.8
Elsasser	Elsasser	3.0	.9

Table No____

Dry Weights of Individual Plants in Experimental Yard

1931, 1932, 1933

Plot No.	Parentage	1930 wt.	1931 wt.	1933 wt.	Average
6-3	Late Cluster	1.6	1.8	2.5	2.0
6-4	Late Cluster	1.3	2.2	2.7	2.1
8-10	Early Cluster	.9	2.1	2.9	2.0
8-12	Early Cluster	.25	2.5	3.5	2.1
11-6	Fuggles	.05	.9	3.0	1.5
12-2	Fuggles	.1	.9	2.3	1.1
14-4	Red Vine	.8	1.8	2.1	1.6
15-6	Red Vine	.5	2.0	2.4	1.6
17-7	German Grape	1.3	2.25	2.9	2.2
17-8	German Grape	1.2	3.1	3.5	2.6

VARIETAL TRIALS WITH HOPS SET OUT IN 1931

In 1931 a varietal trial, including the three chief varieties of hops, Late Clusters, Early Clusters, and Fuggles was initiated in the experimental yard. Yields have been obtained for the 1931, 1932, and 1933 seasons. In general, the method of planting and the plat lay-out were described in the 1931 report. This year all 48 hills of the three row plats, which were made up of 16 hills each, were harvested. Inasmuch as these hills are set 8 feet apart each way and this method of planting gives 680 hills per acre, the plats are 1/14th of an acre in size.

The hops from each row of each of the plats were picked separately, and accurately weighed. The green weights were recorded in each case and representative samples of each plat were dried to obtain the shrinkage. These shrinkage tests are recorded in another section of this report. In general, 100 pounds of Late Clusters dried down to 23.3 pounds, 100 pounds of Early Clusters down to 24.5 pounds, and 100 pounds of Fuggles down to 26.6 pounds. The green weights were converted to dry weights per acre on this basis.

This year the Early Clusters yielded the most dry hops by 5 pounds per acre. In other words, the difference between the Early Clusters and Late Clusters was not significant. Early Clusters yielded as an average of two plots, 2,262 pounds of dry hops per acre, and Late Clusters, 2,257 pounds per acre. The Fuggles variety was a poor third, but still gave an excellent yield for that variety, 2,028 pounds per acre. In other words, all three of these varieties averaged over a ton of dry hops per acre, which is excellent for three year old hops.

The three year averages for the three varieties are as follows:

Late Clusters	1,230 pounds
Early Clusters	1,121 pounds
Fuggles	815 pounds

These figures indicate that the Fuggles variety is slow in coming to full production, and that the production of this variety lags behind.

Attention is called to what is reported as missing hills in the tables which follow. In general, there were 27 missing hills out of the 288 hills in trial. There were 17 of these in the Early Clusters variety, indicating that that variety does not maintain a stand as well as the other two. Apparently much of this reduction of stand in the Early Clusters is due to heavy attacks of downy mildew the previous season. The missing hills in fact are not really missing because they were all replanted with root cuttings this spring and grew vines, but not enough hops to pick. The yields, however, were computed on a perfect stand basis.

Details of the results this year and the average yields for the three year period are given in the following tables. Attention is called to the discussion of the results obtained in the trials set out in 1932. These results are given in the next section of this report.

Comparative Yields per Acre
Three Hop Varieties
Set out - 1931
Corvallis

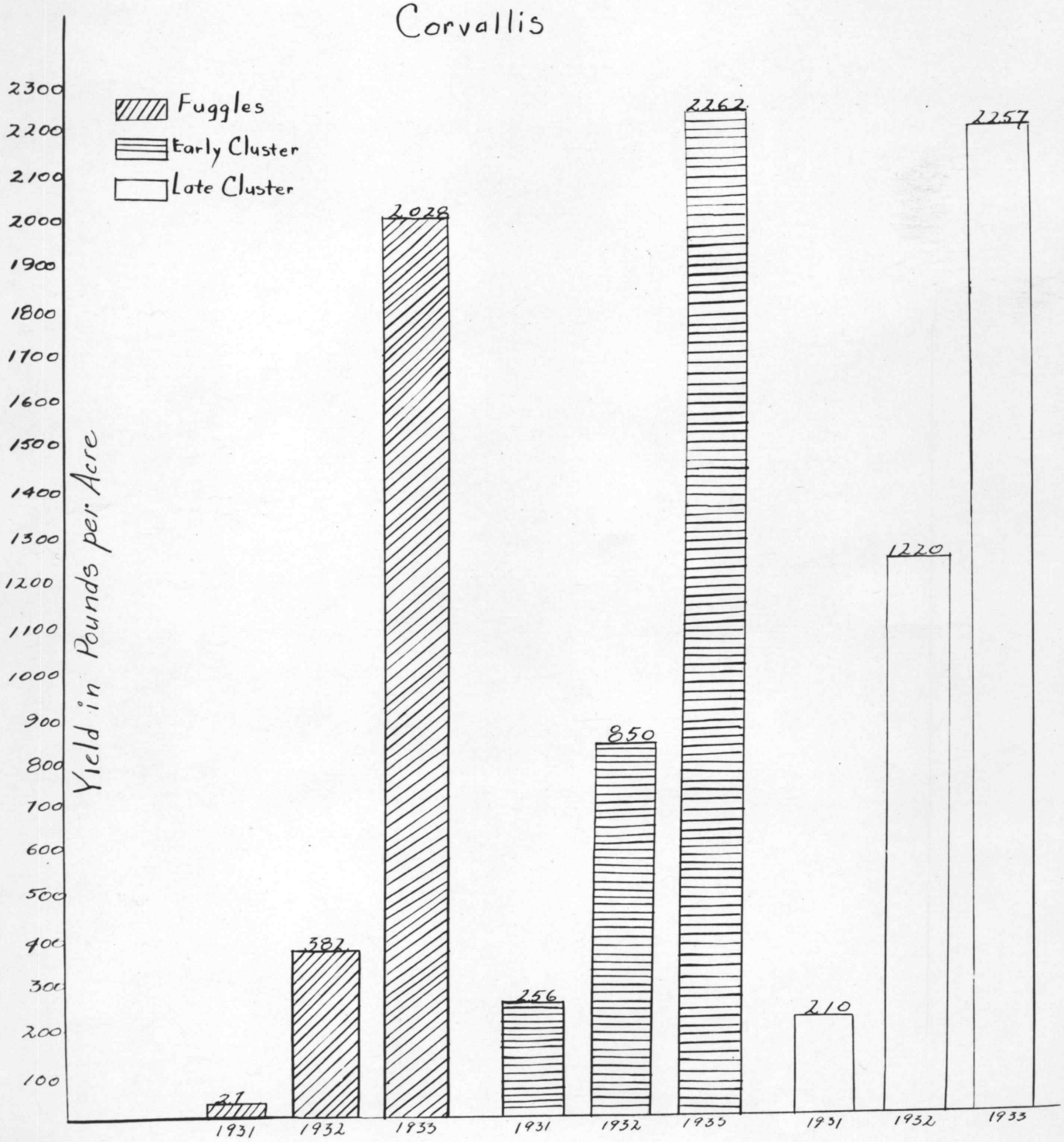


Table No
Hop Variety Trials
3-row plots - 16 hills per row
Yields in pounds
Trial began 1931
Corvallis - 1933

Row No.	Variety	Green Weight	Missing Hills	Corrected Weight	Dry * Weight	Yield per acre
1	Late Clusters	219.5	0	219.5	51.1	2146
2	Late Clusters	226.5	1	241.6	56.3	2365
3	Late Clusters	205.0	1	218.7	51.0	2142
4	Early Clusters	170.0	2	194.2	47.1	1978
5	Early Clusters	170.0	2	194.2	47.1	1978
6	Early Clusters	186.0	2	212.4	52.1	2188
7	Fuggles	185.0	0	185.0	49.2	2066
8	Fuggles	146.0	2	166.8	44.4	1865
9	Fuggles	160.0	0	160.	42.6	1789
10	Late Clusters	205.0	1	218.6	50.9	2138
11	Late Clusters	224.0	0	224.0	52.2	2192
12	Late Clusters	245.0	1	261.3	60.9	2558
13	Early Clusters	197.0	4	262.6	64.3	2701
14	Early Clusters	209.0	2	238.8	58.5	2457
15	Early Clusters	152.0	5	221.0	54.1	2272
16	Fuggles	174.0	1	185.6	49.4	2075
17	Fuggles	191.0	0	191.0	50.8	2134
18	Fuggles	163.0	3	200.5	53.3	2239

*Fuggles = 100# dry to 26.6#

E. C. = 100# dry to 24.5#

L. C. = 100# dry to 23.3

Table No.

COMPARATIVE YIELDS OF THREE VARIETIES OF HOPS SET OUT 1931
1931 Yield, 1932 Yield, 1933 Yield and 3-Year Averages

Yields in Pounds Per Acre
Duplicate Plats - 1/14 Acre

Corvallis, 1933.

Variety	1931 Average	1932 Average	1933 Yields			3-Year Average
			Plot 1	Plot 2	Average	
Late Clusters	210	1,222	2,218	2,296	2,257	1,230
Early Clusters	256	845	2,048	2,477	2,262	1,121
Fuggles	27	390	1,907	2,149	2,028	815

Figure XI

A general view of the experimental yard at Corvallis, Oregon in June 1933.

This shows the variety trials after first training on the wire.

VARIETAL TRIALS WITH HOPS SET OUT IN 1932

As explained in last year's report, an additional variety trial of two duplicate plots of each of the three chief varieties of hops, Late Clusters, Early Clusters, and Fuggles, were set out in 1932 to supplement those set out in 1931. Yields were taken on these hops in 1932 but the yield was practically negligible. The varieties yielded in the order named above giving 44, 9, and 2 pounds per acre, respectively.

This year these hops were picked and handled as explained in the varietal trials set out in 1931 in the previous pages. Green weights were obtained on each row and the yields were on a dry weight per acre basis.

The yields this year for an average of the duplicate plots were as follow:

Late Clusters	1,197 pounds
Early Clusters	870 pounds
Fuggles	723 pounds

It is of interest to compare these yields with the yields of the other varietal trials which were obtained in 1932. Last year the other varietal trials yielded as follows:

Late Clusters	1,220 pounds
Early Clusters	850 pounds
Fuggles	382 pounds

The varieties in both trials yield in the same order and comparatively are the same, with the possible exception of the Fuggles variety, which yielded considerably more in its second year in these trials than it did in the other varietal trials. The yields of Late Clusters and Early Clusters, however, are within 25 pounds of what they were the previous

year. Also, it is striking to note that the three-year old plants of the Late and Early Clusters yield almost the same, while the two year old plants differ by nearly 50 per cent. Apparently the Late Cluster variety gets into yield more quickly than the Early Clusters and Fuggles. The reason for this is not known, but apparently it is due to varietal characteristics.

As a two-year average, the yields are low, but give an indication of what one can expect as an average if he sets out hops. Late Clusters as a two year average yielded 620 pounds, Early Clusters, 439 pounds, and Fuggles, 362 pounds.

In this trial there were only 11 missing hills out of the 288 hills in the trial. Seven of these missing hills were in the Fuggles variety. In general, this was due to the condition of some of the Fuggles root cuttings. Next year there may possibly be more missing hills in the Early Clusters, due to downy mildew.

These variety trial yields will be of real value in comparing yields of new varieties that are being developed in the breeding trials.

Table No.
Hop Variety Trials
3-row plots - 16 hills per row
Yields in pounds
Trial began 1932
Corvallis - 1933

Row No.	Variety	Green Weight	Missing Hills	Corrected Weight	Dry* Weight	Yield per acre
19	Late Clusters	130.0	0	130.0	30.3	1273
20	Late Clusters	120.0	0	120.0	28.0	1176
21	Late Clusters	129.0	0	129.0	30.0	1260
22	Early Clusters	81.0	0	81.0	19.8	832
23	Early Clusters	93.0	0	93.0	22.8	958
24	Early Clusters	86.0	0	86.0	21.1	886
25	Fuggles	78.0	0	78.0	20.8	874
26	Fuggles	52.0	1	55.6	14.5	609
27	Fuggles	35.0	3	42.8	11.4	479
28	Late Clusters	122.0	0	122.0	28.4	1193
29	Late Clusters	109.0	0	109.0	25.4	1067
30	Late Clusters	124.0	0	124.0	28.9	1214
31	Early Clusters	52.0	3	74	18.1	760
32	Early Clusters	73.0	1	77.8	19.1	802
33	Early Clusters	95.5	0	95.5	23.4	983
34	Fuggles	55.0	2	62.8	16.7	701
35	Fuggles	62.0	1	66	17.6	739
36	Fuggles	84.0	0	84.0	22.3	937

*Fuggles = 100# dry to 26.6#

E. C. = 100# dry to 24.5#

L. C. = 100# dry to 23.3#

Table No. ____

COMPARATIVE YIELDS OF THREE VARIETIES OF HOPS SET OUT IN 1932
1932 Yield, 1933 Yield, 2-Year average
Yields in Pounds per Acre
Corvallis, 1933.

Variety	1932 Yield	1933 Yield			2-Year Average Yield
		Plot 1	Plot 2	Average	
Late Clusters	44	1,236	1,158	1,197	620
Early Clusters	9	892	848	870	439
Fuggles	2	664	792	723	362

SHRINKAGE ON DRYING

In estimating the shrinkage of green hops on drying, most growers and dealers figure a 75% shrink. In other words, 100 pounds of green hops usually dry down to about 25 pounds of dry hops. Of course this figure will vary somewhat, depending upon the maturity of the hops, the per cent of seed present, the dryness at picking time, the thoroughness of drying and possibly other factors. In some cases it has been estimated that hops dry down to only about 33% of their original weight. To get more information on this and also to get data to use in computing yields of the varieties in the experimental yard, careful weights were taken on various kilns of hops dried in the small experimental drier in the Agricultural Engineering Building. The results of the various tests are given in the following:

Fuggles

Two kilns of Fuggles from the experimental yard were dried separately and weights computed. One kiln of 125 pounds of green hops dried down to 34.1 pounds of dry hops. The other kiln of 86 pounds of green hops dried down to 22.1 pounds of dry hops. In other words, a total of 211 pounds of green Fuggles hops dried down to 56.2 pounds of dry hops. This gives a percentage of 26.6. In general these green Fuggles hops were quite dry, possibly a little drier than those ordinarily picked, and the cones were large, solid, and fairly well filled with seed. If this is the case the Fuggles normally would have dried down to almost exactly 25% of the original weight.

Early Clusters

There were four kilns of Early Clusters. One kiln of 75.5 pounds of green hops dried down to 18.9 pounds of dry hops; another 51.0 pounds of green hops dried down to 13.2 pounds of dry hops; the third kiln of 39.5 pounds of green hops dried down to 10.7 pounds of dry hops; and a fourth kiln of 86 pounds of green hops dried to 19 pounds of dry hops. In all there were 252.0 pounds of green hops which dried down to 61.8 pounds of dry hops. This gives 24.5 pounds of dry hops out of every 100 pounds of green hops, or in other words, the Early Clusters dried down to 24.5 per cent of their original weight. In general these Early Clusters were just about normal or possibly a trifle drier than ordinarily picked.

Late Clusters

Also there were four kilns of Late Clusters. A kiln of 141.5 pounds of green hops dried down to 32.5 pounds; another of 124.9 pounds dried down to 26.2 pounds; a third kiln of 144.16 pounds dried down to 35.0 pounds; and a fourth kiln of 150.1 pounds of green hops dried down to 36.8 pounds of dry hops. These four kilns were fairly large and gave accurate results. There was a total of 561.1 pounds of green hops which dried down to 130.5 pounds of dry hops. Or in other words, 100 pounds of green hops dried down to 23.3 dry hops, which is 23.3 per cent of the original weight. These Late Clusters were greener than ordinarily picked and would represent the first picking of Late Clusters. In all these figures do not vary greatly

from a shrinkage of 75 per cent. The small variations are readily accounted for in the differences in the maturity of the hops. In Oregon this year, therefore, I am of the opinion that the hops dried down in general to about 25% of their original weight and that appears to be a fairly safe figure to use for estimating.

TRAIN FIRST OR SECOND CROP OF VINES

Apparently growers are somewhat divided in their opinion as to which crop of hop vines to train in the spring. Most growers state that the first crop of vines is of little value and does not produce many hops. They, therefore, hoe off the first crop of vines and do not train until the second crop of vines has appeared. Also, they are of the opinion that the second crop of vines comes from buds lower on the hop crown and have, therefore, a better point of attachment. The writer has noted a difference in varieties and in plants in regard to this point of bud attachment and in some cases this factor may be an important one.

Recently, however, many growers have noted the value of training the first crop of vines to get them on the string and to spray before mildew becomes an important factor. This year, for example, mildew was not common in the yards until about April 26. Growers could have had their hops trained and sprayed by the time of this infection and some did this with apparently good results. It is my opinion that more and more growers will train the first crop of vines.

To get some idea as to the yielding ability of these two crops of vines, two rows in each of the varietal trial plots were compared. These were three year old vigorous growing hop plants and afforded excellent material for testing out differences in yielding ability of these crops of vines. Training of the first vines began April 5. On April 18, after all varieties had made a good growth on the string, one row in each plot was hoed at the ground line. Most of the hills appeared healthy, with the possible exception of some Fuggles.

The results are given in the accompanying table, and show that there was practically no difference, within the realm of experimental error, in the yielding ability of these two crops of vines. In fact, the advantage was with the first vines trained, inasmuch as the average of the two plots showed an increase of 72 pounds per acre for the Late Clusters, 13 pounds per acre for the Early Clusters, and 15 pounds per acre for the Fuggles. These differences, however, are not significant and the only conclusions that may be drawn are that under the conditions of this trial, there was little difference in the yielding ability of the two crops of vines. In the appearance of the plant, particularly the variety Fuggles, the first trained vines showed greater vine growth and vigor, but the actual hops picked showed little differences in yield.

It must be understood that under different environmental conditions and in seasons where moisture relationships are markedly different, the yielding ability of these crops of vines may be significantly different. No grower, however, will make a mistake if he trains the good shoots from the first crop of vines and gets them sprayed before mildew becomes a factor. In fact, this appears to be one of the very best methods for the control of downy mildew, as far as the writer's observations are concerned.

Table No____

Effect of Vines Trained on Yield of Hops

First Vines - Second Vines

Yields in Pounds of Dry Hops Per Acre

Duplicate - 16 hill plots

Corvallis, 1933

Variety	First vines trained		Second vines trained		Average		Increase yield of first vines
	Plot 1	Plot 2	Plot 1	Plot 2	First vines	Second vines	
Late Clusters	2366	2192	2142	2558	2278	2350	72
Early Clusters	1970	2457	2188	2272	2217	2230	13
Fuggles	1866	2134	1789	2239	1999	2014	15

Figure XII

Two methods of stringing in the experimental yard.

This illustration shows the use of three strings.

Figure XIII

nly one string per hill was used in the new portions

of the experimental yard.

EFFECT OF STRIPPING ON YIELDS OF HOPS

Growers differ in their hop stripping practices. Most growers, however, strip the plants heavily and remove practically all of the leaves and arms as high as they can reach.

The two chief advantages claimed for this practice are that it makes easier the spraying of the plants for aphids. With this material removed by stripping, there is less foliage to cover, and a thorough job of spraying may be done. Also, growers claim that it facilitates hop picking. If the lower leaves and arms are not removed, pickers find that there is a great mass of material to go over when the wire is let down at picking time. Undoubtedly these two points are of value and offset the cost of stripping, if the latter practice does not reduce yields.

To check the effect of stripping on the three chief varieties of hops, Late Clusters, Early Clusters, and Fuggles, a trial was conducted in the variety trial which had been set out in 1932. These two-year old hops were handled in various ways from the beginning of the season. Inasmuch as each variety was in duplicate plots and each plot consisted of three rows, three different methods of treatment were devised. The first row in each variety in each plot was not stripped at all, and all the material was left on the plants. The second row was stripped to a height of about 5 feet, and the third row in each case was stripped as high as the worker could reach, which was nearly 8 feet.

At the time that the arms were developing on the various varieties, it appeared that the top growth was greater on the rows that had received no stripping or only a small amount. As the season advanced, however, the rows matured about the same and the final picking results indicate that there is practically no effect on yield under the conditions of the trial. Under different conditions, different results may be obtained.

Results of these trials are reported in a table which follows. In trials this year it was shown that the differences in Late Clusters were practically negligible, in fact the rows receiving the greatest amount of stripping yielded four pounds per acre more than the rows not stripped. In Early Clusters the results were nearly the same, and the rows receiving the greatest amount of stripping yielded the most. In Fuggles, however, the rows that received no stripping gave the highest yield, and observations during the year showed that in this variety, stripping apparently was affecting the growth. One row of Fuggles was abnormally high in yield. The writer cannot account for this yield, but apparently it is higher than it should be. If this figure is incorrectly high, the value of a small amount of stripping in Fuggles is even greater than the difference of 79 pounds in favor of no stripping indicates.

Of course this work covers only one season and is rather preliminary, and also on two-year old hops. Additional work should be done to get the effect of this practice, which in some cases surely injures the plant. Also, it has been noted that downy mildew infection often occurs where a leaf or arm has been stripped from the hop stem.

Table No.___

Effect of Stripping on Hop Yields

Three heights of stripping and three varieties

Two-year old hops

Duplicate 16 hill plots

Yields in pounds per acre

Corvallis, 1933

Variety	No Stripping Check		Stripped 3 ft. high		Stripped 8 ft. high		Average Yields		
	Plot 1	Plot 2	Plot 1	Plot 2	Plot 1	Plot 2	No Stripping	Stripped 3 ft. high	Stripped 8 ft. high
Late Clusters	1273	1193	1176	1067	1260	1214	1233	1121	1237
Early Clusters	832	760	958	802	886	983	796	880	934
Fuggles	374	701	609	739	479	937	787	674	708

Figure XIV

General view of the experimental yard early in the spring of 1933 just after the fertilizer applications had been made.

Figure XV

Another view of the fertilizer trials showing hill applications.

FERTILIZERS FOR HOPS

A fertilizer trial to obtain the effect of the fertilizers on both downy mildew and the yielding ability of the three chief varieties of hops was conducted in the experimental yard in cooperation with Professor C. V. Ruzek of the Soils Department of Oregon State College. The fertilizers were applied around each hill as shown in the accompanying illustration. They were not applied until May 3, which is rather late in the spring. Due to unusually good moisture conditions this year, the time of application apparently was not as important as ordinary.

The fertilizer plots were laid out crosswise of the varietal trials. The three chief varieties of hops, Late Clusters, Early Clusters and Fuggles are planted in duplicate three-row plots. These rows run north and south. The fertilizers were applied in plots three hills wide and eighteen hills long, running east and west.

Information was obtained, therefore, as to the effect of each of the fertilizers applied on all varieties and on each variety separately. At harvest time, each plot had to be kept separately and this involved watching the pickers closely and in general was a difficult procedure to follow.

The fertilizers used were commercial ones made up under the direction of Professor Ruzek. A complete fertilizer, 16-20-8, was applied at the rate of two pounds per hill. Another complete fertilizer, 8-10-4, was applied at the rate of two pounds per hill. Then, followed a check plot which received no fertilizer. On the opposite side of the check plot was a commercial fertilizer of

16-20-0 analysis applied at the rate of two pounds per hill and another of 16-0-8 applied at the rate of one pound per hill. In no case was any injury noted even though the applications were heavy. This may be due to the excellent moisture conditions after the applications and also to the fact that the fertilizers were applied in a ring of a diameter of about three feet around the hop hill.

The results are given in the attached eight tables. The first five tables give the effect of each fertilizer treatment on all three varieties. The last three tables give the effect of each fertilizer on each variety. Of course, the first results are more significant because they are on larger plots duplicated. The size of the plot for each variety was small.

Missing hills were definitely recorded and each plant harvested was noted particularly as to its growth so that due allowance could be made for non-producing hills. In fact, these non-producing hills were not actually missing, but they were replants put out this spring which bore practically no hops.

The results indicated that all fertilizers gave some increase in yields. The check plot which received no treatment yielded an average of 2066 pounds per acre. This is an excellent yield and naturally the fertilizers could not be expected to increase this yield greatly. However, the fertilizers did give increased yields in the following order. The 8-10-4 fertilizer treatment yielded at the rate of 2313 pounds per acre. This in turn was followed by the 16-20-8 fertilizer, which yielded 2230 pounds; the 16-0-8 which yielded 2223 pounds; and the 16-20-0 which yielded 2169 pounds. Apparently the complete fertilizer with a small amount of potash

and the nitrogen and phosphorus in the ratio of 4 to 5 was the most effective, on this particular soil and under the conditions of this trial.

Attention is called to the low yield of the 16-0-8 fertilizer applied on the Late Cluster variety. Apparently, the lack of phosphorus kept this variety from maturing naturally and affected the yield. Growers should watch too heavy applications of nitrogen without a balance of phosphorus because there are other factors in addition to yield that must be taken into consideration. These factors are chiefly maturity and quality of the hops produced.

There are variations in the duplicate plot yields and these yields should not be taken as final. Additional work is needed, but these results should be of value in making fertilizer recommendations for the coming season.

Effect of Fertilizer on Three Hop Varieties

Duplicate Plots

Yields in Pounds Per Acre

Corvallis 1933

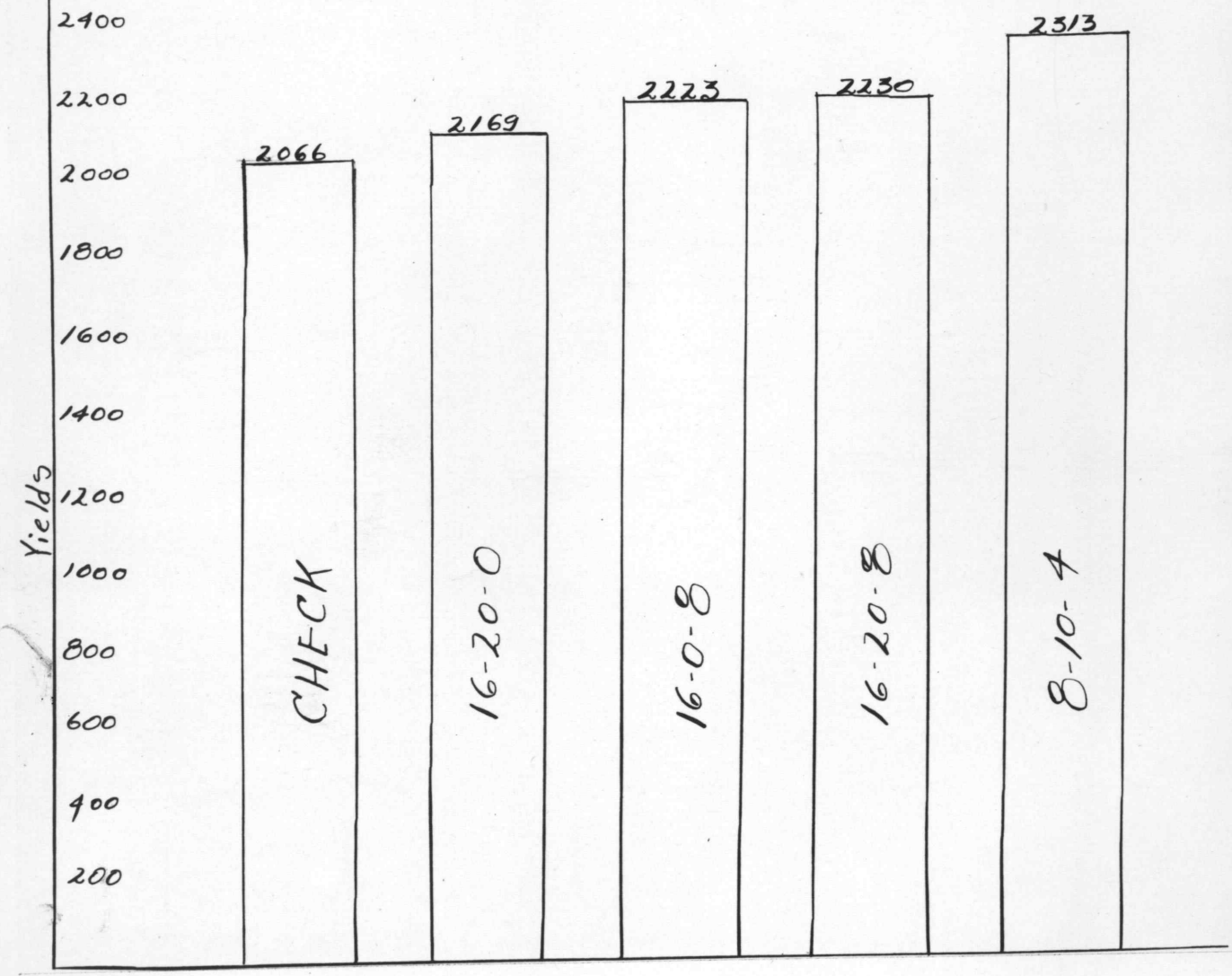


Table No____

Fertilizer Trials on Various Hop Varieties

16-20-8 = 2 lbs. per hill

Corvallis, 1933

Row No.	Variety	Green Weight	Missing Hills	Corrected Weight	Dry Weight	Yield Per Acre
1-2-3	Late Clusters	127.0	1	142.8	33.3	2497
4-5-6	Early Clusters	77.5	1	86.1	21.1	1583
7-8-9	Fuggles	85.0	1	93.3	24.8	1860
10-11-12	Late Clusters	164.0	0	164.0	38.2	2865
13-14-15	Early Clusters	96.0	2	123.4	30.4	2280
16-17-18	Fuggles	115.0	0	115.0	30.6	2295
				Av.	=	2230

Table No____

Fertilizer Trials on Various Hop Varieties

8-10-4 = 2 lbs. per hill

Corvallis, 1933

Row No.	Variety	Green Weight	Missing Hills	Corrected Weight	Dry Weight	Yield Per Acre
1-2-3	Late Clusters	138.0	0	138.0	32.2	2415
4-5-6	Early Clusters	117.0	0	117.0	28.7	2153
7-8-9	Fuggles	93.0	0	93.0	24.7	1853
10-11-12	Late Clusters	143.0	0	143.0	33.3	2498
13-14-15	Early Clusters	111.0	2	143.0	35.0	2625
16-17-18	Fuggles	117.0	0	117.0	31.1	2333
				Av.	=	2313

Table No____

Fertilizer Trials on Various Hop Varieties

Check - No Fertilizer

Corvallis, 1933

Row No.	Variety	Green Weight	Missing Hills	Corrected Weight	Dry Weight	Yield Per Acre
1-2-3	Late Clusters	107.0	0	107.0	24.9	1868
4-5-6	Early Clusters	71.0	2	91.2	22.3	1673
7-8-9	Fuggles	82.0	0	82.0	21.8	1635
10-11-12	Late Clusters	131.0	1	147.3	34.3	2573
13-14-15	Early Clusters	85.0	4	153.0	37.5	2812
16-17-18	Fuggles	81.0	1	92.1	24.5	1838
				Av.	=	2066

Table No____

Fertilizer Trials on Various Hop Varieties

16-20-0 = 2 lbs. per hill

Corvallis, 1933

Row No.	Variety	Green Weight	Missing Hills	Corrected Weight	Dry Weight	Yield Per Acre
1-2-3	Late Clusters	155.0	1	151.8	35.4	2655
4-5-6	Early Clusters	120.0	0	120.0	29.4	2205
7-8-9	Fuggles	80.0	0	80.0	21.3	1598
10-11-12	Late Clusters	112.0	0	112.0	26.1	1957
13-14-15	Early Clusters	114.0	1	128.2	31.4	2355
16-17-18	Fuggles	100.0	1	112.5	29.9	2243
				Av.	=	2169

Table No____

Fertilizer Trials on Various Hop Varieties

16-0-8 = 1 lb. per hill

Corvallis, 1933

Row No.	Variety	Green Weight	Missing Hills	Corrected Weight	Dry Weight	Yield Per Acre
1-2-3	Late Clusters	108.0	0	108.0	25.2	1890
4-5-6	Early Clusters	94.2	3	141.0	34.6	2587
7-8-9	Fuggles	112.0	1	126.0	33.5	2512
10-11-12	Late Clusters	90.4	1	101.7	23.7	1777
13-14-15	Early Clusters	108.4	2	136.8	33.6	2512
16-17-18	Fuggles	80.5	2	103.5	27.6	2062
				Av.	=	2225

Table No____

Effect of Fertilizers on Late Clusters

Green Weight Per Plot and Dry Weight

Per Acre in Pounds

Corvallis, 1933

Treatment	Pounds Per Hill	Plot 1		Plot 2		Total		Average Yield Per Acre
		Green	Dry	Green	Dry	Green	Dry	
16-20-8	2	142.8	2497	164.0	2865	306.8	5362	2681
8-10-4	2	138.0	2416	143.0	2498	281.0	4913	2456
Check	0	107.0	1868	147.3	2573	254.3	4441	2220
16-20-0	2	151.8	2655	112.0	1957	263.8	4612	2306
16-0-8	1	108.0	1890	90.4	1777	198.4	3667	1833

Table No____

Effect of Fertilizers on Early Clusters

Green Weight Per Plot and

Dry Weight Per Acre in Pounds

Corvallis, 1933

Treatment	Pounds Per Hill	Plot 1		Plot 2		Totals		Average Yield Per Acre
		Green Weight	Dry Weight	Green Weight	Dry Weight	Green Weight	Dry Weight	
16-20-8	2	86.1	1583	123.4	2280	209.5	3863	1931
8-10-4	2	117.0	2153	143.0	2625	260.0	4778	2389
Check	0	91.2	1673	153.0	2812	244.1	4485	2242
16-20-0	2	120.0	2205	128.2	2355	248.2	4560	2280
16-0-8	1	141.0	2587	136.8	2512	277.8	5099	2549

Table No____

Effect of Fertilizers on Puggles

Green Weight Per Plot and Dry Weight

Per Acre in Pounds

Corvallis, 1933

Treatment	Pounds Per Hill	Plot 1		Plot 2		Total		Average Yield Per Acre
		Green	Dry	Green	Dry	Green	Dry	
16-20-8	2	93.3	1860	115.0	2295	208.3	4155	2077
8-10-4	2	93.0	1853	117.0	2333	210.0	4186	2093
Check	0	82.0	1635	92.1	1838	174.1	3473	1736
16-20-0	2	80.0	1598	112.5	2243	192.5	3841	1920
16-0-8	1	126	2512	103.5	2062	229.5	4574	2287

Figure XVI

After the vines have been cut off and burned, the yard was seeded to various cover crops. This one is hairy vetch.

Figure XVII

Another view of the experimental yard showing a cover crop of common vetch.

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COVER CROP TRIALS

For the third successive season cover crops have been planted in the experimental yard. On September 15 and 16 the following cover crops were planted: Common vetch, Hungarian vetch, Monantha vetch, Hairy vetch, and Austrian Winter field peas.

It is not hoped to obtain actual differences in yields of hops in plats grown with plantings of these different cover crops, but it is hoped that the cover crop will be of value to the yard from both the standpoint of aiding fertility and decreasing possible washing if the yard overflows. Also, it is hoped that observations of value to hop growers may be made. An article on this subject was published in the August issue of "The Oregon Hop Grower." Many growers are following these recommendations and the practice is becoming common, due greatly to this project.

In the previous season; that is, on September 25, 1932, the following cover crops were planted: Crimson clover, Common vetch, Hungarian vetch, Hairy vetch, Monantha vetch, Bitter vetch, and Austrian Winter field peas. All of these plantings winter-killed with the exception of Hairy vetch. The latter came through in excellent condition, and for that particular year was the outstanding cover crop. It is not the plan, however, to recommend Hairy vetch as a cover crop, as ordinarily the other vetches will come through our winter season. It may be advisable, however, to plant a mixture which has considerable Hairy vetch in it, so that if the other vetches winter kill, the Hairy vetch will survive and give some material to plow under.

Recommendations made by the writer early in the summer of 1933 saved hop growers hundreds of dollars on vetch seed. Growers were told

of the shortage of vetch seed, and that they had better buy their cover crop seed early. Several growers took advantage of this and bought seed at four to five cents a pound, where many growers had to pay as high as eight cents a pound for Common vetch at planting time. Some growers have purchased special drills for seeding their cover crops. One grower informed the writer that he had just purchased a small drill for seeding cover crops, and that the drill had a fertilizer attachment. At the suggestion of our Soils Department, it was recommended that he use some superphosphate at the rate of less than 100 pounds per acre as a possible means of stimulating the growth of the cover crop, and also increasing winter hardiness.

Another grower has advised the writer that this year he has already seeded the ordinary wild turnip, Brassica campestris. This seed was purchased for 3¢ a pound and he advises that he is only seeding 8 to 10 pounds per acre. Undoubtedly this makes a cheap cover crop and one, from all reports, that is valuable.

In 1931 the following cover crops were planted in the experimental yard: Barley, Austrian Winter field peas, Hairy vetch, Common vetch, and Monantha vetch. In that year Winter barley made the most vigorous growth, and in fact grew to such an extent that it was difficult to get it turned under. Of course it is a non-legume, and for that reason not comparable with the other legumes that were planted. Of the latter group Common vetch appeared to make the greatest growth by time of plowing in the spring. Possibly a combination of fall barley with a mixture of Common, Hungarian, and Hairy vetches would give the greatest amount of growth at the least cost.

EFFECT OF COPPER-LIME DUST ON THE SOIL

One of the recommended methods for attempts to control downy mildew is to dust copper-lime on the hill early in the spring. Some growers questioned the effect of this material on the soil fertility and hence on the growth of the plant. Also, it was suggested that if this practice was kept up for several years, there may be an accumulation of copper salts which would be detrimental to the plant growth.

To obtain information on this particular thing, a small trial was set up in the experimental yard early in 1933. Ten hills of hops were set aside to receive various amounts of copper-lime dust each spring for an indefinite period. Applications much larger than those recommended were used in each case. The applications made to each hill were as follows:

Table No.

EFFECT OF COPPER-DIME DUST ON YIELD AND DOWNY MILDEW

Hill No.	Treatment	Remarks
5-7	Check	No effect - mildew
5-8	1/2 lb.	" " "
5-9	1 lb.	" " "
5-10	1 1/2 lbs.	" " "
5-11	2 lbs.	" " "
5-12	2 1/2 lbs.	" " "
6-8	3 lbs.	" " "
6-9	3 1/2 lbs.	" " "
6-10	4 lbs.	" " "
6-11	4 1/2 lbs.	" " "
6-12	5 lbs.	" " "
6-13	Check	" " "

The recommendation as to the amount of copper-lime dust to use is only one ounce per hill and hence the hill receiving five pounds gets

as much copper lime as the ordinary grower would apply in about eighty years' time. This year there appeared to be absolutely no detrimental effect on any of the hills. In fact, it appeared that the copper-lime acted in a small way as a stimulant. On the other hand, the copper-lime apparently had no effect on mildew for in several cases badly infected shoots grew right through the copper-lime dust. Apparently the time of application and particularly if the dust is applied before infection occurs, is important in regard to the efficiency of the dust.

Figure XVIII

This shows an application of copper-lime dust to the hop hills.

This dust, used in mildew control, is being tested for its effect on the soil.

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RESIN ANALYSES

Various hop samples from the 1931 crop were analyzed for the different resins by Mr. C. F. Whitaker of Oregon State College. Mr. Whitaker reviewed the literature and reported fully on his work. His results are included in the writer's 1932 report. Because of lack of funds Mr. Whitaker could not be used to determine the resin values of the samples from the 1932 crop.

Samples of the 1932 crop were forwarded to Mr. Frank Rabak of the Division of Drug and Related Plants, United States Department of Agriculture, Washington, D. C.

Apparently there was some difficulty in obtaining the alpha fraction of the soft resins. A memorandum prepared by Mr. Rabak on May 24, 1933, for Mr. Sievers of the Division of Drug and Related Plants is as follows:

> Commenting on the notes submitted by Dr. E. N. Bressman and Mr. Whitaker on hop analysis, I find that the article "Report on the Preservative Principles of Hops," Part XIV, by Walker, T. K. and Hastings, J. J. H., in the Journal of Inst. of Brewing, vol. 39, 1933, pp. 15-27, stated to be basis of the method employed, contains no details of the method used as mentioned by Mr. Whitaker.
>
> Following the method outlined in Mr. Whitaker's thesis the difficulty has been largely our inability to obtain a precipitation of the lead salt of the alpha-resins. No trouble was experienced with the extraction of the hops with methyl alcohol or the subsequent shaking out of the soft resins with petroleum ether. Rather our troubles begin with the redissolving of the residue left after evaporation of the petroleum ether and the subsequent precipitation of the lead salt of the alpha-resin by means of a one per cent solution of lead acetate in methyl alcohol. This precipitation does not apparently take place quantitatively even with strictest adherence to the details of precipitation. In every case an insufficient quantity of the lead salt was precipitated. While there was some adherence of the precipitate to the side of the vessel no trouble was experienced in the removal of the same before filtration.
>
> It is known, as stated in Mr. Whitaker's notes that heat is destructive to soft resins and that due care must be exercised to keep the temperature as low as possible all through the operation. Even in

the removal of the solvent from the petroleum ether shakings the last 15 c c were evaporated in every case in vacuum (30° to 50° petroleum ether being used). It was noted in several instances that after removal of the petroleum ether the residue in the flask did not always dissolve readily in methyl alcohol and it was necessary to add a few drops of petroleum ether to soften the residue after which methyl alcohol took it up readily. On account of the small quantity of the residue obtained from an aliquot of the petroleum ether extract it would seem that this is soluble portion cannot be ignored (without introducing a serious error) and the proper quantity of lead salt precipitate obtained. This residue although appearing somewhat waxy in nature could not be wax because the waxes present in hops are not extracted by the methyl alcohol and hence could not be in the petroleum ether extract obtained by shaking out the methyl alcohol solution of the resins.

No mention was made in the summarized directions in the thesis of a preliminary "titration" by the test plate method to determine the exact quantity of lead acetate solution to use for the precipitation. It was stated that 12 to 15 cc of lead acetate was ample in all cases.

The fact that the total soft resins obtained by us check fairly close by with Mr. Whitaker's results shows that there is no error in our procedure up to the point where the petroleum ether shakings are evaporated. It is only in the precipitation of the alpha resin by the lead acetate solution that we obtain totally unsatisfactory results.

In view of the above it is suggested that Mr. Whitaker outline very carefully the method from the grinding of the hops to the final weighing and calculation of the alpha-resin, giving in minute detail every step taken as the method is carried out, but particularly with respect to the precipitation. If we then find that the results are not concordant or in agreement it is hard to see how any reliance can be placed on the results.

Whether the whole matter of the preservative principles in hops (alpha-resin content) is of importance seems problematical in view of the fact that expert hop men state that this is not considered by buyers of hops or brewers of beer when hops are judged. Hops are judged by appearance (color), presence or absence of foreign matter (stems and leaves), aroma, and stickiness. This latter is a physical method of evaluating the resin content of the hops. Rather, the total soft resin content of hops would seem to be most important since the bitter flavor of beer is dependent upon the soft resins.

In this connection attention is called to a statement made by J. J. H. Hastings in an article entitled "Ten Years Research on the Antiseptic Constituents of Hops" by T. K. Walker, Jour. of Inst. of Brewing, vol. 38, pp. 24-205, 1932, in which he states that there is a tremendous loss of antiseptic material between the time the hops are picked and the beer is consumed. It is stated that green hops which contain the maximum amount of antiseptic constituents are 2-1/2 times as antiseptic as the same hops dried and when dry hops stored, whether in cold storage of in regular warehouse storage, there is a continuous loss of antiseptic material with a somewhat lower rate of loss in cold

storage. A graph is shown in the article indicating the loss of antiseptic material at different stages from the green hops (100%) to the beer in the barrel and it shows that the amount of antiseptic material in the finished beer is under 10% of the original quantity present. It is further stated that when hops are boiled in the copper 30% of the available antiseptic material is destroyed and not brought into solution. During fermentation another serious loss occurs owing to the removal or destruction of antiseptic material by the yeast. He sums up by stating, "if all these losses are shown collectively in one diagram it is readily apparent that the amount of antiseptic material which finally reaches the beer from the green hops is only a very small proportion of that initially present."

In view of the above does it not seem that the content of total soft resin in hops is far more important than the determination of constituents which apparently have so little relation to the finished beer and which are so easily subject to loss and destruction during the brewing process.

The results obtained by Mr. Rabak on the hops grown in 1932 are tabulated in the accompanying table. Only the total soft resins are given. When these are compared with the results obtained in 1931, it will be observed that the results agree fairly well. In general the Fuggles variety shows a lower soft resin content than the other varieties, and the Red Vine variety was again lower than the Cluster type.

The average of the analyses made on the 1932 hops is as follows:

Seven samples of Fuggles averaged 12.21 per cent total soft resin.

Four samples of Red Vine averaged 14.84 per cent.

Six samples of German Grape averaged 15.01 per cent.

Nine samples of Late Clusters averaged 15.21 per cent.

Four samples of Early Clusters averaged 15.27 per cent.

In other words, the Fuggles and Red Vine varieties appear to be lower in soft resin content than the Cluster types which averaged over 15 per cent soft resin. Of course, this average is high and indicates that Oregon hops, as far as resin content is concerned, are of excellent quality.

Mr. Rabak will conduct analyses on the hop samples from the 1933

crop. As previously explained, all of the samples for the 1933 analyses were dried at the experimental dryer in the Agricultural Engineering building. One-pound samples were baled immediately after drying and placed in cold storage until they were forwarded to Mr. Rabak about the middle of October. The various samples which have been forwarded to Mr. Rabak are listed in an accompanying table.

ANALYSES OF HOPS GROWN IN 1932

Made by Frank Rabak - U. S. D. A.

Corvallis Plant No.	Variety	Moisture P.C.	Total Soft Resins. P.C.	Total Soft Resins. (1931 Crop)
Composite	Fuggles	7.28	13.04	—
"	"	7.47	12.84	—
11/3	"	6.75	10.80	8.25
11/6	"	6.48	12.15	7.45
11/8	"	6.67	11.60	9.83
12/2	"	6.43	12.81	8.25
12/4	"	7.38	12.23	8.44
6/8	Late Cluster	5.64	14.10	18.00
8/4	" "	7.37	14.76	17.21
6/8	" "	7.97	14.01	18.00
6/3	" "	7.40	13.68	16.83
6/4	" "	6.70	14.63	14.95
6/9	" "	7.10	16.60	16.20
7/9	" "	7.60	16.60	10.89
8/11	" "	7.40	17.27	15.38
Composite	" "	7.00	15.27	—
Composite	Early Cluster	7.20	15.37	—
8/9	" "	7.42	14.78	13.73
8/10	" "	6.74	15.43	13.90
8/12	" "	7.55	15.51	15.30
16/6	German Grape	7.40	16.14	14.30
16/6	" "	7.42	16.31	14.30
16/2	" "	6.70	14.57	14.78
17/7	" "	6.85	15.59	12.96
17/8	" "	6.47	12.61	15.48
17/9	" "	6.92	14.86	15.50
15/7	Red Vine	7.75	14.27	11.81
14/8	" "	7.88	14.66	12.52
14/6	" "	6.57	15.77	11.89
15/6	" "	6.77	14.68	11.80

Table No.
Hop Samples of 1933 Crop for Analyses
Forwarded to Washington, D. C.

Package No. 1

Individual Plants 36-8; 17-8; 8-12; 43-5; 53-10; 12-2; 56-28 and Spalter.

Package No. 2

Individual Plants 2-30; 8-10; 53-9; 36-7; 20-31; 62-27; 49-23 and 19-33.

Package No. 3

Individual Plants 73-11; 17-7; 6-3; 38-7; 15-6; 11-6; 2-33 and Fuggles composite.

Package No. 4

Individual Plants 30-8; 63-31; 70-13 and Elsasser and Horst Late Cluster composite.

Package No. 5

Individual Plants 43-22 and 73-12. Date of picking samples August 28; August 31; September 6; September 9 and September 12. Seeded and seedless samples.

Package No. 6

Run No.	Temp. F°	Kiln Velocity ft. min.	Kiln Depth in.
5	180	30	
6 top	200	31	24
6 bottom	200	31	24
7	180	31	
8 top	130	31	24
8 bottom	130	31	24

Package No. 7

Run No.	Temp. F°	Kiln Velocity ft. min.	Kiln Depth in.
8 top	140	31	24
9 bottom	140	31	24
10 (1)	140	52	28
10 (2)	140	52	28
10 (3)	140	52	28
10 (4)	140	52	28

Package No. 8

11	160	55
12	130	32
13	150	35
14	130	32
15	155	32
16	160	32

Package No. 9

17	150	30
18	160	30
19	150	49.5
20	130	30
21	150	50
22	110	30
23	150	49.5

Package No. 10

Individual Plants 6-4 and 14-4.

Figure XIX

Some notables visit the experimental yard in 1933. From left to right: F. E. Price, Agricultural Engineer; G. R. Hoerner, Plant Pathologist; and Frank Rabak, Biochemist, all interested in phases of hop growing and curing.

DOWNY MILDEW ON HOP CONES

Downy mildew was prevalent on hop cones in Oregon for the first time this year. This is the first hop picking season since the introduction of mildew in 1930 that has been favorable for the infection on hop cones.

The symptoms were easily recognized after one became familiar with them. In most cases the downy mildew infection caused dark brown streaked areas on the cones. Often these streaks extended from the base to the tip of the cone. Many growers did not recognize this condition and were of the opinion that it was either damage from mold or wind whip.

Investigation of infected bracts showed that many oospores were present, but ordinarily very few summer spores.

Many growers have been told of this condition and it has been suggested that they watch portions of the yard where plants containing cones of this type were left. These infected areas were noted usually in the last pickings and in many cases pickers did not pick the discolored hops. Possibly this will bring about an unusual condition either in the spring of 1934 or of 1935.

We left a few plants on the string after picking in the experimental yard to get some information on mold and mildew damage. In some of these plants mildew was observed late in September and early in October. On one outstanding seedling, however, the cones were entirely free of mildew damage. Next year it is hoped that at least portions of many of the outstanding new seedlings can be left until long after harvest. This will be possible if the method of using three strings per hill is used, as two strings may be picked and the third allowed to remain to

get after-harvest information on mold resistance, mildew resistance, and resistance to shattering.

One grower has requested information on the non-shattering ability of various varieties of hops and also the possibility of obtaining new varieties which will not shatter so readily. This would be of real advantage in years when growers encountered troubles with the pickers or prolonged rains and harvest was delayed several days or weeks.

THE SEX CHARACTER IN HOPS

It is well known that hops are classified as dioecious plants; that is, the male flowers are borne on plants distinctly different from those that bear the female ones. Many variations of this condition, however, have been noted by the writer, and reported previously.

The work and observations on these conditions were summarized in a 34-page manuscript accepted for publication in the American Journal of Botany. It is hoped that this publication will soon appear so that additional work may be reported on.

One of the most striking conditions noted this season occurred early in February when root cuttings were obtained from a so-called "bastard" or neuter plant that had borne both male and female flowers in 1932. This plant exhibited an unusual condition, in that all of the underground portions were badly infected with the crown gall organism. The conclusion was drawn that this organism in some way interfered with the nutrition of the plant and possibly made a nutritional balance that was favorable to flower or fruit production. Immediately trials were begun to study this unusual condition. Unfortunately, most of the crown gall disease winter-killed during the winter of 1932-33, and so the progress of the trial will not be so rapid. However, attempts have been made to increase both the cuttings and the crown gall organism. Also several neuter plants both in the field and greenhouse have been inoculated.

Observations in the fall of 1933 somewhat confirm the above theory. The writer's attention was called to similar appearing plants

in a grower's yard at Forest Grove, Oregon. A survey in this yard indicated that the grower had 4 or 5 per cent neuter plants and some infection of crown gall. The two plants in this yard that exhibited the unusual grape-like bunches of male and female flowers had indications of being a neuter plant, also they exhibited crown gall disease on the underground parts. The plants were dug and brought to the experimental yard where they will be studied.

As a rule, when a hop plant shows reversion from one sex to the other, it is usually found on a plant that is primarily male. This season, however, several female plants exhibited reversion to male flowers. In some cases this reversion included only one whorl of flowers; for example, a female plant developed female flowers on an arm then one whorl of male flowers and then finally produce female flowers for the rest of the whorl on the arm.

In an attempt to induce neuter plants to bear fruit some plants of this type were injured by stem girdling and root pruning. The roots were pruned on June 19th and the stems were girdled on both June 19th and July 11th. No effect was noted this season. The results are given in the following table.

Table No.
Effect of Root Pruning and Stem Girdling on Fruit Production In Neuter Hop Plants, Corvallis, 1933

Plant No.	Treatment	Remarks
18-6	Stems girdled	No flowers developed
18-7	Roots pruned	" " "
18-8	Stems girdled	" " "
18-9	Check - no treatment	" " "
18-10	Stems girdled	" " "
18-11	" "	" " "
18-12	Roots pruned	" " "
18-13	Check - no treatment	" " "

Figure XX

This illustration shows the writer looking at some new seedlings of Fuggles parentage.

Table No.____

Estimated Percentage of Female Flowers on Male Plants in Experimental Yard, Corvallis, 1931, 1932 and 1933

Male Plant No.	1931 Per Cent Female Flowers	1932 Per Cent Female Flowers	1933 Per Cent Female Flowers
1 - 6	10	0	Dead
6 - 1	0	0	0
13 - 1	50	1	0
15 - 1	3	20	0
16 - 1	65	5	0
17 - 1	5	Trace	0
18 - 1	7	15	Trace (1 flower)
15 - 13	70	Trace	Trace
14 - 13	75	Trace	Trace
12 - 13	5	Trace	0
10 - 13	40	Trace	0
9 - 13	60	Trace	0
7 - 13	75	1	0
6 - 13	15	1	0
5 - 13	75	Trace	0
4 - 13	1	2	0
3 - 13	No bloom	Trace	0
2 - 13	" "	Trace	0
1 - 13	" "	15	0
1 - 30	50	Trace	0
4 - 30	60	0	0
5 - 30	80	Trace	0
6 - 30	75	Trace	0
7 - 30		Trace	0
8 - 30		1	0
9 - 30		0	0
15 - 30		Trace	0
16 - 30		1	0
17 - 30		Trace	0
1 - 6		0	0
10 - 2		1	Trace
10 - 12		0	0
8 - 13		0	0
8 - 8		0	0
4 - 8		2	1
3 - 7		0	
2 - 7		0	Dead
2 - 16		0	0
5 - 16		0	Dead
14 - 16		0	
4 - 26		0	0
3 - 30		0	0
14 - 30		0	0

Male Plant No.	1931 Per Cent Female Flowers	1932 Per Cent Female Flowers	1933 Per Cent Female Flowers
18 - 30		0	0
18 - 32		0	0
17 - 32		0	0
15 - 31		0	0
14 - 31		2	Trace
13 - 33		0	0
12 - 33		Trace	0
10 - 31		0	0
9 - 31		0	0
8 - 31		0	0
7 - 33		0	0
6 - 31		0	0
5 - 31		0	0
5 - 32		0	0
5 - 33		0	0
3 - 31		0	0
2 - 32		0	0
1 - 32		0	0
1 - 33		0	0
19 - 30		Trace	0
19 - 31		0	0
19 - 32		0	0
21 - 33		0	0
26 - 30		30	0
27 - 32		0	0
28 - 33		0	0
28 - 30		Trace	0
33 - 30		0	0
34 - 30		0	Dead
35 - 30		0	0
35 - 31		0	0
47 - 30		0	
54 - 30		0	0
101 - 2		2	0
105 - 2		2	1
103 - 2		1	Trace
100 - 2		0	0
98 - 2		0	0
96 - 2		5	0
95 - 2		10	0
94 - 2		0	0
93 - 2		0	Trace
86 - 2		20	Trace
85 - 2		0	0
84 - 2		10	1
82 - 2		10	Trace
80 - 2		0	0
78 - 2		0	0
68 - 2		2	Trace
65 - 2		0	0
64 - 2		3	0

Male Plant No.	1931 Per Cent Female Flowers	1932 Per Cent Female Flowers	1933 Per Cent Female Flowers
62 - 2		0	1
60 - 2		0	0
58 - 2		2	0
55 - 2		0	0
54 - 2		10	0
49 - 2		0	0
47 - 2		0	0
46 - 2		0	0
45 - 2		10	Trace
44 - 2		15	Trace
41 - 2		2	0
40 - 2		0	0
39 - 4		0	0
38 - 2		3	0
37 - 2		1	0
34 - 2		0	0
29 - 9		0	Dead
28 - 2		10	0 (Bracts)
24 - 10		10	0
23 - 9		0	Dead
23 - 2		0	0
23 - 7		0	0
22 - 2		7	Dead
11 - 32			3
16 - 33			0

Table No. ____

SEX REVERSAL OF SEEDLING HOP PLANTS

Corvallis

1933

Plant No.	Sex	Percentage Reversal
44-24	male	80
46-32	male	95
52-24	male	85
62-28	male	20
64-27	female	90
56-52	male	60
67-17	male	15
92-19	male	10
102-18	male	90
103-14	male	10
101-10	male	5
84-12	male	50

Figure XXI

Seedlings are of various types. This one has an unusually light green stem. Also, it has mildew resistance.

STOMATAL STUDY OF HOP VARIETIES

In the 1932 report some results of stomatal studies made in that season were given. These preliminary studies indicated that there was little difference in size or numbers of stomata of different hop varieties. There was some significant difference, however, in time of opening. Time and funds did not permit a thorough study of this problem, but again some additional notes were obtained. These are reported in the accompanying tables.

One of the greatest differences in the results of the two years' work is in the number of stomata per square centimeter. Last year the varieties had about 20,000 stomata per square centimeter. This year most of the varieties showed about 50,000 stomata per square centimeter. The difference may be due to the growing conditions in the two seasons. Also, the count this year was made earlier in the season. It is surprising, however, that there should be such a wide variation in numbers.

The sizes of the stomata as measured this year wernot greatly different from the sizes reported in 1932.

The time of opening studies indicated that the Fuggles variety again did not tend to open as early as the Cluster types. Also, other varieties such as the M-45, Canadian Red Vine, East Kent Golding, and German were closed at two A. M. while the Cluster types were showing signs of opening. All of the varieties, however, were opening by four A. M. Even though the difference is not so clear-cut in time of opening, there is a difference in favor of the varieties that show resistance to downy mildew. It appears that the general conclusion that should be drawn in regard to time of opening of stomata of the various varieties

is that the resistant varieties do not tend to open as early in the morning as the susceptible types. Of course, one cannot state that resistance is due entirely to time of opening. Undoubtedly this is just one factor in the nature of resistance.

Size (width) of Stomatal Opening and Number of Stomata in High Power Field (1.0 = 5.68)

Late Cluster		Early Cluster		Fuggles		Canada Red Vine		Bastard (L. C.)		East Kent Golding	
Size	No.	Size	No.	Size	No.	Size	No.	Size	No.	Size	No.
1.0	59	0.8	60	0.5	63	0.5	57	0.6	73	1.2	61
0.5	82	1.0	74	0.5	51	0.7	65	0.4	64	1.0	54
0.6	58	0.8	65	0.8	72	1.0	58	0.7	78	0.8	78
0.8	60	0.5	64	0.7	64	0.8	50	0.8	77	1.2	48
0.8	53	0.5	63	0.5	62	0.7	55	0.7	72	1.0	65
0.7	59	0.8	63	0.7	54	0.5	65	0.8	70	1.0	68
1.0	62	1.0	77	0.5	44	1.0	60	0.6	67	0.8	61
1.0	49	1.0	77	0.7	80	0.8	54	0.4	70	1.0	51
0.6	57	0.8	68	0.7	81	0.8	74	0.8	73	0.5	80
0.5	52	0.8	74	0.8	66	0.4	33	0.6	92	0.7	72
0.75	59.1	0.8	68.5	0.64	63.7	0.72	57.1	0.64	73.6	0.92	63.8
Averages											

Actual Size of Stomata in Microns
(Width of opening)

Variety	Microns
Late Cluster	2.76
Early Cluster	2.94
Fuggles	2.36
Red Vine	2.66
Bastard (L. C.)	2.36
East Kent Golding	3.39

Stomata in High Power Field (x 440)

Late Cluster	Early Cluster	Fuggles	German	M-45	Canada Red Vine	Bastard (L. C.)	East Kent Golding
59	60	63	90	68	57	73	61
82	74	51	75	72	65	64	54
58	65	72	74	66	58	78	78
60	64	64	60	75	50	77	48
53	63	62	87	64	55	72	65
59	63	54	41	57	65	70	68
62	77	44	86	76	60	67	61
49	77	80	83	77	54	70	51
57	68	81	86	72	74	73	80
52	74	66	82	65	33	92	72
Ave. 59.1	Ave. 68.5	Ave. 63.7	Ave. 76.4	Ave. 69.2	Ave. 57.1	Ave. 73.6	Ave. 63.8

Stomata per sq. mm. and per sq. cm.

Variety	No. of stomata per sq. mm.	No. of stomata per sq. cm.
Late Cluster	526.0	52,600
Early Cluster	610.0	61,000
Fuggles	567.0	56,700
German	680.0	68,000
M-45	616.0	61,600
Canada Red Vine	508.0	50,800
Bastard (L. C.)	655.0	65,500
East Kent Golding	568.0	56,800

Time of Stomatal Opening and Closing

Late Cluster	Early Cluster	Fuggles	German	H-45	Canada Red Vine	Bastard (L. C.)	East Kent Golding
10:00 p.m. 6/29/33 Most of stomata closed. A few open 1/3 to 1/2.	10:00 p.m. 6/29/33 Most of stomata closed. A few open 1/3 to 1/2.	10:00 p.m. 6/29/33 Most stomata closed. A small number open slightly, but not as wide as in L. C. and E. C.	11:00 p.m. 6/29/33 Occasional stoma open. Remainder closed.	10:00 p.m. 6/29/33 Most of stomata closed. A few 1/4 open.	11:00 p.m. 6/29/33 Most of stomata closed. A few with slit-like openings.	11:00 p.m. 6/29/33 All closed.	11:00 p.m. 6/29/33 All stomata closed.
2:00 a.m. 6/30/33 Occasional stoma open.	2:00 a.m. 6/30/33 Occasional stoma open.	2:00 a.m. 6/30/33 All closed	2:00 a.m. 6/30/33 All closed.	2:00 a.m. 6/30/33 All closed.	2:00 a.m. 6/30/33 All closed.	2:00 a.m. 6/30/33 All closed.	2:00 a.m. 6/30/33 All closed.
3:45 a.m. 6/30/33 Beginning to open.	3:45 a.m. 6/30/33 Beginning to open.	3:45 a.m. 6/30/33 Some opened wide.	4:00 a.m. 6/30/33 Opening.	4:00 a.m. 6/30/33 Few opening.	4:00 a.m. 6/30/33 Opening.	4:00 a.m. 6/30/33 Opening.	4:00 a.m. 6/30/33 Opening.

Examinations made in daytime between hours of 3:30 a.m. and 5:00 p.m. Stomata on all leaves opened at this time, though no leaf was observed on which all stomata were open at the same time.

CHART OF EXPERIMENTAL HOP YARD SHOWING PLANTS WITH DOWNY MILDEW

The accompanying chart shows the plants in the experimental hop yard which were infected with downy mildew.

At various dates for the three months' period from the first of April until the first of July, a record was made of each plant showing the downy mildew disease. At the time the record was made, the infected parts of the plant were removed and carried out of the yard. This material was saved for additional study.

The numbers on the chart indicate the dates on which infection was observed. The numbers refer to the following dates:

1 = April 25
2 = May 1
3 = May 11
4 = June 2
5 = June 12
6 = June 19
7 = June 29

All of these records are for mildew that came in naturally. The dates give some idea of the time at which mildew was spreading most rapidly. This appears to be during the month of June. Also, the chart gives some idea of the spread of the organism. Naturally, this chart cannot be used as a final guide of mildew spread because there are various types of plants both resistant and susceptible. At any rate, it shows the large amount of mildew which was present during the season. Also, it indicates that considerable mildew can be present and still not carry the yield below a ton per acre. Undoubtedly, most commercial yards had even more mildew than the experimental yard.

Row Numbers

Plant Species

Table No____

Mildew Record of Plants in Old Portion

of Experimental Yard Corvallis, 1932 and 1933

Plant No.	Type of mildew* 1932	Mildew** in 1933	Plant No.	Type of mildew 1932	Mildew in 1933
1-1	L	Removed	3-1	T	M
1-2	L	M	3-7	T	M
1-4	L	Removed	3-8	L	M
1-5	L	Removed	3-9	T	
1-6	L	M	3-10	T	M
1-11	L	Removed	3-11	T	
1-14	L		3-13	T	M
1-15	T		3-14	L	
1-16	L	M	3-16	T	M
1-18	L	M	3-17	T	M
1-19	B	M	3-18	T	M
1-20	L		3-19	T	M
1-21	B		3-20	T	M
1-22	B		3-21	T	M
1-23	B		3-23	T	M
1-24	L		3-24	L	
1-25	B		3-25	T	M
1-27	L		3-26	T	
1-30	L		3-27	T	M
			3-28	T	M
2-5	L	M	3-29	T	
2-7	L		3-30	T	M
2-9	L	M			
2-10	L	M	4-1	T	M
2-11	L		4-2	T	M
2-12	L		4-3	T	M
2-13	L		4-6	T	M
2-15	L	M	4-7	T	
2-17	L	M	4-9	T	
2-20	L		4-10	T	M
2-21	T		4-13	T	M
2-28	L	M	4-15	T	M
			4-16	T	M
5-1	T	M	4-17	T	M
5-2	T	M	4-18	T	M
5-3	T	M	4-19	L	M
5-6	T	M	4-20	T	M
5-7	T		4-22	B	M
5-8	T	M	4-23	L	M
5-9	T		4-27	T	M
5-10	B	M	4-28	T	M
5-11	T		4-29	T	

*L = Lateral spike **M = Mildew
B = Basal spike
T = Terminal spike

Plant No.	Type of mildew 1932	Mildew in 1933	Plant No.	Type of mildew 1932	Mildew in 1933
5-12	T	M	6-1	T	M
5-13	T	M	6-2	B	M
5-14	T	M	6-6	T	M
5-15	T	M	8-7	B	M
5-16	T		6-8	T	M
5-17	T	M	6-9	T	M
5-18	T	M	6-10	T	M
5-19	T	M	6-11	L	
5-21	T	M	6-12	L	
5-22	T	M	6-13	B	M
5-23	T		6-14	T	M
5-24	T	M	6-15	T	M
5-25	T	M	6-17	L	M
5-28	T	M	6-18	T	M
5-30	T	M	6-20	T	M
7-1	T	M	6-22	T	M
7-2	T	M	6-23	T	M
7-3	T	M	6-24	T	M
7-4	T	M	6-25	T	M
7-5	T	M	6-26	T	M
7-6	T	M	6-27	B	M
7-7	T	M	6-29	T	M
7-8	T	M	6-30	T	M
7-9	T	M	6-31	T	
7-10	T	M			
7-11	T		8-2	T	M
7-12	T		8-3	T	M
7-13	T	M	8-4	T	M
7-15	T	M	8-6	T	M
7-17	T		8-7	T	M
7-18	T		8-8	T	M
7-19	L		8-10	T	M
7-21	T		8-11	T	M
7-27	T		8-12	T	M
7-30	T	M	8-13	T	M
			8-19	T	
9-1	T		8-20	T	
9-4	T	M	8-22	T	
9-5	T	M	8-26	T	
9-6	T	M	8-29	T	M
9-7	T	M	8-30	T	M
9-8	T	M			
9-9	T	M			
9-10	T	M	10-1	T	M
9-11	T	M	10-2	T	M
9-12	T	M	10-3	T	M
9-13	T	M	10-4	T	M
			10-6	T	M
11-1	T	M	10-7	T	M
11-3	T		10-8	T	M
11-10	T	M	10-9	T	M

Plant No.	Type of mildew 1932	Mildew in 1933	Plant No.	Type of mildew 1932	Mildew in 1933
11-11	T	M	10-10	T	M
11-12	T T	M	10-11	T	M
11-13	L		10-12	L	M
11-14	B	M	10-13	T	M
11-15	B		10-14	T	M
11-16	T		10-15	T	M
11-17	T	M	10-16	T	M
11-20	T	M	10-17	T	
11-23	T	M	10-18	T	M
11-24	T	M	10-19	T	M
11-25	T		10-20	T	M
11-27	B	M	10-21	T	M
11-28	T		10-22	T	M
11-31	T		10-23	T	
			10-24	T	M
13-1	T	M	10-25	L	M
13-14	T	M	10-26	T	M
13-18	T	M	10-27	T	M
13-19	T	M	10-28	T	
13-21	T	M	10-29	T	M
13-25	T	M	10-30	T	M
13-27	T	M	10-32	T	M
13-28	T	M			
13-30	T		12-6	T	M
			12-8	T	M
14-6	T		12-12	T	
14-8	T	M	12-13	T	M
14-10	T	M	12-15	T	M
14-12	T	M	12-16	T	
14-13	T	M	12-17	T	
14-14	T	M	12-19	T	
14-15	T	M	12-21	T	
14-18	T	M	12-25	T	
14-21	T		12-26	T	M
14-22	T	M	12-27	T	M
14-23	T	M			
14-26	T	M	15-1	T	M
14-27	T	M	15-2	T	
			15-4	T	
16-2	T	M	15-6	T	M
16-3	T	M	15-7	T	M
16-6	T	M	15-9	T	M
16-10	T	M	15-12	T	M
16-11	T	M	15-13	T	M
16-12	T	M	15-14	T	M
16/24	L		15-16	T	M
			15-17	T	M
			15-18	T	M

Plant No.	Type of Mildew 1932	Mildew in 1933	Plant No.	Type of Mildew 1932	Mildew in 1933
18/1	L	M	15-20	T	M
18/4	L	M	15-28	T	
18/6	L	M	15-29	T	M
18/8	L	M	15-30	T	M
18/9	L	M			
18/10	L	M	17/1	T	M
18/11	L	M	17/4	T	M
18/12	L	M	17/7	T	M
			17/13	L	M
			17/30	T	

MEETINGS AND FIELD DAYS

The hop breeding work was discussed at various meetings throughout the year. At some of these meetings only the technical work of developing a mildew-resistant hop was discussed, but at other meetings all phases of the hop crop were taken into consideration.

The first meeting attended was on January 27. At this luncheon the writer discussed hop breeding before the Lions Club at Corvallis, Oregon.

On Thursday evening, April 6, the writer discussed hop growing before the Donald section of the Hop Growers Association at Donald, Oregon. There were about 50 growers in attendance.

On April 14, a meeting was addressed at Puyallup, Washington. This meeting was attended by about 45 growers of that western Washington Section. Heavy losses from downy mildew have been obtained by these growers. Examinations of the yards before the meeting indicated the desirability of growing Fuggles in that section. It was suggested to growers that Fuggles was their best possibility at this time.

On May 9 and 10, most of the hop growers in Clackamas County were visited in a tour arranged by the County Agricultural Agent. These visits consumed considerable time but were of real value to both the writer and the growers. It was an excellent opportunity to study mildew early in the season and also to observe some of the other conditions, particularly "blight", which has caused some damage in the Eagle Creek section of that county.

The same type of tour was conducted on May 22 in Washington County in cooperation with the County Agricultural Agent. Mildew was present in

most of the yards at that time, but cold weather was keeping back both the hop crop and the mildew disease.

On June 24, there were ten farmers from Clackamas County, accompanied by their County Agricultural Agent, in the experimental hop yard. These growers were told of the type of work that was being conducted in these trials.

On June 29, fourteen farmers from Washington County accompanied by their County Agricultural Agent visited the experimental hop yard at Corvallis and the work that was going on was explained to them.

On July 7, there were about 200 farmers from Benton County with their County Agricultural Agent at the experimental hop yard to see the trials which were being conducted.

On November 18, the Second Annual Hop Growers Meeting was held at Salem, Oregon.

In addition to these various meetings and delegations of growers in the experimental yards, there have been many individuals from all parts of Oregon and other states visit the experimental yard. An outstanding visitor was Dr. Rexford Tugwell, Assistant Secretary of Agriculture, who, on August 31, observed the work in the experimental hop yard with great interest. It requires considerable time to show these things to visitors but in nearly every case much is gained from the practical experiences of many of these hop growers. It is hoped that in 1934 a large meeting may be held in the experimental yard. By that time excellent production of many of the new developments should be underway and there should be enough things of value to warrant a field day.

Figure XXII

Many visitors were shown the outstanding things in the experimental yard. On this date there were about 200 farmers in the delegation.

Figure XXIII

Another view of a delegation visiting the experimental yard and their cars.

CHROMOSOME STUDIES IN HOPS

In order to make some chromosome studies of various types of hops including male and female plants of both of the hop species Humulus lupulus and Humulus japonicus and particularly some plants which were showing sex reversals, flowers were collected during the growing season. Because of lack of funds and time it was impossible to study these flowers during the growing season and so they were fixed in Carnoy's killing fluid.

As yet none of these flowers have been studied, but they appear to have darkened somewhat. It is not known whether this will affect the studies of the chromosomes.

It is planned to not only imbed and study some of this material later on, but also to stain this fixed material with Bellings aceto-carmine solution.

Both Carnoy's fluid and Belling's stain are described in the following:

ACETO-CARMINE STAIN FOR CHROMOSOMES IN POLLEN MOTHER CELLS

Preparation of Stains: To 100 c. cs. of 45 per cent glacial acetic acid, add enough carmine to give a saturated solution at boiling point.

Put the stain in when cold and bring to a boil. Do not boil for any length of time.

Cool and filter the stains through enough filter to give a clear liquid.

This stain was first used on fresh collected material. A few drops of full strength stain are put on a slide and the young anthers opened up in this. The mother cell frequently separates from

the anther wall. In such cases, remove the anther walls with the edge of the cover glass so that the stain will contain mostly mother cells. Put the cover glass on carefully and let the slide dry in the air until evaporation has drawn the slide and cover glass close together. The slide can be kept for some time if it is then sealed around the edge with paraffin.

Although this stain is generally used with fresh material, it has been successfully used on killed and fixed material. A killing fluid such as Carnoy's that bleaches the buds is satisfactory. In staining killed material, it is often necessary to dilute the stain a little, using 45 per cent acetic acid or even full strength glacial acetic acid.

A trace of iron in the carmine stain improves considerably the chromosome preparation. Sufficient iron to serve the purpose will be obtained by the use of steel dissecting instruments. However, too much iron is to be avoided and some workers use bone instruments to keep from overstaining with iron. No iron is better than too much.

The Carnoy's solution is made up of six parts of absolute alcohol, three parts of chloroform and one part 45 per cent glacial acetic acid.

These are the directions given by Dr. A. E. Longley of the Biophysics Laboratory, Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C.

WITCHES BROOM

The peculiar hop plant which the writer has designated witches broom was common in the seedlings. No less than fifty of these plants have been found in the breeding trials to date. In general, these plants produce a large number of vines which, as a rule, get no higher than one or two feet. In some cases there are as many as 200 of these small vines per plant.

The vines show no tendency toward vining and will not climb the hop strings. Apparently, most of the strength goes into the production of additional shoots rather than the extension of them. There appears to be no dominant vines and all ordinarily are of about the same type of size.

Inasmuch as practically all of these have been dug and removed from the experimental yard, there was an opportunity to observe the root growth. In every case the roots showed a gnarled, knotty condition. Both the peculiar type of root and above-ground growth are plainly shown in the accompanying illustration.

It is not known whether the root condition causes the above-ground growth or vice versa. Also, it may be possible that the two symptoms are the result of this abnormal condition. Inasmuch as the condition is commonly noted in seedlings, it appears that it is inherent rather than pathological.

One plant of this type was observed in a grower's yard and other growers have stated that these plants have been seen, but rarely. Ap-

parently, the breeding work is bringing out this character which may be a recessive and ordinarily covered.

Even though these plants have been removed from the experimental yard, they have not been destroyed, but have been placed in a nursery row for additional observation and study. Some two-year-old plants exhibit the condition and show no signs of becoming normal.

Figure XXIV

"Witches broom", an abnormal plant commonly found in seedlings.

Figure XXV

Another view of a "witches broom" plant. Note the knotted condition of the roots.

Figure XXVI

A portion of the propagating bed at the experimental yard, Corvallis 1933. Thousands of seedlings are grown in this bed for transferring to the greenhouse and nursery.

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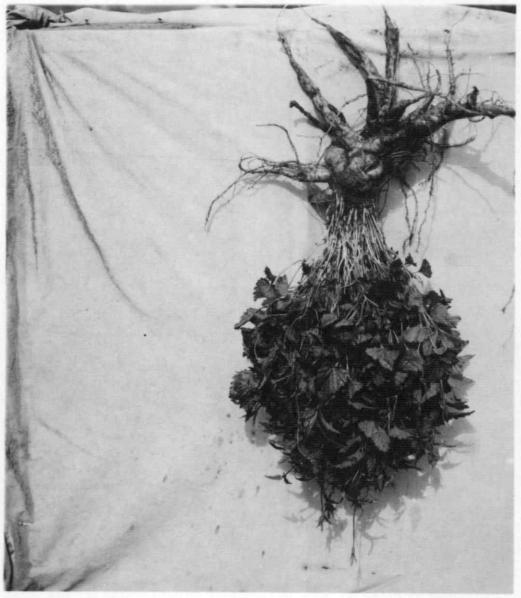
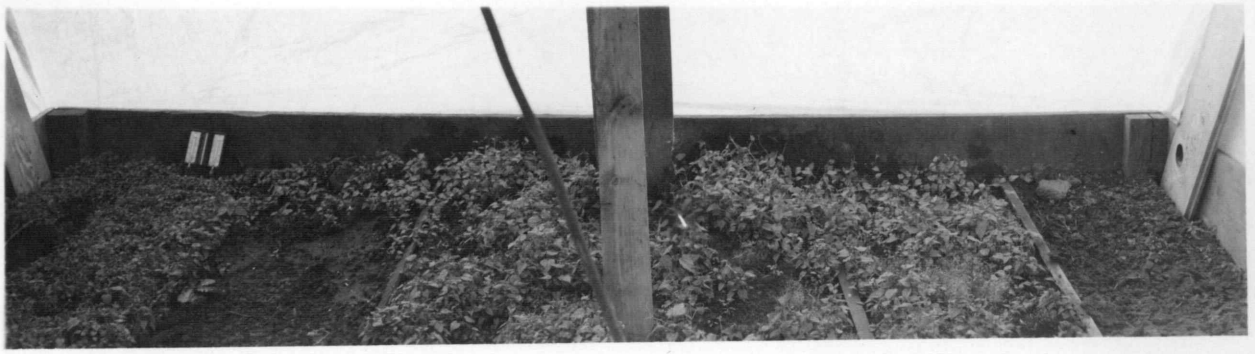




PROPAGATING BED

A propagating bed constructed at one edge of the experimental yard was described in the last annual report. This bed has been of real help in germinating seeds and obtaining seedlings for transferring to the greenhouse and for growing the mildew organism.

Similarly to last year, good results have been obtained in the propagating bed. In March enormous numbers of seedlings came up in the bed. Quadrats laid down in various parts of the bed demonstrated that there were at least 25,000 seedlings growing in this small bed at that time. Most of those were crosses between Fuggles and Late Cluster males. It is necessary to grow seedlings on a large scale if many plants are to be grown to maturity. There were so many seedlings in this propagating bed, however, that all of them could not be transferred to the greenhouse. In June, therefore, large numbers were transferred to a small nursery established in the field. These grew in an excellent fashion, particularly because they were watered. They were inoculated with mildew by pouring germinating spores on them at various times during the season. It was hoped to eliminate the susceptible and weaker plants. Much of this was accomplished for several of them passed out of the picture. On the other hand, this nursery will yield about 2,000 desirable plants for transferring to the yard. In fact, several plants in the nursery were transferred to the main yard during the season, a few this fall and next spring it is hoped to use more of them if there is room.

As early as August, 1933, some seeds were planted in the propagating bed. In September large numbers were planted and just as soon as they come up and make a growth of a few inches they are

transferred to the greenhouse where they are forced, by means of heat and artificial light, to make sufficient growth for transferring to the main experimental yard.

Of course, in addition to the propagating bed, large numbers of the seeds are planted in small flats. These flats were planted during the month of September and placed out of doors so that they would be exposed to the normal days and cool nights. Most of the actual hybrids made between specific plants are grown in these flats so that the seeds from each hybrid may be kept separate.

Undoubtedly, seeds of better inheritance are obtained each season. Each year's work gives one an opportunity to observe the good and bad points of the various plants in the experimental yard and select better parents. Also, since practically all varieties and types grown in this country and many from foreign countries are now grown in the experimental yard, it is not so necessary to go around to various yards and pick up seeds which may or may not be of value.

HOP INSECTS IN 1933

Various insects have been reported as doing damage on hops this year. Apparently the greatest damage was caused by aphids which were plentiful at ordinary time of spraying in July and in larger numbers late in August and September. This second attack did considerable damage in many of the yards, particularly the larger ones which had considerable mold because of this aphis attack. The attention of the growers was called to the possibility of spraying in sections of the yard that were usually attacked with aphids or yards that were to be picked last. The use of various dusts in this connection was suggested. In fact, one of the larger yards, Horst, dusted late in August with success. They are of the opinion that it would be worth while to dust an entire yard before picking if aphids appear to be a problem.

Attacks of red spider were not great this year but did some damage, as usual, to the Fuggles variety. Some growers had to pick their crop a little earlier than usual because of damage from spider. In general, however, growing conditions and the green condition of the plants were not favorable to spider.

Damage was reported, particularly to seedlings, from slugs and spittle bugs early in the season. A strawberry insect also was reported as causing some damage to one planting. Again, many growers were alarmed at the damage caused by the common wood borer. Specimens of these were obtained from one yard for identification. There are many hop insects and from time to time they do sufficient damage to direct the growers' attention to them.

SPRAY FOR APHIDS

The experimental yard was sprayed for aphids on July 14 and 15. At this time a limited number of aphids were showing and it was rather doubtful if spraying was necessary. Inasmuch, however, as practically all other growers were spraying and the hops were of value, it was decided to spray the yard and also vary the material somewhat so we could get some observations, at least, on standard sprays.

Standard Blank Leaf 40 was used at the rate of 3/4 pint to 100 gallons of water. The spreader was varied somewhat. In the first few rows a colloidal spreader known as "Fluxit" was used in varying amounts up to one pound per 100 gallons. Observations indicated that it was not doing a thorough job of spreading and so various amounts of fish oil-resin spreaders were used for the rest of the yard. In general, it appeared that one quart of fish oil resin spreader was satisfactory. This is the same spreader that has been recommended for Bordeaux spray.

In the experimental yard, practically no aphids or mold was noted. Possibly, this was due to the early picking of the yard inasmuch as practically the entire crop was picked by the first week in September. Possibly, greater attacks of aphids would have occurred later in September in this same yard, as they did in many of the yards which did not complete their picking until the fourth week in September.

Many growers are still using the ordinary quassia spray and comments heard this year indicated that even the quassia did not give the lasting effect that it is supposed to give. On the other hand,

possibly the yards sprayed with quassia did not suffer as greatly as those that used Black Leaf 40.

Some yards, particularly the Horst Yard at Independence, did some dusting in August with both airplanes and ground machines. They are of the opinion that this offers great possibilities and that it saved considerable hops. The foreman was of the opinion that the entire yard should have been dusted for aphids again in August, and apparently he plans to use a dust just before picking time next fall.

Our growers have been repeatedly told of the apparent relation between prune trees and hops as far as the life history of the hop aphid is concerned. It is commonly known that a hop aphid over-winters in the egg stage on the bark of prune trees. Nevertheless, some hop yards also have prune orchards and the largest yard in Oregon has a large sized prune orchard almost in the center of the yard. Large numbers of aphids were noted in several yards many weeks after picking. Frost was late and vines remained green longer than usual.

EXPERIMENTAL HOP DRYER

Until this year much difficulty was encountered in getting small samples of hops dried properly. Previously some of the small lots were dried in loose woven sacks hung on the trellis in the hop yard and others were dried in the prune drier in the Horticultural Products Building. The latter was not satisfactory because, ordinarily, heat was not available at that time of the year.

This year we were fortunate to be able to make use of the experimental dryer constructed by F. E. Price in the Agricultural Engineering Building on the campus. Mr. Price utilized a corn dryer which he had constructed the season before. This corn drier made use of an electrically driven fan and an electric heater. The fan forced the heated air through the material to be dried. In converting this corn dryer into a hop dryer it was necessary to change the container for the material to be dried. A kiln about eight feet in height and six feet square was used as a unit. It was found that this kiln required some 300 to 400 pounds of green hops to get a test on drying, and so the kiln was reduced in size so that smaller units of about 100 pounds could be utilized. Finally the entire drying unit was suspended on a Fairbanks-Morse butcher scale of a beam type. The dryer is shown in the accompanying illustration.

In addition to having hops from individual plants dried separately, some information was obtained on different methods of drying, a comparison of seeded and seedless hops, hops picked on different dates, etc.

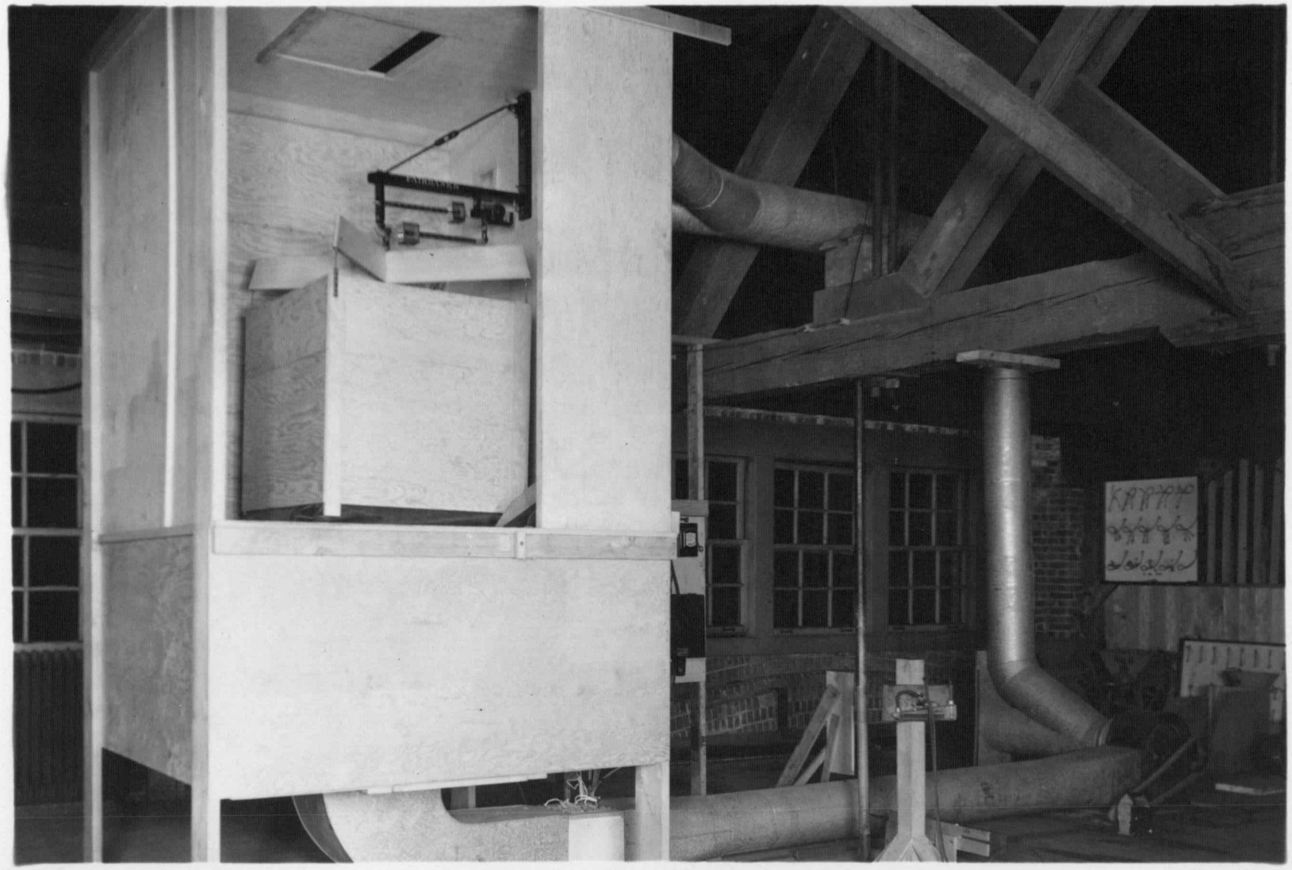
As soon as the hops were dried samples of about one pound of dry hops were baled in the small experimental baler described in the

last report. These bales were then stored at low temperatures in a refrigerator room in the Poultry Building. About the middle of October these samples were divided and half of each sample was forwarded to Mr. Frank Rabak, of the Division of Drug and Related Plants, United States Department of Agriculture, Washington, D. C. Mr. Rabak plans to analyze both resins and oils. It is hoped that this information will complete the picture of new hops developed. Our program is outlined to obtain data on mildew resistance, yield, time of maturity, quality as to resins and oils, physical appearance, and other factors which influence the value of a hop variety.

Figure XXVII

Experimental dryer located in the Agricultural Engineering Building at Corvallis, 1933.

Crop from individual plants dried here.



FIBER IN HOP STEMS

The hop plant is well known for the tough stem which it produces. Growers have often expressed an opinion that this stem should be of some commercial value and have indicated that they would like to know something about its fiber. The opportunity presented itself this fall to get some information of this type. Some stems of three year old plants in the experimental hop yard were turned over to Mr. B. B. Robinson, Specialist in Fiber Flax at this station. Mr. Robinson retted these stems and also put them through the flax machine. He stated that the fiber is of poor quality and broke up into small lengths about 1/2 inch long. He stated that the fiber was so poor that it would not be of value even for tow.

Apparently, some other use must be found for hop stems if they are to be used commercially. Some growers are plowing them under as a green manure crop, but they find that they do not rot readily and are in the soil more than a year. Most growers, however, burn the entire plant as soon as it is cut from the hill after frost in the fall.

SEEDLINGS GROWN IN THE FALL OF 1933

Before the 1933 crop had been harvested, plans were being made for producing new seedlings for 1934. In the propagating bed, located at the experimental yard, green seeds were planted in the last of August. Later, about the middle of September, the bed was entirely planted with seed from various outstanding plants.

In addition to the propagating bed seedlings, others are being grown in flats kept out-of-doors at the greenhouse. Hybrids made between specific male and female plants are kept separate by growing the seeds in individual flats. Also, some seeds are placed in cold storage to help in overcoming dormancy.

Last year, no new seedlings were obtained until November, but this year the first seedlings appeared on October 18, and many have been obtained before the date of first appearance previous to this season. This may be due to differences in dormancy of the seed and possibly environmental conditions this year.

In the greenhouse space has been leased for one large bed to grow seedlings. Many seedlings from out-of-doors have already been placed in this bed. It is hoped that at least one other large bed can be utilized if it is available. In general, these seedlings are grown with the aid of artificial light. Ordinarily the lights are turned on about four o'clock in the afternoon and turned off about eleven p.m. by means of an alarm clock.

It is hoped to produce at least 2,000 new seedlings this winter season and have them ready to be transferred out-of-doors in the spring. It appears that there will be little or no room for these seedlings in

the experimental yard. Seedlings will therefore possibly have to be kept in nursery rows if arrangements can not be made for additional land for a hop yard. Last spring the propagating bed yielded so many seedlings of Fuggles x Clusters parentage that many of them had to be transferred to a nursery row. This was a successful method of handling the seedlings and yielded a large number of excellent plants.

As the work progresses better parental material is obtained, and the seedlings should be of greater value. At any rate, the project will either have to go ahead or fall back.

HOP GROWING IN OTHER SECTIONS OF THE UNITED STATES

There is keen interest in hop growing in all sections of the United States. Naturally the greatest interest is in Oregon, Washington, and California, and some interest in Wisconsin and New York, former hop-growing regions. Inquiries on the growing of hops, however, are from various sources.

In the six months previous to May, 1933, 162 letters in regard to growing hops were received and answered by the writer. The letters received were from the following states: Oregon, 93; Washington, 20; California, 14; New York,6; Florida, 3; Pennsylvania, 3; Oklahoma, 2; Michigan, 2; North Carolina, 2: Louisiana, 2; Arizona, 2; Minnesota, 1; Montana, 1; Virginia, 1; Ohio, 1; Connecticut, 1; Texas, 1; Illinois, 1; New Mexico, 1; Massachusetts, 1; Tennessee, 1; Colorado, 1; Wisconsin, 1; and Mexico, 1. In all of these cases, as well as in regard to letters received later, the inquiries were properly answered, and the inquirer furnished with at least two publications, Farmers Bulletin 304, and Oregon Station Bulletin, No. 288.

In many cases the factors involved in hop growing were pointed out the hop growers, and the growing of this crop in all sections by everyone was never advised. In fact no one was encouraged to go into hop growing unless they were well equipped both in experience and funds.

Naturally, during the summer months there were not so many inquiries in regard to hop growing. Nevertheless, several inquiries were received. Then in the fall of 1933, inquiries began again. In September, for example, 32 letters in regard to hop growing were received. These letters were from the following states: Minnesota, Iowa, Montana, Florida,

California, New York, Washington, Idaho, Oregon, Louisiana, Connecticut, and Wisconsin. Likewise, these inquiries were promptly answered and as much information as possible was given to the inquirer.

There was no official or definite information available on increased acreage, but various reports, including those from dealers, indicated that the new plantings in 1933 was about as follows: Oregon, 4,000 acres increase; California, 2,500 acres increase; and Washington, 1,500 acres increase. Plantings in other states, if any, were small, due to lack of information, and particularly lack of root cuttings.

The situation in New York, because of its former importance in hop growing, is of interest. A portion of a letter dated May 15 from H. B. Hartwig, Extension Agronomist in charge of hop growing is as follows:

> "I am told that Pindar Bros. of Middleburgh who were out of the hop business for a number of years did have a few New York hops growing around their hop house. At present, these men are setting out 12 acres of Oregon hops. As explained in previous correspondence, they may not be able to name the varieties growing around their hop house.
>
> "The following persons have grown hops continuously since prohibition:
>
> Charles Hazard of Clinton, N. Y.
> Mark Ruth of Clinton, N. Y.
> Albert Brandis of Deansboro, N. Y.
> Miss Rose Onion of Clinton, N. Y.
>
> "It is possible that some of these persons have hops under variety names. If I could visit them all in a day's time I would drive over and get the roots for you, but to visit the above five persons would take three days. I have never contacted these people and under the present conditions it would be a little difficult for me to correspond with them."

On March 3, letters were directed to the various state departments of agriculture in states which had reported hop growing in previous years. California was the only state that furnished any information of value.

In nearly every case the State Department of Agriculture was entirely ignorant of hop growing possibilities and had no information whatsoever on the crop. Apparently there is both lack of information and appreciation of hop growing. It has always been a specialized crop and more than likely always will be, because of its specific demand and rather high cost of growing.

RADIO TALKS ON HOPS

During the year 1933 at least nine different radio talks were given over Station KOAC. For the period June 1 to September, or during the growing season, a talk of fifteen minutes duration was given every other Thursday evening at eight p.m.

It is difficult to find out just how many hop growers listened to these talks, as apparently they do not answer requests. Conversations with growers, however, bring out the fact that they have listened at various times. It seems that these talks are of some value, particularly during the growing season.

One of the talks "How About Going into the Hop Business" was mimeographed by the United States Department of Agriculture, and used to answer inquiries. Others of the talks were used as a basis for articles in regard to hop growing.

The titles of the talks and the dates on which they were given are as follows:

Dates	Titles
February 23	"How About Going Into the Hop Business?"
May 18	"What We Are Doing in Hop Breeding"
June 1	"Hop Improvement"
June 15	"Training and Stripping Hops"
June 29	"Cultivation of Hops"
July 13	"Male Hop Plants"
July 27	"Experimental Hop Yard"
August 10	"Hop Yard Activities"
August 24	"Visit to Experimental Hop Yard"

AMOUNT OF WIRE NEEDED TO TRELLIS HOP YARDS

Many growers, and particularly beginners, have requested information in regard to type of hop trellises to construct and also kinds of wire to use. The Columbia Steel Company of Portland, Oregon, was asked for this information and they kindly furnished the accompanying table.

The table shows the amounts of wire of different sizes needed for what they call, the "line or string" wire. This is similar to what many growers call the "down" wire. In other words, it is the smaller wire which is let down at picking time. They give the amount of wire of different sizes for different spacings which are commonly used.

The second portion of the table gives the amount of wire used in different spacings for the cross or main trellis wires. It must be noted that both the information in regard to distance between hills and the spacing of the wire is necessary to compute the amount needed.

The third portion of the table gives the amount of wire used for anchors. Ordinarily growers use heavy wires for anchors and usually the same weight as used for the cross wires.

Finally, there is given some information in regard to the number of feet in one pound of steel wire.

Table No____

ESTIMATED NUMBER OF POUNDS OF WIRE PER ACRE TO TRELLIS HOP YARDS

LINE OR STRING WIRE

	8-Ft. Hills	7-1/2 Ft. Hills	7-Ft. Hills
#6 ———	535	570	610 lbs. per acre
7 ———	465	495	520 " " "
8 ———	382	408	437 " " "
9 ———	318	340	364 " " "
10 ———	265	283	303 " " "
11 ———	210	225	240 " " "
12 ———	160	171	183 " " "
14 ———	90	96	103 " " "

CROSS OR TRELLIS WIRES

	8-Ft. Yard Spaced-5 Hills	7-1/2 Ft. Yard Spaced-6 Hills	7-Ft. Yard Spaced-7 Hills
#2/0 ———	326	290	266 lbs. per acre
1/0 ———	280	250	230 " " "
1 ———	238	210	195 " " "
2 ———	206	184	170 " " "
3 ———	178	160	145 " " "
4 ———	151	135	123 " " "
6 ———	110	98	90 " " "

ANCHOR WIRE - 30 FT. LENGTH

#2/0 ———	8.71 lbs.
1/0 ———	7.49 "
1 ———	6.37 "
2 ———	5.50 "
3 ———	4.73 "
4 ———	4.03 "

ESTIMATED NUMBER OF FEET IN ONE POUND OF STEEL WIRE

Gage	2/0	1/0	1	2	3	4	6	7	8	9	10
Feet	3.10	3.24	4.68	5.44	6.31	7.39	10.17	11.97	14.29	17.05	20.57

Furnished by

COLUMBIA STEEL COMPANY
PORTLAND, OREGON

Figure XXVIII

Ford truck was utilized in the hop training operation.

Figure XXIX

Another view of "training on the wire."

It is planned to use a platform on the top of the car next season.

HOP VARIETIES

Practically every crop has many varieties and these varieties differ greatly in their adaptation to environmental conditions, yielding ability, disease resistance, time of maturity, susceptibility to damage from cold, quality of product, and other factors that are of importance in determining the choice of a variety to grow. In hops we find that all of these factors are somewhat different in the more than 100 varieties grown in the various parts of the world.

Ordinarily, vegetatively reproduced crops like hops have a limited number of varieties and there is not the wide choice of varieties that we find in such crops as wheat and corn which are reproduced by seed. Still most all crops may be reproduced from seed if necessary and so new varieties can be developed. This is the situation in hops. It is a crop that is normally reproduced by "root cuttings" but it may be reproduced from seed. The plant breeder, therefore, has a ready method of producing new varieties and retaining them after they are developed. In the first two years of hop breeding work we have grown 10,000 seedlings in the greenhouse and transferred them to the field for additional testing.

Varietal names are of real importance to the grower. There is a great need for an accurate classification of all varieties and it is a task that we plan to complete as soon as time and funds permit. On the other hand, the trade tends to designate hops by the name of the locality where grown. For example, "Oregons" refer to hops grown in Oregon, "States" is used to designate hops grown in New York state, "Mendocinos" and "Sonomas" refer to California districts, and so on.

It is commonly believed that the environmental conditions affect the quality of hops.

Three Main Varieties in Oregon

In Oregon there are but three main varieties of hops. These three varieties in the order of their importance are Late Cluster, Early Cluster, and Fuggles. The Late Cluster variety makes up about 75 per cent of the acreage, the Early Cluster another 15 per cent, and the Fuggles the remaining 10 per cent. There are many other varieties of hops, a few of which are grown each year as mixtures in one of the above mentioned varieties and others on a very small scale.

First, I will discuss the standard Late Cluster variety, which is also called English Cluster by some growers. It is claimed that the Late Cluster is similar to the English Grape variety. The Late Cluster variety is our highest yielding one. It has a high resin content as measured by its antiseptic value, and in general it has a good reputation with the trade. Some references, however, note that its odor is not as desirable as some other varieties for certain uses. This is the common variety in the Yakima and Puyallup sections of Washington. The California hops are similar but apparently of different origin.

There has been some difference of opinion in regard to the mildew resistance of the Late Cluster variety. My observations have revealed that in general it is susceptible and neither much better or worse than the Early Cluster variety. It is the standard variety that I would recommend to any new grower, for I feel that he would have less difficulty with it and that it would be readily accepted by the trade. In our actual

field trials which have only been underway two years, the Late Cluster variety yielded 210 pounds, or one bale of hops per acre in its first year, when ordinarily no hops are picked. In the second year, when most growers get about a half a crop, it produced 1,220 poundw, or six bales per acre. I look for at least twice that amount in its third year of production, which would be a high yield on good river bottom soil where our experimental yard is located. Picking of the Late Cluster variety in Western Oregon usually begins about September 3, and the season lasts most of the month.

The second most important variety in Oregon is known as Early Cluster. Apparently this variety originated from a mutation developed in a yard of Late Clusters near Albany, Oregon, in 1908. Two early plants were found by a grower and roots from them used to increase and develop the new variety. The Early Cluster variety got its real start a few years ago when Wm. Magness, a hop grower at Wheatland, Oregon, produced 3,000 pounds of dry hops per acre of this variety. This excellent yield attracted considerable attention and a great demand for the variety. The variety was extremely popular until 1930, when it was found to be extremely susceptible to the downy mildew disease, and most growers gained the opinion that it was more susceptible than any other variety. The variety is a fast grower and capable of producing a large crop under favorable conditions. In its first year of production in our yard, Early Cluster yielded 256 pounds, and in the second year it yielded 845 pounds per acre. In general, it is ready to pick about 10 days before the Late Cluster. In addition to being very susceptible to mildew, it is readily attacked by aphids.

The third variety in importance in Oregon is Fuggles, an English variety, and it occupies a peculiar and interesting place. Right now the outstanding characteristic of this variety is its resistance to downy mildew. Although mildew has been found on this variety, there is no doubt that it has a high degree of resistance, and for practical purposes it can be called resistant to downy mildew organism. On the other hand, Fuggles has some limiting factors such as low yields, limited demand, which is chiefly by English and Canadian buyers, and susceptibility to red spider. In the trials referred to previously, Fuggles produced only 27 pounds of dry hops per acre the first year, and 382 pounds the second year. Of course, these figures should not be compared to the yields ordinarily given because yields for the first two years as a rule are not computed. I have had reports of yields better than a ton of dry hops per acre from this variety under good river bottom conditions.

Varieties of Minor Importance

There is a fourth variety which is fairly common in Oregon yards, but there are so few exclusive plantings of this variety that ordinarily it is not included as one of the chief varieties. This variety is known as the Canadian Red Vine or Red Vine. The total amount of this variety is possibly a few hundred acres. Most yards of Late Cluster, however, have a few hills of Red Vines scattered through the field. In general, pickers do not like the Red Vine because it is hard to pick, as the hops and leaves are intermingled. On the other hand, it is a high producer and imparts a characteristic odor to hops which is desired. Several growers state that Red Vines are more susceptible to red spider than any of the other varieties. In addition, it is a little later than the Early

Cluster in maturing. Apparently it is a little more resistant to the downy mildew organism than either the Early or Late Cluster but not nearly as resistant as Fuggles.

There have been other varieties grown in Oregon, and I am told that several of them are the result of importations made by Stephen Smeed, of Eugene, Oregon. He came to Oregon from Sussex, Kent County, England, a prominent hop growing section, and on the way spent a few years growing hops in Wisconsin. I am informed that many years ago he grew six varieties as follows: English Cluster, Prolific, German Grape, Jones, Cobbs, and Fuggles, and decided that the English Cluster and Fuggles were the best varieties for this section and discarded all but those two varieties.

Linn & Linn, of Albany, Oregon, are growing a variety known as Bavarian. It is a little earlier but similar to the Late Cluster and is high yielding. Also, our tests have shown that it has a high antiseptic value. In its second year of growth we produced 3,000 pounds of dry hops per acre with this variety on good river bottom land. It is, however, rather susceptible to mildew and a little difficult to pick.

Another variety of interest is grown by Frank Miller of Forest Grove, Oregon. This is a variety somewhat similar to Fuggles but earlier in maturing. It is strikingly resistant to the downy mildew organism. In cases where mildew is bad, this variety may have a place, but more than likely its chief value will be as a parent in making hybrids with the Cluster types, so that one can get a new hop that has its mildew resistance and the desirable characteristics of the Cluster variety.

Several Varieties Imported

In 1931 we introduced two new varieties from foreign countries. The M-45 variety was obtained from Professor E. S. Salmon of the Southeastern Agricultural College at Wye, England, and the East Kent Golding was obtained from British Columbia. Both of these varieties were supposed to be resistant to downy mildew, but in our trials we have found them to be susceptible. Neither is well adapted to our conditions, but I hope that they will have some value in our breeding work to develop better varieties for this section.

In 1932 we introduced root cuttings of ten different varieties and seed of six varieties from foreign countries. None of these varieties, however, have made sufficient growth as yet to tell a great deal about them, but many of them are of the Fuggles type, having dark green, heavy leaves. Possibly this type of growth is in some way connected with mildew resistance. In the 1933 season I look for some extremely interesting and valuable things from these new varieties. The new varieties that were obtained in 1932 are as follows: Spalter, Elsasser, and Semsch, from an experimental station in Germany. From an experiment station in Czechoslovakia I obtained the Golding (mildew resistant) variety, and from another German station I got the following mildew resistant varieties: Rottenburger Spat, Striesselspalter, tauer. From a large hop importing company in Germany I obtained two valuable varieties: Auschaer Rothopfen and Muhlviertler Grunhopfen. The seed came from Tasmania and was from the varieties White Grape, Late Grape, Kent Golding, Fuggles and Golden Cluster.

I have a list of about a hundred different hop varieties. I doubt if all of them are different. Many of the names are synonyms;

that is, different names are given for the same varieties in different localities. Inasmuch as hop growing is limited to rather certain definite sections, I feel that it is possible to get all the known varieties and with the aid of federal authorities I am attempting to do so. For example, I recently received a notice that from Italy we are to receive three interesting varieties: Saaz, Spalt, and Alsaziana.

From France we are to get eight different varieties as follows: Spalt, Alsace, Landhopfen, Samling, Burgander, Tige verte, Tige blanche, ad Striesselspalter. The latter is said to be the most downy mildew resistant variety on the European Continent. It will be of interest to compare all of these varieties with the ones that we now grow and to test them for mildew resistance under our conditions. In addition to these varieties that I have previously mentioned as resistant to mildew, the following have been reported as resistant: Buvrinnes, Saaz, Bohemian Grunhopfen, Wurttemberg, Aussoha, and Schwetzinger. A recent notice tells me that these have been shipped to me from Germany to test for adaptation, yield ability, and quality, and to use in our breeding work. One can readily see that there is a large amount of material to work with and that the possibilities of hop improvement through better varieties are great.

Watch for Outstanding Plants

In addition to having many hop varieties already developed and the possibilities of developing many new ones from seed, there is also a somewhat limited possibility of getting superior plants by natural mutation from varieties that we are now growing. In general, hop varieties do not change greatly, but a Late Cluster apparently is always a Late

Cluster until in rare cases something upsets it and changes its inheritance. Undoubtedly this is what has happened in the development of the Early Cluster variety and we may be able to get other individual selections of value. For example, in a yard near Dallas, Oregon, there is an outstanding hop plant from which we have obtained cuttings. Possibly this difference is heritable and not just due to an unusual seasonal condition. In many other yards there have been plants not outstanding because they were exceptionally good but outstanding because they were undesirable, many plants with golden color in their leaves with various stripings, etc.

Undoubtedly there are other valuable hop varieties. I feel sure that some grower may have a few plants of a variety that is different. I am interested particularly in plants that have shown resistance to mildew, and I would like to include them in our experimental yard.

Figure XXX

General view of experimental yard early in the season just after training the vines on the wire, 1933.

Figure XXXI

Another general view of the experimental yard. Note the method of numbering each hill in the yard.

THE CULTIVATION OF HOPS

Hop yards are kept in an excellent state of cultivation and growers pride themselves on the condition of their yards. In general, most of them do a thorough job of cultivation, and, in fact, some are possibly spending too much time and money in doubtful cultivation practices. At any rate, cultivation is an important and costly operation in the production of hops, and any factors that will help to increase the effectiveness of cultivation and possibly reduce the cost should be investigated by all growers.

Cultivation is not only an important practice in the production of hops, but also in the production of other well known crops. For example, cultivation of corn, potatoes, orchards, berries, and truck crops must be thorough to produce the maximum quantity of quality products. We have actual experimental evidence in regard to the desirable practices in the crops just named, but I am doubtful if we have many actual experimental trials to determine the value of number of cultivations, depth of cultivation, time of cultivation, different types of implements, and other important factors as far as the hop crop is concerned. I believe, however, that we can draw some conclusions from the work with other crops and also draw on the great fund of observation which many of our leading hop growers have gathered.

Before suggesting desirable cultivation practices, it is essential to point out just what cultivation does. There are a large

number of beneficial results which have been assigned to the cultivation practice, and some are as follows:

1. Kill weeds
2. Aerate the soil
3. Increase available plant food
4. Conserve moisture
5. Improve the tilth
6. Stop soil erosion
7. Loosen the soil
8. Increase organic matter
9. Germinate weed seeds
10. Mix the various soil constituents

Many have been lead to believe that these practices are important and operative in all cases of cultivation. This is somewhat misleading because many of them are important only under special soil conditions, such as heavy soils which tend to bake. In extremely dry years extra cultivation may be profitable. Undoubtedly the one really valuable thing that cultivation does, under ordinary soil conditions, is to kill weeds. Cultivation, therefore, should be so designed as to kill weeds efficiently and cheaply. Maybe the largest number of trials to prove the importance of the weed factor in cultivation have been carried on with corn, and practically all of these trials have shown that the killing of weeds is the all-important object. Trials of this sort have been conducted in Minnesota, Illinois, and Kansas, and we have similar results in Oregon. For example, at the Kansas Station, over a period of seven years, they were able to get the same yields of corn regardless of the type of cultivation, as long as the weeds were killed. In fact, where they gave no cultivation and only scraped the weeds with a hoe, the yields were as large as where they cultivated the crop during the entire season. In Illinois, as a six year average, they were only able to get

seven bushels of corn per acre where the weeds were allowed to grow, but if the weeds were scraped with a hoe, the yields were 53 bushels per acre. Ordinary cultivation also gave a yield of 53 bushels per acre. In other words, they were convinced that as soon as weeds were killed their job of cultivation was done.

Here in Oregon we have obtained similar results during the past two years. On good river bottom soil, which is typical of much of our better hop land, we found that ordinary cultivation yielded 70 bushels per acre, plots that had the weeds scraped with a hoe yielded 80 bushels per acre, and those that received no cultivation and the weeds were allowed to grow yielded only 30 bushels per acre. There was some little difference in the average yield of the plots that got ordinary cultivation and those that had just the weeds scraped in 1932, but in 1931 those plots yielded practically the same. I believe that the difference in 1932 was not due to the advantage of intensive cultivation, but there was not a thorough job of hand hoeing in the plots that had the weeds scraped. In other words, I am of the opinion that under our conditions for corn, on river bottom land, the removal of weeds was the important object.

In hops we have a situation which is somewhat different from the various corn, potato and truck crops that I have mentioned. In hops we are dealing with a perennial crop which is propagated from buds developed on the crown. Naturally, cultivation has an effect on the development of both crown and buds. Also, there is a development of feeding roots at about the time the hops come into burr. It has been pointed out that late cultivation may possibly injure buds and feeding

roots and check the growth of the plant. Also, injury to the plant late in its growth may interfere with the best development for the crop the following year.

Dr. W. W. Stockberger in his discussion of the hop crop in the United States Department of Agriculture Farmer's Bulletin No. 804, "Growing and Curing Hops," has the following to say in regard to cultivation:

"Thorough cultivation is important and should begin early and continue until the plants are well armed out. This is necessary, not only to keep down the weeds, but also to prevent the top-soil from forming a crust and becoming hard, for when it is in this state the moisture of the undersoil rises to the surface and evaporates quickly. The frequent stirring of the top-soil to a depth of 2 or 3 inches will produce a layer of finely divided soil which conserves the moisture near the surface, where it is more readily reached by the young feeding roots which develop at about the time the hops go into the burr. If these small feeding roots are destroyed or seriously injured by late cultivation, growth will be checked and early ripening favored. Careful growers agree that the young buds do not set so well if the feeding roots are seriously disturbed, and that the crop is shorter in consequence. Nevertheless, if the soil is becoming hard and the moisture is readily evaporating, it may be best, at least in dry sections, to cultivate and depend upon a second growth of the feeding roots for the proper maturing of the crop. The existing soil conditions must determine the advisability of cultivating after the appearance of the feeding roots."

Growers have pointed out the importance of different cultivation

practices for different varieties of hops. For example, it is well known that the Early Cluster variety tends to produce numerous suckers and "roots", and "putting the dirt" to hills of this variety early in the season increases the number of both suckers and "roots." Most growers "open the hill" at holing time and cover it as soon as the soil begins to dry. On the other hand, some growers keep the hill open until mid-summer.

There appears to be two general cultivation practices, namely "flat" and "ridge." In the former method no hilling or ridging of the soil about the hill is practiced but the cultivation is designed to keep the yard "flat" as the name implies. Observations early this spring, after a severe winter, indicated that there was less winter damage where the "ridge" method of cultivation was practiced the previous summer. Of course, this method tends to produce a "high crown" and "crowning" should be done each spring.

It appears that a thorough job of cultivation may be of some value in the control of downy mildew. Heavy weed growth, many suckers and general lack of care have characterized several of the total losses from this disease. From observations during the last three years I would not encourage anyone to abandon hopes of getting a crop, particularly at these high prices, even if an attack of mildew was severe. In some severe attacks growers have obtained a crop if they continued cultivation and finally got a "break in the weather."

Patches of persistent perennial weeds such as Canada thistle, morning glory and quack grass may be eradicated by the use of chlorates. Great care should be exercised in the application of these dusts for

they kill all plant growth and there is a fire hazard in connection with their use. Small amounts of dust directly on the weed pest will kill the weed in most cases. Be sure that the dust is not applied to the hops for it will kill the hop plant. The use of these dusts to kill wild hops in fence rows and anchor rows has been suggested.

In summing up, then, the value of cultivation of hops, it appears that the important factor is to kill all of the weeds present so that they do not compete with the hop crop for moisture and plant food during the growing season. This means thorough frequent cultivations at a reasonable depth early in the season. In turn, as the season advances, cultivation should be shallow and frequent enough to kill all weeds and keep the crop growing. Formerly hops were "laid by" on the Fourth of July, but now many growers continue cultivation about once a week during July. Then the cultivation should be reduced at the time the hops come into burr so that small feeding roots are not destroyed and that the crop will mature normally, and not be kept growing too long, if it is a cool, wet season. Planking or "slabbing" breaks clods, keeps the moisture coming and puts the ground in excellent shape for pickers. On good river bottom soil where moisture can be somewhat by cultivation, growers can regulate somewhat the actual growth of the crop. The amount and type of cultivation depends on the soil, season, variety, weeds, insects and other factors. I have tried to point out the relationship of these factors to cultivation and show the need of adapting practices to conditions.

* * * * *

Figure XXXII

This shows a spring-tooth harrow in the yard early in the season. This implement, together with the planker, was used for cultivation throughout the season.

HOW THE HOP PLANT GROWS

The hop plant is an unusual one and there are many things about it which arouse both the curiosity and interest of everyone who comes in contact with it. Naturally, growers and buyers are most interested in its performance, but many hopyard workers have noted unusual things about the growth of the plant. For example, I have an inquiry from a grower. He asks, "Why does the hop vine wind clockwise and the bean counter-clockwise?" Others have asked why the hop vine makes such an enormous growth in a season, many questions about the value of male plants in a yard and other phenomena peculiar to this plant.

Growth in Length

I have had more than one grower tell me that the growth of a yard on a warm day would average a foot in height. This is considerable growth for a plant to make, but we have had similar experiences and have actually measured growth of a foot per day in the greenhouse. The work of Professor Schmidt, at the Carlsberg Laboratory in Copenhagen, Denmark, is of interest. As a result of some studies he made many years ago, he summarizes as follows: "It has been found that the growth in length of hop stems under natural conditions has a very distinct diurnal period, the rate of growth being smallest during the night, greatest during the day. This periodicity is determined by outer factors, among which the temperature has such a predominent influence that under natural conditions it determines the rate of growth."

Professor Schmidt found that the smallest growth in length was observed during the six hours from 9 p.m. to 3 a.m., and that the hours after the dark period; that is, from 3 in the morning until 9 in the morning, did not give the greatest growth. The greatest growth occurred during the period from 3 p.m. until 9 p.m., and this is the period which preceded the darkest one.

I am wondering if any of our growers have made actual measurements of the growth of different varieties. If they have, I would be glad to know of their results. From our studies last year of the breathing pores or stomata on the underside of the hop leaf, we were surprised to find that these pores opened so early in the morning and stayed open until so late at night. This is particularly true of the Early Cluster variety, which apparently opened earliest in the morning and stayed open longer than any other variety. We were of the opinion that this factor may have been an important one in the susceptibility of this variety to the downy mildew disease. Of course, it is not the only factor but it surely contributes to ease of infection. Also, this characteristic may account for the extremely rapid growth that the Early Cluster variety can make in a short time and may be an important factor in the susceptibility of this variety to other growth factors. We know that the Early Cluster variety is greatly affected by growth conditions, adversely when conditions are adverse and favorably when conditions are favorable.

Rotary Movement

In another publication Professor Schmidt describes just how the hop stem grows. He states as follows: "When the hop seed germinates the cotyledonous stem grows in the beginning vertically upward, and this

is also the case with the shoots of older hop plants. After the stem has reached a certain height above the ground, in seedlings often only 10 centimeters (about 4 inches), in strong shoots of older plants much more, it ceases to grow vertical. The upper end of the shoot now bends horizontally and then begins a circular or rotatory movement in the direction of the clock around older vertical parts of the stem."

Later on he states as follows: "It is very easy to see what advantages the movement mentioned gives to a twining plant such as the hop. By first growing vertically upward the stem gets free of the soil and the lower plants around and by its later rotational movement it has a chance of coming in contact with a support, twining around, which it can, then continue its growth. If it does not meet any support immediately after it has begun its rotation, this is continued, the apex, owing to the growth in length of the horizontal part of the stem, describing circles of constantly increasing radii. It follows from this that the seeking hop stem obtains a greater and greater range, which naturally greatly increases its chance of meeting such a support, without which the plant is unable to unfold its growth in a normal manner."

In other words, Professor Schmidt is of the opinion that it is an advantage for the hop stem to grow straight up for the first few inches and then to grow horizontally, for the first growth gets it above the soil and any other plants which may be growing near by. The horizontal growth which follows gives the hop plant a greater area to reach anything that it may twine on.

This rotary movement is of interest, and Professor Schmidt has studied both the amount of rotation that a hop stem will make and the times of day when this is the greatest. In his experiment he used vigorous three-year old hop plants which were firmly rooted. During May and June he found that the hop stems made a rotational movement which was just about one-third of the rate of the minute hand of the clock. The minute hand of the clock moves pretty fast, as far as the movement of plant life is concerned, and so a movement of one-third this rate indicates that there is some activity in a hop yard on a warm day. The statement "one can see a hop plant grow" is not very far wrong, and on a warm, still day one can see the stems bobbing about, which is an indication that they are growing rapidly.

Additional work in Denmark showed that this rotational movement, just the same as the growth in length, was different during different periods of the day. The rate of rotational movement was greatest during the day and least at night. This was the same thing that Professor Schmidt found in regard to increase in the length of the stem. Also, it was shown experimentally that this difference between growth and rotational movement in the day and at night is determined by external factors, such as temperature. In experiments with hop plants which could be placed alternately in the light and dark but with all other factors such as temperature constant, it was found that the rotational movement was not very different, and the conclusions were that the big difference under field conditions was one of temperature, where in the night temperatures were somewhat lower.

Figure XXXIII

This new seedling is resistant to the downy mildew disease and more vigorous than the Fuggles parent.

Grow at 40° F.

It is of interest to know at what temperatures hop plants will grow. In the experiments described above it was found that the lowest temperature at which growth and rotational movement would occur lies at about 40° Fahrenheit. The low temperatures for both of these factors is about the same. I have been interested in growth temperatures this spring and have noted that even though temperatures have been low, we have been getting a good growth of the hop plant. We have noted that the Fuggles variety was most active during these low temperatures and apparently had the ability to grow under cooler temperatures than the other varieties. The Fuggles variety in our experimental yard is excellent this year. Theplants have been up to the wire for a long time, dark green in color and well armed. Under real low temperatures; that is, those approaching freezing, this variety, because of its activity at low temperatures, is adversely affected, and often one sees it turn golden in color. We have been able to produce this golden color in Fuggles plants in a very few hours under artificial conditions.

Male Plants and Blooming

Hops are blooming early this season. This is due, possibly, to early training. On June 12 I saw Late Clusters in burr in California. On June 1 we had a plant that showed some bloom. This is a new plant developed by crossing Fuggles and Clusters and it is a male. Last year it was one of our earliest plants to bloom and had a long blooming period. I believe that a desirable male plant is one that makes a good high growth and is able to shed its pollen over a long period

of time, and undoubtedly we will be able to get distinct male plants which are better than those which we now have. Professor Schmidt found in his investigations that the pollen grains from the male plant retained their power of growth for three days on being kept in a dry room in the laboratory. Also, he found that the ordinary hop does not develop seed without fertilization from the male plant. We have made observations indicating that some of our varieties would produce seed without pollination but that the seed was not fertile and would not grow. This was particularly true of one yard near Albany where there were practically no male plants. A few scattered seeds in this yard were empty and apparently had not been stimulated to growth by fertilization from the pollen. In other words, if one wants to have seeds in hops there must be male plants present to fertilize the female flowers.

Where Hops Are Grown

Of late one of the common questions is: "Where can hops be grown?" This question is answered by Dr. Stockberger in Farmers' Bulletin No. 504. He states: "The hop plant can be grown generally throughout the United States, but at present its large commercial production is practically restricted to areas situated in the states of Oregon, California and Washington. Small quantities are raised in New York, Wisconsin, Idaho, Massachusetts, Pennsylvania, Michigan, Vermont, Kentucky, and Ohio. Long and severe winters frequently kill out many of the plants and continued damp or foggy weather is usually followed by severe attacks of lice or molds. While it appears that hops are grown under very different climatic conditions, they are

produced most successfully in the milder regions where abundant early rainfall is followed by warm, dry weather as the crop approaches maturity. In the Yakima valley, Washington, where the rainfall is very scanty, irrigation is necessary. The hop plant readily adapts itself to very different conditions of rainfall, but when the harvest months - August and September - are accompanied by much rainfall the crop frequently suffers heavy damage from lice and molds."

Recently we had a prospective grower bring us a sample of soil. The surface soil of a foot or so was mellow and in excellent condition but the subsoil was very peculiar inasmuch as it was a sticky clay intermingled with partly decomposed matter. It did not appear as if this would be good soil for hops as the subsoil would not lend itself readily to drainage and growth development and health of the hop crown and roots which are developed beneath the soil surface. In regard to this matter, Dr. Stockverger states: "Since the roots of the hop plant penetrate the earth for a distance of many feet, a well drained subsoil is essential. Especial attention must be given to the depth, fertility, drainage and fineness of the soil. Heavy wet soils are avoided and stiff clay soils are in general disfavored."

GREEN MANURES FOR HOP YARDS

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Hop growers have long realized the value and importance of green manures in their soil building program. It is now time for growers to be planning their green manure program for next year's hop crop and a discussion of this practice as related to hop yards is timely.

Growers who are interested in a discussion of this entire subject would do well to read United States Department of Agriculture, Farmers' Bulletin No. 1250, "Green Manuring." This publication may be obtained from the United States Department of Agriculture at Washington, D. C., the Farm Crops Department of Oregon State College, Corvallis, Oregon, or from your County Agricultural Agent's office. This bulletin states as follows:

"Green manuring means the turning under of green plants for the enrichment of the soil. Taken broadly, this would mean the turning under of weeds or the aftermath of a grass or clover crop, as well as a crop especially grown for turning under."

In this discussion, we will deal chiefly with crops especially grown for turning under, although we will point out the value of some of the weeds commonly found in good river

bottom hop yards.

In our experimental yard at Corvallis, we have been conducting some green manure trials ever since the establishment of the yard. In the fall of 1931 we put in five green manure plots as follows: barley, Hungarian vetch, hairy vetch, common vetch and Austrian winter field peas. These crops were put in for a double purpose. In the first place, they were planted to keep the soil from washing in case of high water, and in the second place, they were put in for their fertilizer and organic matter value.

In the fall of 1932, the same crops as above, with the exception of barley but with the addition of Monantha vetch, bitter vetch, and crimson clover, were planted. In the first year's trial, all of the crops made excellent growth. In fact, the barley grew so vigorously that we had difficulty in getting it turned under. In the second year's trials, all of the crops winter-killed with the exception of hairy vetch. It came through the winter with 100 per cent stand and apparently was the outstanding green manure under the winter conditions of 1932-33.

The Value of Green Manure

Already it has been indicated that green manures may have a real value during the winter and early spring in keeping the soil from washing. In addition its fertilizer value is from both the chemical and physical effect that it has on the soil. It readily can be seen that green manure crops return to the soil the various fertilizer elements that have produced the crop. In addition to this, green manure adds organic matter to

the soil. Organic matter is of extreme importance in its great effect upon both the moisture-holding ability of the soil and the soil texture. Soils high in organic matter can hold considerable moisture and some of our soils are lacking in this respect. This is particularly true of many of our rather sandy, river bottom soils. In fact, I am of the opinion that the use of both green and barnyard manures is of real value on some of the sandy, river bottom hop yards which otherwise would be extremely productive.

What Crop to Use

In general, the legume crops such as vetch or clover, are preferable to non-legumes such as the crucifers--turnips, rutabagas, etc. The chief value of the leguminous green manure crops is that they have the ability to take some nitrogen from the air if they are well inoculated. The non-leguminous crops do not have this ability. In cases of real nitrogen shortages, this is of real importance. In many of our hop yards, however, it is not altogether a case of adding additional nitrogen to the soil, but a case of conserving this important fertilizer element. Any crop, therefore, growing on the land will make use of available nitrogen and hold it in the plant until the latter is turned under in the spring. Also, a green crop turned under decays readily and the plant food which went into its makeup is returned for use of the hop crop.

Rate of Decay

The whole subject of the rate of decay of the material turned under is of such great interest and importance that I

am quoting a discussion of this subject from the bulletin that I have previously mentioned. The bulletin states as follows:

"Very little is known about the exact rate of decomposition of green manures under field conditions, as measured by the production of nitrates. By laboratory experiments it has been found that when legumes are turned under fresh considerable quantities of nitrate may be produced after 2 to 4 weeks. The maximum production seems to take place from 4 to 12 weeks after the green material has been placed in the soil under favorable conditions of temperature and moisture. Dried or cured material is much slower to start and lags behind the fresh material in the production of nitrates as much as 80 to 100 days. In Delaware it was shown that dried plant material when plowed under in spring might remain in the soil practically unchanged until August and so would be of no use to the corn crop for that season. However, in warm, moist, sandy soils even dead plant material, if turned under early and well disked and chopped, is said to have benefited cantaloupes, tomatoes, sweet potatoes, and even corn. Fresh clover turned under in May has been shown to provide nitrates for the corn crop that year. The rate of decomposition depends, of course, on the character of the soil and the nature of the plants turned under. Legumes decay more rapidly than the grains or grasses. In a loose, warm, moist soil, decay will be more rapid than in a cold, stiff, or dry soil."

Fertilizing Green Manures

Of late years, it has been a practice, particularly in orchards, to apply fertilizers to green manure or cover crops

in the orchard as well as to the individual trees. The fertilizer applied to a green manure crop, of course, stimulates the growth of that crop, and when they are returned to the soil the materials are in excellent condition for use of the hop plant. Growers who have difficulty to get a stand of a green manure crop or who get small growth due to poor soil fertility, should investigate this plan. Also, this is a possibility in portions of a yard which are particularly low in fertility.

Time of Planting

In general, most green manure crops in hop yards are planted in the fall either just before or after harvest. Some growers make use of a small one-horse drill to put in their crop, particularly vetches. This works satisfactorily and the crop may be put in either before or after picking. Crops such as crimson clover must be planted real early in August if they are to make a desirable growth. Vetches, of course, may be planted most any time in the fall, but best returns are obtained when planted by the middle of September.

Crops to Use

I imagine that most growers that have used green manure crops in hop yards have made use of one of the vetches, either common or Hungarian vetch. The latter vetch is somewhat resistant to aphis attack and it has been suggested that in yards where aphids are a real problem, that this vetch may be more valuable than others. There has been no connection established, however, between aphids on Hungarian vetch and aphids on hops, as yet. The real tie-up between the hop plant and other plants in regard

to aphids, appears to be prunes. It has been shown that hop aphids over-winter on prune trees. Some growers have used Austrian winter field peas but have claimed that growth is too late in the spring if they want to get their hops on the strings early and out of the way of mildew attacks. Crimson clover is a winter annual and may have possibilities in certain yards. Other growers have used various members of the mustard family to good advantage and report excellent success with turnips. To this same family belongs the common wild mustard which should be more correctly called wild turnip. It is claimed that in England that good use is made of crops of this type.

Cost of Green Manure

The cost of green manure crops is a factor in the selection of the one to use. In general, the non-leguminous crops such as turnips are inexpensive; only a few pounds of seed are sown per acre and the cost is usually less than one dollar per acre. On the other hand, some of the leguminous crops are rather expensive. Most hop growers use about forty pounds of vetch for their green manure crop. It may be possible to increase this amount to advantage if seed can be purchased at a reasonable figure. Vetches now run all the way from four to seven cents per pound and the cost, therefore, is from $1.60 to $2.80 per acre when only 40 pounds are used. Of course, growers can take advantage of mixed seed, or seed which is not in the best condition and increase their rate somewhat per acre, depending upon the quality of the seed. It is not necessary to use the highest quality seed for green manure purposes in a hop yard.

Conclusion

In general, I think it is of real advantage for every hop grower to sow in his yard, anytime between August 15 and September 15, a green manure crop of some kind. This crop not only well protects the soil from washing and the beating rains of the winter, but also improves both the physical and chemical condition of the soil. Green manure will "open up" and improve the texture of heavy soils and at the same time it has the ability to improve the moisture-holding capacity of some of our sandy soils.

Possibly the best green manure for general purposes is one of the vetches, either common or Hungarian vetch, and it more than likely is desirable to use barley with this vetch if additional growth is desired. The only drawback of this combination is the possibility of winter-killing in a winter such as we had last year. Growers who want to insure themselves of a cover crop regardless of the cold conditions, can use hairy vetch to advantage. Growers who do not care to make an investment to the extent of using vetches may use turnips or even purchase seed of wild mustard (wild turnip) if it is available.

Large returns should not be expected immediately. Over a period of years, however, the green manure crop will surely improve the soil. Most hop growers plan to be in business for a long time, and take off large crops year after year. These large crops can not be removed indefinitely without returning something to the soil. A real soil building program which includes a green manure surely appears to be advisable and particularly at this time when the possibilities for fairly good hop prices are in view.

Figure XXXIV

"Spikes," a symptom of the downy mildew disease.

Figure XXXV

Another view of plants showing "spikes," shortened arms.

HOP PICKING

The words, "hop picking," are magic ones for many because they signify to the grower that he is approaching the end of a long and weary season that involved hoeing, pruning, plowing, disking, staking, stringing, training, suckering, cultivating, and spraying — not to mention threatened attacks of lice, spider and mildew, and the worries that go with these possibilities; and to the picker they mean several days of healthful outdoors employment and some much needed cash.

Time of Picking

Hop picking is already underway, for picking of the early varieties began in the latter part of August. Ordinarily, Fuggles picking begins about August 20. This in turn is followed by Early Clusters, which are picked about a week later. The main crop, Late Clusters, and Red Vines, usually are picked beginning the first week in September. Regardless of the season, hop picking begins on about the same dates each year. It is well known that practically all plants bloom and ripen when there is a certain day length; that is, plants may be grouped into what is known as short day-length plants and long day-length plants. The latter group, including the cereals, ripens when the days are long and the nights short. The short day-length plants, including hops, ripen as the days begin to shorten.

One prominent grower stated that invariably he begins picking Early Clusters on August 24 and Late Clusters on September 3. It is of interest to know that most growers are agreed in regard to these dates of ripening.

Of course the above dates apply chiefly to the main crop in western Oregon. For similar sections the dates would be about the same. In

southern Oregon picking begins approximately a week earlier, and in California sections picking is still earlier in the season.

Also, there are other important considerations as to the proper time to pick hops. Shortage of pickers, lack of kiln space, weather conditions, possible disease attacks, and other factors may influence a grower to pick his hops before they are ripe. This raises the question, "How may one determine when hops are ripe and ready to pick?" This question is answered in a clear-cut way in Farmers' Bulletin No. 304.

Tests for Ripe Hops

Dr. Stockberger says, "By means of certain practical tests the degree of ripeness and suitability for picking of the hop may be readily determined. (1) The strobiles or cones, which are bright green in color in the vegetative state, change gradually to a bright yellowish green as they approach ripeness. This is not always an exact test, as the color is somewhat dependent upon the soil and some other facts. Some hops have a greenish color when they are ripe. Sometimes in fields infested by the wild Morning-Glory, a yellowing of the cones may occur, which is not due to ripening, but rather indicates an unhealthy condition in the plants themselves. (2) Immature hops are soft and pliable and have no resiliency or elasticity. As they ripen, however, they become more and more elastic, and if slightly compressed between the fingers will, on being released, assume at once their original conditions. (3) When hops have a crisp feeling and give forth a rustling sound when crushed in the hand, they are regarded as ripe. (4) The so-called seeds of the hops are in reality fruits, the seed being covered by a closely adhering pericarp, which, when the hop is ripe, takes on a dark purple color. At this time also the seeds fill out and become hard. (5) The bracts at the point of the cone close as

ripening progresses, and the cones themselves feel sticky or greasy. (6) Immature hops have little odor aside from the natural green or plant odor until they are near ripeness, when the characteristic lupulin odor becomes very marked. (7) As the hops approach maturity the upper foliage leaves change from light green to dark green, while those on the lower part of the plant turn yellowish and drop off."

Ripe hops picked at the proper time will have the highest possible resin content and show the greatest proportion of dry hops to green. Most growers find that hops on drying shrink to one-fourth of their original weight. This relation of dry hops to green hops depends upon many factors and one of the chief ones is the number of seeds present. A couple of years ago I dried down baby hops from several of the important varieties and was much surprised to find that practically all of them reduced to 23-1/2 per cent. These were not very well seeded due to the lateness of the male plants in the yard. The number, kind, and placement of the male plants is of real importance in this respect.

Clean Picking

Clean picking has been the watch-word of growers in the last few years. I have heard this emphasized by dealers and growers at meetings and in their yards. Everyone connected with marketing conditions realizes that it is important to keep up the high standard of quality of American hops. The Hop Growers Association is to be commended for its stand on clean picking, proper drying, and attractive baling. All of these factors will mean much in regard to holding our market. Growers and dealers alike have an excellent opportunity at this time to establish a reputation and obtain the business of many large establishments.

Curing the Crop

Hops are usually dried immediately after picking. Drying is usually done by an experienced worker who is familiar with local conditions, inasmuch as there is no very accurate method of regulating all of the drying factors and knowing when a kiln is completely and accurately dried. Undoubtedly some of the greatest strides in the entire hop improvement program will be made in the curing of the crop. It has been shown that a green hop has a very high preservative value, which is reduced greatly on drying. Proper temperatures and methods may possibly offset this change.

Recently there has been an enormous increase in interest in forced draft drying. Heretofore the number of forced draft driers has been small, as they involve an outlay for equipment. Just within the last few months, however, some growers have installed large electrically driven fans to force the heated air throught the drying hops. Others have installed airplane type propellers in the cupolas of the kilns. Undoubtedly both of these methods allow the laying of deeper floors and shorten the time of drying. Some have been of the opinion that the quality of hops dried in this fashion is better and the weight of the dried hops is greater. We have done a small amount of work in comparing hops dried in forced draft and natural draft driers. Our limited results show a little higher resin content for the former. These results, of course, are not final, but indicate some possibilities in this connection.

There is great need of utilizing our hop driers to a greater extent, and also a possibility of using a continuous type of drier, so that all hops can be dried down to uniform moisture and quality. Large bulk drying invariably will mean differences in hops at different levels.

Improvement in Practices

This year will be an excellent one to study picking and drying methods. Many growers are using special methods this year. We are hoping to observe the various methods and also to do some experimenting in both drying and picking in relation to quality of hops, particularly resin values. Personally, I believe we are just at the beginning of the application of many new practices in hop growing, picking and curing. Alert growers can find a great deal of interest and profit in observing some of the newer practices which will be placed in operation this fall. Finally, I hope that this 1933 crop will be both a large and profitable one for all of our growers. At picking time growers have an opportunity to stake both desirable and undesirable plants. The latter may be removed during the fall or early spring months and the former should be the source of root cuttings. This is the last opportunity this year to make an inventory of hop plant resources. Progressive growers will know what they have; others will guess.

Figure XXXVI

Rows of hops one mile in length. This view is at the Wigrich ranch, Independence, Oregon, 1933.

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NEUTER HOP PLANTS

A conspicuous plant in many hop yards at picking time was the one that is now designated as a neuter hop. This large, dark green, non-bearing plant is commonly called a "bastard" plant by hop growers. The plant is a "boarder", the same as the low producing dairy cow, is of no economic value and should be eradicated.

These neuter hop plants are found in the yards of Washington, Oregon, and California. Few yards are entirely free of them and in some yards they are common; in fact, one 40-acre yard had 6,000 of these non-producing plants, or about 25 per cent of the total plants in the yard. These plants are, therefore, of both scientific and economic importance. We have been studying them in some detail ever since 1930 in commercial yards and lately in our experimental yard at Corvallis.

Origin of neuter plants

There are many different ideas in regard to the origin of these neuter hop plants. Some have been of the opinion that this condition is caused by a disease; others state that it is a "running out" condition of an old hop plant. Another, and possibly the best explanation, is that this condition is hereditary; that is, there are certain strains of hops that will tend to produce foliage rather than fruit cones. Now we find out that if this condition is hereditary it is influenced greatly by the nutrition that the plant receives.

In the fall of 1930 we observed several of these neuter hop plants and staked them so that we could get root cuttings the following spring. In the spring of 1931 root cuttings of several neuter plants were placed in our experimental hop yard. Every root

cutting came true to its parental type and produced a neuter plant that year. In 1932, much to our surprise, two of these neuter plants produced peculiar "grape-like" bunches of both male and female hop flowers. These particular plants had received no treatment different from the other plants in the yard, and we were unable to account for this sudden appearance of fruit. During that winter, however, we attempted to get root cuttings of these plants to grow in the green house. Much to our surprise, every underground part was covered with galls of the crown gall disease. It is our present theory that this crown gall disease utilizes certain plant food elements and upsets the ordinary nutritional balance of these plants and stimulates them to produce fruit.

Carbohydrate-nitrogen ratio

Work done here at the Oregon Experiment Station many years ago on tomatoes showed that the carbohydrate-nitrogen ratio influenced the production of fruit in tomatoes. For example, if the carbohydrate-nitrogen ratio was changed one could influence the plant to increase or decrease fruit production. Apparently the same holds true in hops and if we supply the correct plant food elements, we can stimulate the plant to produce fruit which, of course, is the thing that we want to do. All of this work on these neuter plants, I believe, will someday have a profound influence on fertilizer recommendations.

Fertilizers influence not only plant growth but time of ripening, disease resistance, proportion of fruit to foliage, and other important plant characteristics. We are greatly interested in the effect of fertilizers on proportion of fruit to vine and time of ripening. For example, during this past year, many hop growers had difficulty in getting their crop to ripen properly and difficulty

was encountered in drying because of the green condition of the hops. Of course, this was chiefly due to weather conditions. In our experimental yard we had individual plants which were heavily fertilized and would not close down properly. A new seedling that last year showed every evidence of making an excellent hop was heavily fertilized this spring to produce cuttings. This fall the hop stayed green and would not close down. Apparently we over-did the fertilizer application. In determining the value of a fertilizer I believe that it is important to not only measure the yield of hops but also to get the shrinkage on drying and the percentage of soft resins present. We have had some evidence that sulphur increases soft resins. It is necessary to know something about the influence of fertilizer on all of these factors before we know the whole story.

Remove neuter plants

I do not want to leave the impression that we can make neuter hop plants profitable ones. By all means, I recommend that growers should stake and remove every neuter hop plant because undoubtedly they are inherently different from other plants. If they are not removed, one will take root cuttings from them and increase them by placing the cuttings in missing hills. They are enormous growers and produce large numbers of underground stems which may be made into root cuttings. On the other hand, I do believe that what we are learning from the stimulation of them to produce fruit may be applied to production practices. In neuter plants the development of fruit is so striking that it is easier to measure results.

We have had other striking phenomena as far as fruit production is concerned. For example, we are studying the development

of hop cones on male plants. The development of these cones, we believe, is due in a large measure to the plant nutrition. I believe that male plants in a yard are good indicators of the type of fertilizer balance that is necessary. If male plants are producing many hop cones, we may have the proper condition for the female plants to produce a larger amount of cones as compared to foliage.

Sex reversals of various kinds

In the last two years we have noticed some female hop flowers revert to males; that is, on a lateral we have had the production of hop cones, then the production of male flowers, and finally the production of hop cones again. This is a double reversal of sex all within a few inches distance on a lateral.

Possibly growers have noted some of these things and have some unusual plants of this type in their yards. If so, I would greatly appreciate information on them. We are trying to collect data on the development of the hop flower and formulate some well-grounded principles that we can apply to production practices. Recently I was in a yard of "babies", which had about four per cent neuter plants. It was of interest to find two neuter plants which were producing typical "grape-like" bunches of male and female flowers, previously described. These showed evidence of galls. With the help of growers and some intensive experimental work, I am firmly of the opinion that within a few years' time we can develop new varieties and practices that will give us the largest amount of high quality hops per acre and retain for us a leading position in the hop world.

Figure XXXVII

This is another view of the experimental yard early in the season to show early growth and application of fertilizers.

Figure XXXVIII

The lower illustration shows the vigorous growth of seedlings early in the season. This seedling has made more growth than plants from cuttings.

HARVEST OBSERVATIONS

The harvesting of the 1933 hop crop in Oregon ended on September 25 when some of the largest growers completed the picking of their heavy crop. As soon as harvest was over, many were prone to forget about that particular crop and give their attention to other things. I believe, however, that each harvest brings up new problems and gives us new information which may be used with profit in the years to follow.

After completing the harvest in our experimental yard, I attempted to observe the picking in other yards and to converse with growers in various sections of the state. There were many things of interest in regard to the 1933 crop which were brought to my attention.

The Aphis and Mold Problems

Of course, two of the outstanding problems were the late attack of aphids and the resultant mold which characterized the late pickings in some yards. If growers are to profit by this experience, they should make at least a mental note to thoroughly spray for aphids not only at the normal time in July but possibly again in August, if conditions are favorable for the development of this troublesome insect. This second spray, more than likely, could be limited to the portions of the yard that are to be picked last, and particularly to portions that are usually susceptible to aphis and mold attacks. The use of dusts at this time, so that a large part of the yard can be gone over quickly, appears to be worth investigating.

Some Mildew on Cones

Another unusual harvest situation and possibly the first real

difficulty of this kind since downy mildew appeared in 1930 was the downy mildew attack on the hop cones. Up until this fall heavy attacks of mildew on the hop cones at picking time have not been observed generally in growers' yards in Oregon. This year, however, typical discolorations of the cones due to the downy mildew organism were observed. This came late in the season and chiefly on the last picking. In many cases this mildew damage could not be distinguished from the browning due to wind-whip or mold, but once the characteristic striped streaks of downy mildew on the cone were known, they usually could be recognized. Of real importance was the formation of winter spores in the bracts of these cones. Many of these bracts shattered to the ground or were left in the field and undoubtedly will be a source of infection in the future. This is a situation which must be watched and infected portions of a yard should be inspected in the spring of 1934 and 1935.

Effect of Weather

I was interested in an analysis of the weather to see if it would answer questions in regard to the large yield of hops, attacks of aphids, attacks of mold, attacks of mildew, and even attacks of spiders this year. It does not seem logical, for example, that we should have spider attacks and aphid attacks all within a short period of time because each desires a different situation. At any rate, all of these things happened. The unusually wet weather in June led to the rather severe mildew attack that we had beginning June 21 and continuing until the end of the month. Undoubtedly, this attack of mildew destroyed a large number of arms and reduced the crop materially, even though it was hard to see it because

of the resulting large crop. On the other hand, practically the entire month of July was hot and dry. Downy mildew did not continue to be a factor but spider did. In August we had almost a normal month with the average rainfall which is just about a half inch. There were but two rains in August and the usual number of clear days. Apparently, however, hops grew faster and better during August than in the previous several years. Undoubtedly this made the large crop that was obtained and also made a green vigorous plant that was much to the liking of aphids. At any rate, there was a second attack of aphids during that month which caused considerable loss in some yards.

September was an unusual month. Offhand, I imagine most people would estimate that we had considerably more moisture than usual. Weather reports, however, show that we had only a little over an inch and a half of rain, which is about normal for September. Still, there was an unusually large number of cloudy, damp days during September which, of course, would be favorable for aphids, mold, and mildew even though it was not raining. Also, this type of weather delayed both maturity and picking.

Several Down Yards

The large crop brought about another condition which was a little different from the last few harvest seasons. Apparently there was an unusually large number of yards that went down. All through the period of low prices, not much attention was given to hop trellises. Also, crops were rather light and not much damage was done, but the large crop this year, together with some rains brought down the trellises that were weak. This situation indicates the need of new trellises in certain yards and the close inspection and repair of practically all trellises.

Hop Pickers

Difficulties with pickers were a little greater this harvest season than they have been for several years past. Undoubtedly this was due to the general understanding that hops are high in price. Pickers, naturally, were desirous of getting some of the muchly advertised price. I presume that few realized that they were paid on a basis of green hops and that prices are quoted on a dry basis--approximately one-fourth of the green weight. Growers should keep this in mind for next harvest and should be making plans now as to the most feasible method of paying pickers. The suggestion has been made in regard to the advisability of the bonus system so that pickers would stay on the job throughout the season and not go from yard to yard or leave the harvest entirely. Pickers as well as growers have a responsibility in the harvest. Surely there are many possibilities along this line and undoubtedly a thorough study of the situation by a committee of the hop growers association would contribute much and be of real help.

Forced Draft Drying

Another new and interesting situation at harvest time was the widespread use of various types of fans to facilitate drying. It appeared that almost every grower of any size was interested enough in the use of fans to invest a few hundred dollars, at least, to observe the results. Of course, much of this interest in fans was brought about by the unusually large crop and the higher price of hops. Also, growers were of the opinion that fans would offset the need of new kilns and other equipment. Fortunately, a check was made on many of these fans by Mr. F. E. Price

of our Agricultural Engineering Department and information should be available in regard to their performance and methods of operation to get the greatest efficiency out of any particular system—the systems are legion.

Undoubtedly, some of the difficulties encountered were due to poor kilns which were not tight, limited stove capacity and other inherent features of kilns which could not be adapted to the modern method of forced draft drying. At any rate, much progress was made and I believe that in the hop industry alone could there be such a rapid development of a practice. Other producers of crops are not so quick to move. My experience has been that hop growers act quickly and usually in a large way if they are convinced that a practice is of value. One, therefore, should be certain of his grounds when making recommendations to hop growers.

Disposal of Vines

After harvest comes the disposal of the vines and other material on the yard. Some growers have followed the practice of turning under their vines to add organic matter. On the other hand, most growers have disposed of their vines by burning. The value of disposing of vines, and particularly those that were not picked and infected with mildew, as soon as possible after picking, is apparent. I do not believe that it is of great value to burn the crop to get rid of disease if one allows the vines to lay on the yard for a long period of time. Undoubtedly the diseased hop cones and leaves will be the first to shatter to the ground and the damage is usually done before the vines are removed. If one is to gain anything from disposal of the vines, the clean-up should follow harvest as soon as practicable. Of course it is commonly stated that

cutting the vines at the ground immediately after picking lowers production the following year. Our results for one season show no injury to Early Clusters or Puggles and possibly a small amount to Late Clusters cut right after picking.

Cover Crops

I was glad to note the rather widespread use of cover crops this fall. Some growers planted a cover crop of vetch before picking time. In portions of these yards, this cover crop received pretty rough treatment from pickers. Ordinarily the cover crop, if planted early, will not make the great growth that it did this year, but the early September rains before picking, caused the plantings to grow several inches in height. Tramping on wet days caused some injury to these advanced growths.

Excellent weather, however, early in October afford an opportunity for most growers to plant cover crops if they so desired. Some growers purchased new drills with fertilizer attachments so that they can even apply fertilizer to stimulate the growth and possibly increase the winter-hardiness of the cover crop. Various things are being used, all the way from wild turnip (mustard) to the ordinary turnip and various varieties of vetch. Undoubtedly, all of these are of some value in a soil fertility program. In our experimental yard we have excellent stands of common vetch, Hungarian vetch, Monantha vetch, hairy vetch and Austrian winter field peas.

Disposal of Crop

Also after harvest comes the baling and disposal of the crop. Already growers and dealers have mentioned the possibilities of new

types of packs and new methods of baling. Undoubtedly, great strides will be made along these lines and we will have many improvements within the next few harvest seasons. Also, reputations established at this time will mean much to growers and dealers when hops are more plentiful and possibly prices are not so high. It is my prediction that those having quality hops during these times will be the ones who receive profitable values when prices are lower. In this connection, winners in the "Oregon Hop Growers' Quality Contest" will profit and the only way that one can win a contest and prove that he has quality hops is to enter the contest. To me, it appears that a grower has everything to win and nothing to lose in entering a contest of this sort and I hope that there will be far more entries than there were last fall.

In conclusion, it appears that hop growing in the future will mean more than being on the job from the first of April to the first of October. Apparently, there is ample work to be done in all twelve months of the year if a grower is to produce the greatest crop at the lowest cost. There isn't a grower that can not improve the soil that is producing the crop, his production practices, methods of picking, methods of drying, methods of baling, and other operations. These improvements will go far in the retention of our position as one of the leading hop areas in the world.

Figure XXXIX

General view of the experimental yard after the pickers have gone through the crop.

NEW TYPES OF HOPS

Hops have been grown on the Pacific Coast for more than a half a century with comparatively little change. Possibly this is a desirable situation, if the types that we are now growing are satisfactory in every respect. New conditions, however, make it appear feasible that new types could be grown to advantage. A new situation was forcibly brought to the attention of everyone interested in hops when the downy mildew disease appeared here within the last few years. Attention was called to the desirability of a hop which was not only resistant to this disease, but also had other desirable factors including yielding ability, time of maturity, insect and mold resistance, and hardiness of underground parts.

Experimental Yard Established

The downy mildew disease was first noted in Oregon in 1930. That fall we began some preliminary investigations into the possibilities of developing varieties which were resistant to this disease. By the spring of 1931, we had the beginning of a small experimental yard, and by the middle of that year had completed arrangements for cooperative work between the Oregon Experiment Station and the United States Department of Agriculture for a hop breeding project. Our actual work in developing some new types of hops has really been underway, therefore, about two years. In 1932, our experimental plantings were greatly increased and in 1933, many of our new developments produced fruit and sufficient growth to get a fair idea as to their desirability.

In developing a new breeding project, naturally we turned to the literature and printed information on what had been done elsewhere. A thorough study revealed the fact that comparatively little had been done

and there was not much printed information as to the methods and results. One interesting bit of information indicated that it required at least five years to develop a hop from a seedling up until it produced enough fruit for testing. This is a long period of time and too long to be of great value in a situation that appeared to be acute. Efforts were made, therefore, to shorten this period. These were rather successful inasmuch as we were able to develop new hops from seeds to maturity and production in a period of nine months rather than one of five long years. In general, this was done by resorting to some of the newer methods of plant development, such as chilling seeds to overcome the dormancy period which most of them have. Chilling was accomplished by mixing seeds with moist sand and peat moss and subjecting this mixture to freezing temperatures for a period of a month or longer. Seeds subjected to this treatment germinate readily if placed under the proper conditions for germination. Seedlings just produced from seed grow rather naturally at any season of the year. On the other hand, buds from root cuttings apparently do not want to make a growth until the spring season of the year.

Inasmuch as seeds are collected in the fall and time would be lost if one waited until spring to get germination, our work has involved the germination of these seeds in the fall and the subsequent planting of them under greenhouse conditions. Naturally, plants do not thrive during the winter months even under greenhouse conditions because of the lack of sunlight and shortened days. To offset this, artificial illumination was used to give the equivalent of the normal length of day which a plant would have during the spring and summer season. Just ordinary Mazda lamps are used for this illumination. From fall until

spring, seedlings make a growth of anywhere from three or four feet in height up to as much as 20 or 30 feet. Our work indicates that it is only necessary to get a seedling to a height of three or four feet to make sufficient crown and root system for transplanting the following spring.

Thousands of Seedlings

We have grown some ten thousand new hop plants from seeds in this way and have transferred them out-of-doors. Ordinarily, the first season out-of-doors, a seedling handled in this way will not make a great deal of growth. Apparently, its growth during the previous winter season has forced it into more or less of a dormant condition. I have seen seedlings remain from April to July without making any growth and then begin a rather rapid growth of several feet before fall. The following season, however, the seedlings, handled in this way, make a normal growth and plants of type and appearance of ordinary hop plants produced from cuttings. Our normal procedure, therefore, involves two years of growth, including a winter season in the greenhouse. The value of all new developments can not be told in this length of time, but those that are outstandingly poor or of no particular value may be eliminated and the outstandingly desirable ones may be increased for additional study. Breeding for the development of new varieties is a slow and unfolding process. It is not something that can be accomplished in one season or in a few seasons. In the first place, as the work progresses more desirable parental material is obtained. In the next place, a new development has to have more than one desirable characteristic. It must be of sufficient yielding ability, mildew resistance, and quality to be readily accepted by both growers and buyers. In addition, it would be

desirable to have other outstanding characteristics such as previously listed. Naturally, all of these things are rather difficult to obtain in one plant, but the more of these that the parental material has the easier it is to get them combined into one new individual.

It is of interest to note how many desirable new types of hops that we have been able to obtain in the short period of time that we have been at this thing. Our observations and records indicate that at picking time this fall, we had at least fifty desirable new seedlings. Each of these, potentially, is a new variety of hop, but naturally we would not want to foster this many new varieties for it would surely lead to chaos. We find that our big task now is to reduce this number to as few as possible and particularly down to one new variety which has the necessary desirable characters. This we can not do without additional years of testing and increasing these outstanding types. To date no new developments have been distributed.

As is generally known, newly established plants do not have many "root cuttings." We have to resort, therefore, in some cases to making the arms take root and produce more plants of a given type in this way, but this is a rather difficult and tedious thing to do and not generally practiced.

Fuggles x Clusters Plants

One combination which we attempted to get was a new hop which contained the desirable mildew resistance of the Fuggles and the growth habits, quality and yielding ability of the Clusters. Naturally, most of our seedlings are of this combination, and we have several of this type which I consider our most valuable ones. Inoculation trials have shown them to be as resistant to mildew as the Fuggles parent and

observation and actual yields have shown them to be better than the Fuggles in yielding ability. Also, we have for example, many Fuggles type plants which are similar to the Fuggles in nearly every respect except that they have long arms and other indications of higher yielding ability.

Early in our observations of plants which were mildew resistant, we found that in practically every case, the resistant type of plant had a heavy green leaf much the same as found on Fuggles. Now, we have a fairly good idea of our resistant sorts, but do not rely on appearance alone to find out if a plant is resistant. Practically always we inoculate artificially with the mildew organism several times during the season. It is true that a resistant plant will sometimes show some mildew. We have found various Fuggles plants with mildew. It is not known just what is the cause of this, but studies in other plants of resistance to various diseases indicate the same situation.

We have many other interesting types of plants, some of them outstanding because of exceptional vigor of growth, some early, some late. One is a striking plant with a peculiar deeply cut leaf type. Some plants have peculiar stripings on the leaves and one in particular has a bright green color of stem. There apparently is considerable differences in type of cone. We have some with very light colored cones, hops which undoubtedly would need no sulfuring to bleach them out for at the time of harvest, they are bleached out to a beautiful light color. Some run all the way from nearly white to golden.

Growers Greatly Interested

One of our most striking plants has a top-shaped cone, that is, a cone that is rather broad at the base and runs down to almost a point. One of our leading growers stated that in forty years of experience, he

has never seen such a beautiful type of plant and cone. Some plants have dark glossy green cones, others have various shades of red. Apparently, the red color does not carry through because as the season advances, the red becomes lighter and almost disappears at harvest time. It is of interest to note that many of these seedlings with red cones originated from seed obtained from California. This red coloration is also noted in the seedlings as they come up. Apparently, the strains of Clusters or at least the males that they use in certain sections of California are different from those which we have here in Oregon, for I am able to tell their seedlings in most every case.

Of all of the phases of hop production which are being studied, I believe that the development of better varieties offers the greatest possibilities for improvement. On the other hand, it is a type of work which requires a period of years. In the meantime, we have had an opportunity to study various production practices, including methods and times of pruning, hoeing, stripping, training, and harvest. Also we have considered somewhat the possibilities of grafting and budding, particularly to get combinations of desirable underground parts of varieties such as the Red Vine and desirable above-ground parts such as the Clusters or resistant Fuggles.

Hop production involves many operations and each brings up new factors. The problems, therefore, are many and complicated. Scientific information based on first-hand knowledge of the crop and data from experimental investigations over a period of years should yield information of interest and profit to the growers of this section.

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