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Progress Report

Hop Project

Oregon Agricultural Experiment Station

AGRONOMIC STUDIES WITH HOPS 1939 AND 1940

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Introduction

Agronomic studies with hops were started in the spring of 1937 when legislative funds were made available through a special state appropriation for this work. The primary purpose of these experiments is to determine the effect of various cultural practices upon yields, quality, length of life of the plants, downy mildew infection and insect infestation in hops so that the best and most profitable methods can be recommended to hop growers.

The trellis for a 10 acre experimental yard was erected during the spring of 1937, roots were planted on approximately seven acres and experimental plots were started. The remaining three acres were planted in the springs of 1938 and 1939. Data on the majority of experiments under study could not be obtained on plants less than two years old. Therefore, the data reported in this paper are for the 1939 and 1940 seasons only. Irrigation experiments were started in the spring of 1939. Irrigation plots were planned so that a portion of each other experiment was irrigated and a portion non-irrigated. It is therefore possible to study the effect of irrigation in relation to all other cultural experiments. Most of the experiments now underway should be conducted over a reasonable period of years if the greatest possible amount of information and benefit is to be obtained from them. Since only two years' data are now available, small differences obtained in some experiments should not be given too much weight. Results from a number of experiments are definite enough to be of considerable value to growers and hence are being reported at this time.

Irrigation

An irrigation well and high pressure sprinkler irrigating system was installed in the experimental hop yard by the department of Agricultural Engineering in the spring of 1939. The well is 10 inches in diameter, cased with a standard pipe casing and 35 feet deep. Equipment includes a $7\frac{1}{2}$ horsepower 3-phase electric motor, close coupled to a $2\frac{1}{2}$ inch centrifugal pump of

175 to 200 gallons per minute capacity, the motor being complete with starter and overload protection, 800 feet four-inch mains with couplers, 480 feet three-inch lateral, 320 feet two-inch lateral, 20 sprinklers and 20 special stands, for holding high risers erect. The total cost of this well and equipment according to the department of Agricultural Engineering was $1387.60. This equipment is sufficient in size to serve 30 acres, thus making the equipment cost $46.25 per acre.

Yields of Late Cluster hops were increased an average of 537 pounds per acre or 27 per cent during the 1939 and 1940 seasons by two irrigations. The first irrigation was applied during the latter part of June and the second during the latter part of July, approximately 2½ to 3 inches of water being applied each time. Figuring the price of hops at 20¢ a pound, an increased yield of 537 pounds per acre would increase the gross returns to the grower by $107.40 per acre. The cost of irrigation, as determined by records kept on the experimental yard, including depreciation on equipment, power, and labor of moving pipe was approximately $12.00 per acre. Figuring a picking and drying cost of 10¢ per pound upon the increased yield, and adding $12.00 for irrigation costs, the net profit per acre to the grower would be $41.70 or almost enough to pay for the cost of equipment the first year. However, the 1939 and 1940 seasons were both unusually dry and therefore the increase in yield over a period of years may not be so great.

Increases in yield per acre due to irrigation were secured for all varieties under test during the two seasons in which irrigation experiments have been conducted. The amount of increase obtained in the Early Cluster, Fuggles and Red Vine varieties was not as great, being 15 per cent, 23 per cent and 22 per cent respectively. Yields in pounds per acre from irrigated and non-irrigated plots and the average increase due to irrigation are given in Table 1.

Table I

Effect of Irrigation Upon Yield of Four Varieties of Hops

	Yields in Pounds Per Acre						Average Increase Due to Irrigation	
	Irrigated			Non-irrigated				
	1939	1940	Ave.	1939	1940	Ave.	Lbs. per Acre	%
Late Cluster	2041	1932	1987	1404	1496	1455	532	27
Early Cluster	1467	1512	1490	1297	1249	1273	217	15
Fuggles	1056	869	963	899	591	745	218	23
Red Vine	1500	1888	1694	961	1695	1328	366	22

Experiments with various heights of risers indicated that with this type of equipment, the sprinklers should be placed above the trellis. Lower placing of sprinklers resulted in mechanical injury to the hop vines and in somewhat poorer distribution of water.

No burning from overhead sprinkling was found during the 1939 and 1940 seasons, even when the water was applied during the hottest portion of the day. In an attempt to see if water burn could be caused by overhead sprinkling, the irrigation system was operated during some of the hottest days in both seasons and no evidence of water burn was found.

Notes on downy mildew infection were taken before and a few days after each irrigation was applied to determine whether sprinkler irrigation would increase the amount of downy mildew infestation. A slight increase in the amount of mildew was found in the Early Cluster variety following one irrigation during the 1939 season. No increase was found even in Early Clusters during the 1940 season and there was no evidence of increased mildew during either season in the other hop varieties. However, the fact that a slight increase in the amount of mildew infection was found following one irrigation in the Early Cluster variety indicates that sprinkler irrigation during a period of cloudy days and humid weather might tend to increase the amount of downy mildew.

Cultivation

Light cultivation as often as needed to keep weeds under control gave higher yields during both the 1930 and 1940 seasons than no cultivation or cultivation to a depth of approximately six inches. Plots given no cultivation after the soil was worked down following plowing in the spring were compared with plots given light cultivation when needed and plots cultivated to a depth of approximately 6 inches with a disc. Yields obtained from these plots during the 1939 and 1940 seasons are given in Table 2. It will be noted in this table that deep cultivation caused less injury in irrigated plots than in non-irrigated plots.

Table II

The Effect of Various Amounts and Depths of Cultivation Upon Yield Per Acre of Irrigated and Non-Irrigated Red Vine Hops

Irrigation Treatment	Year	Type of Cultivation			
		None*	Harrow and Drag only	Disk, Harrow and Drag	Deep Disk only
Irrigated	1939	867	1802	1666	1666
	1940	1047	2188	2285	2033
	Ave.	957	1995	1976	1850
Non-Irrigated	1939	748	1723	1621	1485
	1940	918	1819	2149	1894
	Ave.	833	1771	1885	1690
General Average		895	1883	1930	1770

*Soil worked after plowing in the spring but not cultivated during the summer.

Date of Vine Cutting

Cutting vines at harvest time as compared with leaving the vines until late in the winter increased the per cent of dormant hills and weak plants and decreased the average yields per acre. These effects were particularly noticeable in the Late Cluster variety. In this variety during the 1940 season, the per cent of dormant and weak hills was increased by 69.9 per cent as determined by counts made on June 5 and the yield per acre was reduced 37 per cent by early vine cutting. Early vine cutting also increased the per cent of dormant and weak hills in both the Early Cluster and Fuggles varieties, and decreased yields somewhat in non-irrigated plots. Yields in these varieties were not reduced in irrigated plots. Data obtained in this experiment during the 1939 and 1940 seasons are given in Table 3.

Table III

Effect of Date of Vine Cutting Upon Yield, Dormant Hills and Weak Plants

		Irrigated				Non-irrigated			
		*% of Dormant and Weak	Yield - lbs. per acre			*% of Dormant and Weak	Yield - lbs. per acre		
Variety	Treatment	Plants	1939	1940	Ave.	Plants	1939	1940	Ave.
Late Cluster	Vines Cut at Harvest	82.4	1020	996	1008	100.0	884	612	748
	Vines Cut Late in Winter	12.5	1394	1564	1479	00.0	1360	959	1159
Early Cluster	Vines Cut at Harvest	82.4	1802	1119	1460	100.0	1564	993	1278
	Vines Cut Late in Winter	11.8	1530	1200	1365	00.0	1700	1136	1418
Fuggles	Vines Cut at Harvest	50.0	918	969	943	72.7	476	825	650
	Vines Cut Late in Winter	11.1	986	966	976	9.1	680	843	761

*Notes on dormant and weak hills taken June 5, 1940.

The counts on weak and dormant hills were made on June 5, 1940, and many of the hills that were weak or dormant at that date made considerable growth later in the season and produced fairly good yields. During the two-year period in which this experiment has been conducted, the yield has been reduced considerably more in the Late Cluster variety by early vine cuttings than in other varieties. Further studies are being undertaken for the purpose of determining, if possible, methods of reducing or eliminating the damage due to early vine

cutting. It is possible that this damage may be eliminated by the use of fertilizers or by variations in cultural practices such as less suckering and stripping. This problem will be a very important one as the use of hop picking machines becomes more general. The vines must be cut at harvest time when picked by machine and therefore it will be necessary to find some way of avoiding or lessening the damage due to early vine cutting.

Fertilizers

Increased yields have been obtained in the Late Cluster variety during the two-year period in which fertilizer trials have been conducted from the use of fertilizers containing nitrogen and phosphorus. Results have not been so pronounced in the early maturing varieties such as Early Cluster and Fuggles. Average yields in pounds per acre from fertilizer plots are given in Table 4.

Table IV

Average Yields in Pounds Per Acre of Various Fertilizer Treatments in Irrigated and Non-irrigated Plots of Three Varieties of Hops

Variety	Irrigation	Year	Check	Super-phos.	Treble-phos.	Cyanamid Fert.	Cyanamid Crown T.	Ammophos 11-48	Complete 9-39-9
Late Cluster		1939	1989	1972	2550	1530	1938	2618	1938
	Irrigated	1940	1869	2220	2333	2163	2043	1999	2577
	Non-irrigated	1939	1496	1156	1768	1156	1904	1972	1836
		1940	1360	1128	1332	1808	1781	1727	1496
Average for Variety			1679	1619	1996	1665	1920	2079	1962
Early Cluster		1939	1683	1836	1530	952	1122	1360	1700
	Irrigated	1940	1699	1408	1578	1258	1442	1452	1513
	Non-irrigated	1939	1190	680	884	748	1156	1496	884
		1940	1323	1027	1353	1496	1292	1550	1326
Average for Variety			1474	1238	1356	1114	1253	1465	1356
Fuggles		1939	1088	918	1360	782	782	1258	1122
	Irrigated	1940	779	783	955	760	829	983	803
	Non-irrigated	1939	1156	748	884	884	1020	1020	1156
		1940	830	632	653	836	857	687	843
Average for Variety			964	771	963	816	922	987	981
Average - all varieties			1372	1209	1438	1198	1365	1510	1443
% of check - all varieties			100	88	105	87	99	110	105

The fertilizers included in these trials, together with the approximate rate of application per acre were: superphosphate, 450 pounds per acre; treble phosphate, 180 pounds per acre; Ammo-Phos 11-48, 180 pounds per acre; complete 9-39-9, 225 pounds per acre; and Cyanamid both as a fertilizer and as a crown treatment, at the rate of 85 pounds per acre. The use of Cyanamid, both as a fertilizer applied in a ring around the hill and as a crown treatment spread in a circle completely covering the crown of the plant resulted in decreased yields during the 1939 season due to burning of the plants. The fertilizer was applied during the month of March, but there was not sufficient rain to take it into solution until the latter part of May. A rain at that time apparently gave the plants too much available nitrogen in a short period of time and caused severe burn. The burn continued to show up throughout the season and was very noticeable on the cones. The cones were so badly burned that no marketable hops were harvested from the Cyanamid plots, although the plots were picked so that yield records could be obtained. Cyanamid gave increased yields in the Late Cluster variety during the 1940 season. No burn was noted.

Results from the use of fertilizers have been rather variable to date but seem to indicate that increased yields may be expected from the use of nitrogen and phosphorus in the Late Cluster variety. Increases in yield in other varieties have been slight or lacking. In a few cases the application of fertilizers on Early Cluster and Fuggles varieties has apparently resulted in a slightly decreased yield, probably due to fertilizer burn.

A legume cover crop such as vetch or a mixture of grain and vetch should be used in connection with a fertilizer program. The results to date have been too variable to permit definite recommendations with regard to the commercial fertilizer mixtures.

Cover Crops

A number of different cover crops and cover crop mixtures are being used in experiments to determine which are best with regard to the amount of organic matter added to the soil and with regard to effect upon yield of hops. This experiment must be conducted over a long period of years to obtain the greatest benefit from it and to determine the effect of various cover crops upon the soil. Legume cover crops such as vetch are recommended if sufficient growth can be obtained from them. However, in some seasons the growth obtained from legumes is rather sparse by the time the cover crops must be plowed under in the spring. A mixture of barley and vetch or rye and vetch is suggested when sufficient growth cannot be obtained from legumes alone. A grain crop will not add nitrogen to the soil but is beneficial in that it adds organic matter.

Various clovers have been tried as cover crops in hop yards, but usually do not produce sufficient growth by plowing time. In some seasons, crimson clover makes a good cover crop, but it must be seeded early enough in the fall to make considerable growth before cold weather starts. Early seedings are often unsuccessful without irrigation as the soil is too dry to germinate the seed or a light shower may start germination and drouth may kill the seedlings later. If irrigation is available, it may be possible to seed legume crops early and irrigate to get them started.

Crowning and Pruning

Pruning alone, pruning and crowning lightly, and pruning and heavy crowning are being compared with no treatment. The term pruning, as used here, applies to the process of trimming all underground stems or sets away from the crown of the plant. The term crowning is used to indicate the cutting back of the crown which is a common practice among many hop growers. Results in field plots have been rather variable to date and no definite conclusions can be drawn as yet. This experiment must be carried on for a long period of time to determine the effect each treatment may have upon length of life of the plant and yields. There is some evidence to indicate that heavy crowning may increase root rot and hence decrease the length of life of the plant.

Suckering and Stripping

Plots in which no suckers are removed and the plants are not stripped are being compared with the standard practice of keeping the plants suckered and stripping to a height of three or four feet, and with suckering and stripping to a height of six to seven feet. Data obtained to date are somewhat variable, but the indications are that suckering and stripping, unless the plants are stripped to a considerable height, has little if any effect upon yields. Yields from the check plot have been practically the same as from plots that were not stripped or suckered.

Although data obtained to date indicate that suckering and light stripping do not increase the yields, the practice may be advisable as an aid in controlling diseases and insects. The amount of downy mildew has, in some cases, been found to be greater in plots in which the suckers were allowed to grow. The presence of suckers and lower leaves on the plants also increases the difficulty of controlling downy mildew and insects such as aphis and red spider, as the lower leaves are difficult to cover with spray or dust.

Number of Vines per Plant

The number of vines trained per plant in commercial hop yards varies from two to six although the more common practice in the Willamette Valley is to train four vines per plant, two per string. In these experiments, two, three, five and six vines per plants are being compared with four vines per plant, two strings per hill being used in all cases. Yields obtained from these plots have been rather variable, but the limited data available seem to indicate that under most conditions four vines per plant will give yields equal to or above other numbers. Six vines per plant have given slightly higher yields in irrigated plots of the Late Cluster variety, but there appears to be a tendency for the hops to be slightly more fluffy, probably due to the heavier mat of foliage on the drop wire and the consequent lack of sunlight.

Summary

Sprinkler irrigation has proven successful on Willamette Valley hop yards. Decided increases in yields have been obtained in four hop varieties in experimental plots from the use of irrigation. Average increases due to irrigation for a two-year period have been 27 per cent in the Late Cluster variety, 15 per cent in the Early Cluster variety, 23 per cent in the Fuggles variety, and 22 per cent in the Red Vine variety.

Experiments indicate that the sprinklers should be placed above the trellis when a high pressure sprinkling system is used. Low risers result in mechanical injury to the hop vines.

No damage resulted from the use of overhead sprinklers during the 1939 and 1940 seasons even when the water was applied during the hottest portion of the day.

A slight increase in downy mildew infection was found in the Early Cluster variety following one irrigation during the 1939 season. Downy mildew infection was not increased in other varieties and no increase was found even in the Early Cluster variety during the 1940 season following irrigation.

Light cultivations as often as necessary to keep weeds under control gave higher yields than deep cultivation or no cultivation.

Cutting vines at harvest time as compared with leaving the vines until late in the winter increased the per cent of dormant and weak hills and decreased the yield per acre. These effects were particularly noticeable in the Late Cluster variety.

Increased yields have been obtained in the Late Cluster variety during the two years in which fertilizer trials have been conducted from the use of fertilizers containing nitrogen and phosphorus. The use of cover crops such as vetch or barley and vetch is recommended in connection with a fertilizer program.

The long-time effects of various amounts of pruning and crowning are being studied.

Data obtained to date indicate that suckering and stripping has little, if any, effect upon yield, but may be a desirable practice in controlling diseases and insects.

The effect of training from two to six vines per plant is being studied. Present indications are that four vines per plant are best under most conditions.