AGRONOMIC STUDIES WITH HOPS

PROGRESS REPORT - JANUARY 1941

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Agronomic studies with hops were started in the spring of 1937 when legislative funds were made available for this work through House Bill 465. Funds were made available for the continuation of this work in 1939 through House Bill 496. The primary purpose of these experiments is to determine the effect of various cultural practices upon yields, quality, length of life of plants, downy mildew infestations and insect infestations 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 and roots were planted on approximately seven acres. The remaining three acres were planted in the springs of 1938 and 1939. One acre of this yard was placed at the disposal of the Entomology Department for insect control studies. The remainder of the yard is being used for agronomic experiments.

Irrigation

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 2 1/2 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, including depreciation on equipment, power and labor for moving pipe, was approximately $12.00 per acre.

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 per cent increase in yield obtained in other varieties were Early Cluster, 15 per cent; Fuggles, 23 per cent; and Red Vine, 22 per cent. Yields in pounds per acre from irrigated and non-irrigated plots are given in Table 1.

A high pressure sprinkler irrigating system capable of handling 30 acres was used in all irrigation experiments. The water was pumped from a 10 inch drilled well 35 feet deep. The total cost of the well and irrigation equipment amounted to $46.00 per acre, on the basis of a 30 acre capacity.

Table 1

Effect of Irrigation Upon Yield of Four Varieties of Hops

Variety	Yields in Pounds per Acre						Average Increase due to Irrigation	
	Irrigated			Non-irrigated				
	1939	1940	Ave.	1939	1940	Ave.	Lbs. per A.	%
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 plants and in poor distribution of water. 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. Some growers have thought that sprinkling during the middle of the day would cause water burn, but no evidence of burn has been obtained during the two seasons in which irrigation has been practiced in the experimental hop yard.

A slight increase in the amount of downy mildew infection was found following irrigation in the Early Cluster variety during the 1939 season. No immediate increase in mildew infection was found following irrigation during the 1940 season. Mildew notes were taken on all varieties before irrigation and a few days after irrigation and the amount of new infection in 1940 was found to be no greater in the irrigated plots than in non-irrigated plots. Data on the amount of infection before and after irrigation are given in Table 2.

Table 2

Relation of Downy Mildew Infection to Irrigation as Shown by the Average Number of Spikes Per Acre and the Per Cent of Infected Plants, 1940

Variety	Year	Date Irrigated	Date Notes Taken	Average No. Spikes per Acre		% of Infected Plants	
				Irrigated	Non-irrigated	Irrigated	Non-irrigated
Late Cluster	1939	7/11	7/10	3.5	7.0	3.5	6.1
			7/14	2.9	12.7	1.4	8.5
			7/24	10.6	4.2	6.4	2.8
			7/29	3.5	1.4	3.5	1.4
	1940	7/1 and 7/20	5/18	229.5	268.4	101.0	131.4
			5/23	267.1	513.6	195.3	309.6
			6/30	540.1	683.6	363.2	399.8
			7/8	8.7	15.7	9.3	10.9
			7/31	0.0	0.0	0.0	0.0
Early Cluster	1939	7/11	7/10	106.1	66.7	30.3	42.4
			7/14	31.8	30.3	16.7	12.1
			7/24	92.4	39.4	39.4	27.3
			7/29	15.2	3.0	12.1	3.0
	1940	7/1 and 7/20	5/18	297.5	316.8	125.9	160.6
			5/23	455.6	638.0	249.2	387.2
			6/30	643.2	783.2	353.8	455.4
			7/8	26.8	22.0	17.4	17.6
			7/31	0.0	0.0	0.0	0.0
*Fuggles	1940	7/1 and 7/20	5/18	2.7	13.2	8.0	11.0
			5/23	10.7	15.4	9.4	15.4
			6/30	167.5	79.2	143.4	74.8
			7/8	4.0	11.0	4.0	8.8
			7/31	0.0	0.0	0.0	0.0
Red Vine	1939	7/16	7/10	17.0	71.4	12.8	42.9
			7/19	10.6	57.1	6.4	14.4
			7/24	2.1	5.7	2.1	5.7
			7/29	0.0	2.9	0.0	2.9
	1940	7/1 and 7/20	5/21	39.7	20.5	27.2	17.2
			6/30	309.4	270.9	229.9	240.1
			7/8	0.0	0.0	2.1	0.0
			7/31	0.0	0.0	0.0	0.0

* No mildew found in the Fuggles variety in 1939.

Considerable cone infection developed near picking time in the Early Cluster, Late Cluster and Red Vine varieties and the infection was principally in one of the irrigated plots. This was thought, however, to be due to the location in the yard rather than to irrigation. The cone infection followed a slight dip in the yard quite closely and it was noted that during the nights and early morning fog often hung in this low spot while the remainder of the yard was clear. It seems unlikely that an irrigation during the latter part of July would increase the amount of mildew infection a month later although it is possible that the higher moisture content of the soil in the irrigated plots may have been a factor. Data on the losses due to cone infection of downy mildew are given in Table 3.

Table 3

Losses Due to Cone Infection of Downy Mildew in Irrigated and Non-Irrigated Plots(1) - 1940

(2)Variety	Date on which notes were taken	Irrigated		Non-irrigated	
		Ave. No. plants infected per acre	Ave. No. plants lost per acre	Ave. No. plants infected per acre	Ave. No. plants lost per acre
Early Cluster	8/26/40	104.5	59.9	8.8	1.1
Late Cluster	8/28/40	41.5	5.1	3.1	0.0
(3)Red Vine	9/20/40	453.5	128.3	313.7	109.8

(1) The large difference in losses between irrigated and non-irrigated plots are thought to be due to location in the yard rather than to increased infection caused by irrigation. See text.

(2) No cone infection was found in the Fuggles variety.

(3) Losses in the Red Vine variety occurred late in the season and were due to mold, downy mildew, and overripeness. It was impossible to determine the amount of loss due to each of these factors as all three were found on the same plants.

Cultivation

Light cultivation as often as needed to keep weeds under control gave higher yields during both the 1939 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, gave an average yield of 895 pounds per acre as compared with 1907 pounds per acre from light cultivation plots and 1770 pounds per acre from deep cultivated plots.

Table 4

The Effect of Various Amounts and Depths of Cultivation upon Yield per Acre in 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, the per cent of 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 plants

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 are given in Table 5.

Table 5

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

Variety	Treatment	Irrigated				Non-irrigated			
		% of dormant and weak plants	Yield - Lbs. per acre			% of dormant and weak plants	Yield - Lbs. per acre		
			1939	1940	Ave.		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	0.0	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	0.0	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

The counts on dormant and weak hills were made on June 5, 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 much more in the Late Cluster variety by early vine cutting than in

either the Early Cluster or Fuggles 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 practice. This problem will be a very important one if the use of hop picking machines becomes 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 cuttings.

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 treble phosphate, Ammo-Phos 11-48, and a complete fertilizer 9-39-9. Yields obtained so far from the use of Ammo-Phos and complete fertilizer have been practically the same, indicating that probably potash is not needed on this particular soil type at the present time. Increases in yield were obtained in both irrigated and non-irrigated plots. The results have not been so pronounced in the Early Cluster and Fuggles varieties. The average yields in pounds per acre from the fertilizer plots are given in Table 6. Yields are given in per cent of the check in Table 7.

Table 6

Average Yields in lbs. per Acre of Various Fertilizer Treatments in Irrigated and Non-irrigated Plots of 3 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	Irrigated	1939	1989	1972	2550	1530	1938	2618	1938
		1940	1869	2220	2333	2163	2043	1999	2577
		Ave.	1929	2096	2442	1847	1996	2309	2258
	Non-irrigated	1939	1496	1156	1768	1156	1904	1972	1836
		1940	1360	1128	1332	1808	1781	1727	1496
		Ave.	1428	1142	1550	1482	1843	1849	1666
Early Cluster	Irrigated	1939	1683	1836	1530	952	1122	1360	1700
		1940	1699	1408	1578	1258	1442	1452	1513
		Ave.	1691	1622	1554	1105	1282	1406	1607
	Non-irrigated	1939	1190	680	884	748	1156	1496	884
		1940	1323	1027	1353	1496	1292	1550	1326
		Ave.	1257	853	1158	1122	1224	1523	1105
Fuggles	Irrigated	1939	1088	918	1360	782	782	1258	1122
		1940	779	783	955	760	829	983	803
		Ave.	934	851	1158	771	806	1121	963
	Non-irrigated	1939	1156	748	884	884	1020	1020	1156
		1940	630	632	653	836	857	687	843
		Ave.	993	690	768	860	938	853	999

Table 7

Average Yields in Per Cent of the Check Plot 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	Irrigated	1939	100	99	128	77	97	132	97
		1940	100	119	125	116	109	107	138
		Ave.	100	109	127	96	103	120	117
	Non-irrigated	1939	100	117	118	77	127	132	123
		1940	100	83	98	133	131	127	110
		Ave.	100	100	109	104	129	129	117
Early Cluster	Irrigated	1939	100	109	91	57	67	81	101
		1940	100	83	93	74	85	86	89
		Ave.	100	96	92	68	76	83	95
	Non-irrigated	1939	100	57	74	63	97	126	74
		1940	100	78	102	113	98	117	100
		Ave.	100	68	92	89	97	121	88
Fuggles	Irrigated	1939	100	84	125	72	72	116	103
		1940	100	101	123	98	106	126	103
		Ave.	100	91	124	83	86	120	103
	Non-irrigated	1939	100	65	77	77	88	88	100
		1940	100	76	79	101	103	83	102
		Ave.	100	69	77	87	94	86	101

The fertilizers being tested, 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 the fact that considerable burning resulted. The burn was so severe on the leaves and the cones that no marketable hops were harvested from the Cyanamid plots although the plots were picked so that yield records could be obtained. During the 1940 season, Cyanamid increased yields in both irrigated and non-irrigated plots of the Late Cluster variety.

Results obtained to date in these fertilizer trials seem to indicate that increases in yields of from 100 to 300 pounds per acre may be expected in certain seasons from the use of fertilizers containing nitrogen and phosphorus. No increases in yield have been obtained from the use of potash on the river bottom soil of the experimental hop yard.

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 of the plant which is a common practice among many hop growers.

Yields from the plots in this experiment are given in Tables 8 and 9. The data in Table 8 are in pounds per acre and that in Table 9 in per cent of the check. Yields in the various plots vary considerably and no

definite conclusions can be drawn from the limited data now available. However, it seems likely from the evidence obtained so far that none of these treatments will prove better than the check treatment. The check plots were pruned and crowned lightly in much the same fashion as is now the practice among the majority of hop growers.

Table 8

Yields in Pounds per Acre of Various Crowning and Pruning Treatments in Irrigated and Non-Irrigated Plots

Variety	Irrigation	Year	Check pruned crowned lightly	Pruned-not crowned	Pruned-crowned heavily	Not pruned or crowned
Late Cluster	Irrigated	1939	2006	2652	1972	1394
		1940	1735	1459	1992	1819
		Ave.	1870	2055	1982	1606
	Non-irrigated	1939	1292	1360	952	1224
		1940	1094	1238	1238	1238
		Ave.	1193	1299	1095	1231
Early Cluster	Irrigated	1939	1700	1462	1938	1564
		1940	1467	1360	1530	1316
		Ave.	1583	1411	1734	1440
	Non-irrigated	1939	1666	1836	1292	1632
		1940	1248	1244	1142	1265
		Ave.	1457	1540	1216	1448
Fuggles	Irrigated	1939	1207	1224	1020	1360
		1940	974	697	836	915
		Ave.	1090	960	928	1137
	Non-irrigated	1939	952	748	748	1020
		1940	738	687	796	665
		Ave.	845	717	772	842
Grand Average			1340	1330	1288	1284

Table 9

Yield in Per Cent of Check Plot of Various Crowning and Pruning Treatments in Irrigated and Non-irrigated Plots

Variety	Irrigation	Year	Check pruned & crowned lightly	Pruned not crowned	Pruned crowned heavily	Not pruned or crowned
Late Cluster	Irrigated	1939	100	132	98	70
		1940	100	84	115	105
		Ave.	100	110	106	86
	Non-irrigated	1939	100	105	74	95
		1940	100	113	113	113
		Ave.	100	109	92	103
Early Cluster	Irrigated	1939	100	86	114	92
		1940	100	93	104	90
		Ave.	100	89	109	91
	Non-irrigated	1939	100	110	78	98
		1940	100	99	92	101
		Ave.	100	105	83	99
Fuggles	Irrigated	1939	100	101	85	113
		1940	100	72	86	94
		Ave.	100	88	85	104
	Non-irrigated	1939	100	79	79	107
		1940	100	93	108	90
		Ave.	100	85	91	99
Grand Average			100	99	96	96

Suckering and Stripping

Various amounts of suckering and stripping are being compared with the standard practice of keeping the plants suckered and stripping to a height of approximately three feet. The data obtained during the 1939 and 1940 seasons are somewhat variable but the indications are that suckering and stripping has little if any influence on yield. Yields from the check plots have been practically the same as from plots that were not stripped or suckered. The practice of stripping to a height of 6 to 7 feet has reduced yield somewhat in nearby plots in which this treatment has been used. Yields in pounds per acre and in per cent of the check are given in Tables 10 and 11.

Although data obtained to date indicate that suckering and light stripping do not increase yields, the practice may be advisable as an aid in controlling diseases and insects. Downy mildew infestation was higher in the plots in which suckers were allowed to grow and the lower leaves were not stripped off. However, during the 1939 and 1940 seasons, the increased mildew infection did not reduce yields, but it is possible that the results might be different in a bad mildew season.

Suckers around the base of the plant increase the difficulty of controlling insects such as aphids and red spider as it is difficult to cover the lower leaves with spray or dust. The insects left alive on the lower part of the plant will continue to multiply and in a short time after spraying the infestation in the upper portion of the plant is likely to be heavy enough to cause commercial damage.

The suckering and stripping problem is also closely tied up with the problem of early vine cutting. The use of picking machines necessitates early vine cutting. Early vine cutting will in some cases reduce the vigor of the plants and cut yields. There is some evidence to indicate that suckers left on the plant may reduce the amount of injury from early vine cutting. Hence it may be necessary to either find methods of controlling diseases and insects on the suckers or to develop other cultural methods of preventing injury due to early vine cutting. Further research on these problems is needed.

Table 10

The Effect of Various Suckering and Stripping Experiments upon Yield per Acre in Irrigated and Non-irrigated Plots

Variety	Irrigation	Year	*Check	Not stripped or suckered	Suckered not stripped	Stripped not suckered	Suckered-stripped to height of 6' to 7'
Late Cluster	Irrigated	1939	2193	2312	2414	2176	2040
		1940	1837	1697	1958	1843	1710
		Ave.	2015	2004	2186	2009	1875
	Non-irrigated	1939	1224	1224	1768	1224	1088
		1940	1108	952	986	1149	1278
		Ave.	1166	1088	1377	1186	1183
Early Cluster	Irrigated	1939	1249	1394	1700	1054	952
		1940	1476	1605	1462	1574	1537
		Ave.	1362	1499	1581	1314	1244
	Non-irrigated	1939	901	952	1020	816	612
		1940	1213	1136	1340	1068	911
		Ave.	1057	1044	1180	942	761
Fuggles	Irrigated	1939	748	884	850	714	680
		1940	846	758	785	925	766
		Ave.	797	821	817	814	723
	Non-irrigated	1939	527	544	544	340	408
		1940	481	381	415	415	415
		Ave.	504	462	479	377	411
Grand Average			1150	1153	1270	1107	1033

* Check plots were suckered and stripped to a height of approximately three feet.

Table 11

The Effect of Various Suckering and Stripping Experiments upon Yield in % of Check Plot in Irrigated and Non-Irrigated Plots

Variety	Irrigation	Year	*Check	Not stripped or suckered	Suckered not stripped	Stripped not suckered	Suckered stripped to height of 6' to 7'
Late Cluster	Irrigated	1939	100	105	110	99	93
		1940	100	92	107	100	93
		Ave.	100	99	108	100	93
	Non-irrigated	1939	100	100	144	100	89
		1940	100	86	89	104	115
		Ave.	100	93	118	102	101
Early Cluster	Irrigated	1939	100	112	136	84	76
		1940	100	109	99	107	104
		Ave.	100	110	116	96	91
	Non-irrigated	1939	100	106	113	91	68
		1940	100	94	110	88	75
		Ave.	100	99	112	89	72
Fuggles	Irrigated	1939	100	118	114	95	91
		1940	100	90	93	109	91
		Ave.	100	103	103	102	91
	Non-irrigated	1939	100	103	103	65	77
		1940	100	79	86	86	86
		Ave.	100	92	95	75	82
Grand Average			100	100	110	96	90

* Check plots were suckered and stripped to a height of approximately three feet.

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. In these experiments, two, three, five and six vines per plant are being compared with four vines per plant. Two strings were used per hill in all cases.

Yields during the two seasons in which these experiments have been conducted have varied considerably but from the limited data available it seems that under most conditions four vines per plant will give yields equal to or above other numbers. There is a slight indication that six vines per plant may give higher yields than four vines per plant in irrigated plots of the Late Cluster variety. However, the cones appeared to be slightly more fluffy in plots in which six vines were trained, probably due to the heavier mat of foliage on the drop wire and the consequent lack of sunlight. Yields in pounds per acre and in per cent of the check, four vines per plant, are given in Tables 12 and 13.

Table 12

Effect of Training Two to Six Vines per Plant upon Yield

Variety	Irrigation	Year	Yield - Pounds per acre (Check) 4 vines per plant	2 vines per plant	3 vines per plant	5 vines per plant	6 vines per plant
Late Cluster	Irrigated	1939	1530	1530	1598	1462	1904
		1940	1557	1380	1414	1557	1703
		Ave.	1543	1455	1506	1510	1803
	Non-irrigated	1939	1496	1360	1904	1224	1224
		1940	1200	1292	904	979	1061
		Ave.	1348	1326	1404	1101	1142
Early Cluster	Irrigated	1939	1224	1224	1122	1360	1258
		1940	1895	1506	1598	1792	1629
		Ave.	1559	1365	1360	1576	1443
	Non-irrigated	1939	1020	816	1020	1088	1156
		1940	1448	1129	1306	1564	1299
		Ave.	1234	972	1163	1326	1227
Fuggles	Irrigated	1939	782	782	816	782	680
		1940	789	782	670	765	755
		Ave.	785	782	743	773	717
	Non-irrigated	1939	476	476	340	476	476
		1940	506	313	415	428	408
		Ave.	491	394	377	452	442
Grand Average			1160	1049	1092	1123	1129

Table 13

Effect of Training Two to Six Vines per Plant upon Yield

Variety	Irrigation	Year	Yield - In Percent of Check (Check) 4 vines per plant	2 vines per plant	3 vines per plant	5 vines per plant	6 vines per plant
Late Cluster	Irrigated	1939	100	100	104	96	124
		1940	100	89	91	100	109
		Ave.	100	94	98	98	117
	Non-irrigated	1939	100	91	127	82	82
		1940	100	108	75	82	88
		Ave.	100	98	104	82	85
Early Cluster	Irrigated	1939	100	100	92	111	103
		1940	100	79	84	95	86
		Ave.	100	88	87	101	93
	Non-irrigated	1939	100	80	100	107	113
		1940	100	78	90	108	90
		Ave.	100	79	94	107	99
Fuggles	Irrigated	1939	100	100	104	100	87
		1940	100	99	85	97	96
		Ave.	100	100	95	98	91
	Non-irrigated	1939	100	100	71	100	100
		1940	100	62	82	85	81
		Ave.	100	80	77	92	90
Grand Average			100	90	94	97	97

Cover Crops

A number of different cover crops 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. It will be necessary to conduct the experiment over a period of several years before any definite conclusions can be drawn concerning the effect of the various cover crops on yield.

Legume crops would normally be expected to be the best as cover crops as they add nitrogen as well as organic matter to the soil. However, since hop yards are usually plowed in March or April, most legume crops will not produce enough organic matter. Legumes such as the clovers start growth late in the spring and in most seasons will produce little growth by the time the hop yard must be plowed. Good growth can be secured in some seasons from vetch but if the winter is severe, growth from vetch may be sparse at plowing time. Trials to date indicate that a greater amount of organic matter will be produced by a mixture of grain and vetch as the grain starts growth early in the spring. Both barley and vetch and rye and vetch have been found to be good combinations and are recommended. However, barley or rye and vetch may in favorable seasons produce more organic matter than will rot readily in droughty soils without irrigation. Considerable moisture and nitrates are required to rot the barley and if either is limited the hop plants may suffer and yields will be reduced. Under such conditions, a cover crop of vetch alone is recommended. Yield of hops in pounds per acre from the cover crop experiment plots are given in Table 14.

Table 14

Yields in Pounds per Acre from Plots on which Various Cover Crops Are Grown

Cover crop	Irrigated			Non-irrigated			Grand average	Cover crop yields - 1939 Dry wt. lbs. per Acre
	1939	1940	Ave.	1939	1940	Ave.		
Natural	2295	2135	2215	1598	1081	1340	1777	2952
Vetch	2244	1867	2056	1700	1149	1425	1740	2420
Crimson clover	1785	1931	1808	1802	1231	1517	1622	3872
Barley	1836	1710	1773	1870	1176	1523	1648	2920
Barley, peas & vetch	2108	2020	2064	2006	1414	1710	1887	3291
Barley and peas	2154	2302	2228	2004	1217	1611	1919	2646
Rye	1615	1870	1743	1564	1190	1377	1560	4291
Rye and vetch	1547	2220	1884	1700	1564	1632	1758	4840
Rye and peas	-	2530	-	-	1720	-	2125	-
Rye, peas & vetch	-	1938	-	-	1537	-	1738	-
Peas	-	2237	-	-	1748	-	1993	-
Turnips	-	2326	-	-	1870	-	2098	-
Barley and vetch	2142	2023	2083	1394	1992	1693	1888	4759